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THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Volume 39, January—December, 1917

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frontispiece

IRA NELSON HOLLIS
PRESIDENT 1917
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

THE JOURNAL OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Volume 39 January 1917 Number 1

THE ANNUAL MEETING

THE thirty-seventh Annual Meeting of The American Society of Mechanical Engineers, held in the Engineering Societies Building, New York, December 5 to 8, 1916, was the successful culmination of a year conspicuous in the annals of the Society because of the remarkable growth and the broad development of the varied activities of the organization during that period.

Outstanding features of the meeting were the record attendance, the unusually complete program arranged by the Committee on Meetings, and the spirit of coöperation which pervaded the whole proceedings and which rendered this meeting the most democratic which the Society has held.

The total registration was 1868, of which 953 were members and 915 were guests; the registration of members represented one in every eight in the entire membership. The total registration exceeded that of last year by 431 and showed an attendance from all sections of the United States.

This year, for the first time, as a result of the alterations and improvements in the Engineering Societies Building, it was possible to hold all the professional and social events of the meeting in the building. The social functions were simple in their nature, there was no charge for any of them, and the attendance was correspondingly large and representative. This situation served more than anything else to offset the usual conditions at big conventions that those who attend do not have a chance to get well acquainted. This feature of acquaintanceship, the encouragement of which has been one of the main purposes of the Annual Meetings, has now been developed to a degree which makes attendance at these gatherings immeasurably worth while.

> *"We have a duty clearly laid before us by William James when he writes, 'The martial type of character can be bred without war. Strenuous honor and disinterestedness abound elsewhere and we should all feel some degree of it imperative if we were conscious of our work as an obligatory service to the state.'*
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> *"That is our motto and that is what we must strive toward during the coming year and for all time, as we must pass on into the higher atmosphere of goodwill, service and co-operation in order that our profession may take its place alongside of the science of Preventive Medicine, as one of the two constructive agencies in human life. It will not be enough that we remain simply conscious of the high mission of our profession. We must serve as soldiers of peace in a country prepared to defend its homes."*
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> *IRA N. HOLLIS, in accepting the Presidency of The American Society of Mechanical Engineers.*

As expressed by E. J. Prindle, Chairman of the Entertainment Committee, in presiding at the smoker on Wednesday evening of the Annual Meeting, everyone was requested to "consider that the fellow on your right hand is modest and would like to know you; and that the fellow on your left hand is interesting and well worth talking to." This sentiment admirably voices the evident feelings of those who came to the convention and is one to which all apparently responded in the most cordial manner.

As at recent meetings, there were delegates from most of the local Sections, sixteen of the twenty being represented at this meeting. Several conferences of these delegates were held, which were productive of numerous suggestions that will be helpful to the Sections and to the Society generally. More and more, the influence of the local Sections is being felt. They already play a major part in the conduct of the Society. They are representative of the Society's membership, covering as they do the whole expanse of the country. They include all shades of opinion. Because of these strong local affiliations they are influential factors in their communities, and are developing coöperation in the engineering profession.

A wealth of experience was contributed at the twelve professional sessions held during the meeting, at which 36 papers were presented. Several of these sessions were in charge of committees or sub-committees and five of the papers were contributed by local Sections, having previously been read at Section meetings and because of their exceptional value assigned also to the Annual Meeting. Two committee reports were considered and the public hearings of the Boiler Code Committee continued the professional meetings until Saturday.

PRESIDENTIAL ADDRESS AND ELECTION

The meeting was opened on Tuesday evening, December 5, in the auditorium of the Engineering Societies Building with the presidential address by Dr. D. S. Jacobus, on Education in Engineering. In his presentation of this subject, Dr. Jacobus analyzed, in the light of his twenty years' experience as a teacher of engineering subjects and his ten years' acquaintanceship with the practical side of the engineering profession, the fundamental requirements in education of an engineer and reviewed his own suggestions for attaining the best results. The full text of the address follows this brief introductory account of the convention.

After the address, the Tellers of Election of Officers reported the result of the balloting as follows:

Total Votes Cast	2261
Thrown out defective ballots	1
Valid ballots counted	2260
For President:	
IRA N. HOLLIS	2259
Scattering	1
For Vice-Presidents:	
CHARLES H. BENJAMIN	2253
ARTHUR M. GREENE, JR.	2253
CHARLES T. PLUNKETT	2255
Scattering	7
For Managers:	
ROBERT H. FERNALD	2256
WILLIAM B. GREGORY	2256
C. R. WEYMOUTH	2255
Scattering	1
For Treasurer:	
WILLIAM H. WILEY	2260

The newly-elected President, Dr. Ira N. Hollis, President of Worcester Polytechnic Institute, was escorted to the platform and in accepting his election spoke as follows:

"MR. PRESIDENT, I thank the Society for having elected me president to serve during the coming year. Entirely apart from the high honor which you have conferred upon me, I accept the office as a serious duty and as a great opportunity for service. That word alone expresses what should be the motive behind the actions of every citizen of our Republic and especially of every engineer who is charged with tasks involving the safety and well-being of his countrymen.

"This is not the occasion for a long address from me, but I cannot refrain from just a few words on what I conceive to be the fundamental relation of our profession to society. We have for years worked honestly as individuals who long for the success, comfort and beauty of every American city. Now, we are at the dawn of a consciousness of our place and our duty as an association in which every member is eager to coöperate with every other members to the greater glory of our country.

"There are two thoughts that lie in the subconsciousness of every engineer. They are brought out in one sentence of 'The World Set Free' by H. G. Wells, and in the whole tenor of an essay by William James on the 'Moral Equivalent of War.' In the first sentence of Mr. Wells' book, he expresses the underlying force that has made man a civilized, reasonable being. 'The history of mankind is the history of the attainment to external power'; that is, to the use of energy external to man's body. Somewhere behind every great human problem lies the work of the engineer. Our country is a perfect example of this in its evolution from a few colonies with imperfect means of communication into the United States of America. A history of the great inventions and the changes wrought by the applications of science will some day reveal the potent influence of our profession upon every department of national life. What made the great slaveholding states possible? The Cotton Gin. What, therefore, created the whole atmosphere of political discussion during sixty years of the nineteenth century and finally plunged us into a great war? The Cotton Gin. What again saved the Union and welded it into one country from coast to coast? The railroads. We can name few of the questions before Congress that do not in origin or in their solution depend in some way upon the engineer. That is the complete justification of Mr. Wells' statement and of our existence as a society of engineers.

"We have a duty clearly laid before us by William James when he writes, 'The martial type of character can be bred without war. Strenuous honor and disinterestedness abound elsewhere and we should all feel some degree of it imperative if we were conscious of our work as an obligatory service to the state.' That is our motto and that is what we must strive toward during the coming year and for all time, as we must pass on into the higher atmosphere of goodwill, service and coöperation in order that our profession may take its place alongside of the science of Preventive Medicine, as one of the two constructive agencies in human life. It will not be enough that we remain simply conscious of the high mission of our profession. We must serve as soldiers of peace in a country prepared to defend its homes."

The remarks of Dr. Hollis indicate that the efforts of the Society for the coming year will be in the direction of public service; or, as he expressed it, that the motto will be "service to the state."

The President's Reception, which followed the exercises in the auditorium, was held this year on the remodeled and spacious fifth floor of the building, the large halls of which are now connected by three doorways 12 ft. wide. The brilliantly illuminated rooms were most attractive with their decorations.

OUTLINE OF MEETING

As usual, the business meeting and first professional sessions occurred on Wednesday morning. At exactly 12.30 o'clock, the sessions were brought to a close in order to honor the memory of John E. Sweet, the beloved founder of the Society, whose keen personality and simplicity of manner will long endure in the minds of all who knew him. A most fitting address was made by one of his older friends, Past-President Worcester R. Warner, and brief remarks were also made by Capt. Robert W. Hunt and by Dean Albert W. Smith, of Sibley College. Mr. John H. Barr, one of "Sweet's Boys," presided.

On Wednesday afternoon no less than four varied sessions were held simultaneously. On Thursday, attention was concentrated on the subject of Industrial Valuation for which an all-day meeting had been arranged. No other sessions than this were held in the morning, but in the afternoon there was a well-attended meeting in charge of the Gas Power Sub-Committee.

Friday ended the professional sessions with meetings in charge of the Railroad Sub-Committee and the Boiler Code Committee, besides one Miscellaneous Session at which a remarkably strong paper was given by W. L. Cathcart on the Development of our Fleet and Naval Stations.

In the afternoon of Friday, the public hearing of the Boiler Code Committee began, which continued on Saturday. The work of this Committee is increasing in importance and effectiveness and its accomplishments bid fair to be among the most enduring works of the Society.

On Friday evening, many of the college men who had been in attendance, attended banquets of their own institutions and joined in what has become an annual event for the alumni of several of the colleges or universities which have engineering courses.

The success of this, the largest and in many respects the best Annual Meeting which the Society has ever held, is due to the untiring efforts of the many committees actually engaged in its conduct. The convention as a whole was in charge of the Committee on Meetings, H. L. Gantt, chairman; and the entertainment in charge of the New York Section Committee, H. R. Cobleigh, chairman, with E. J. Prindle as chairman of the sub-committee on entertainment. The President's Reception was under the direction of the House Committee, William N. Dickinson, chairman. The welfare of the ladies was carefully provided for by the Ladies' Committee, Mrs. Herbert Gray Torrey, chairman.

ENTERTAINMENT FEATURES

Many of the New York members willingly assisted in the reception of out-of-town members and in making everyone acquainted through the organization of the President's Reception and Acquaintanceship Committees. The excursions were planned by a committee for that purpose, J. H. Norris, chairman.

The plan, instituted last year, of a Smoker on Wednesday evening of the convention was again followed with unqualified success. Like most of the other social affairs, it was held on the fifth floor and it was attended by about 750 who enjoyed the evening to the fullest extent. In a talk upon his experiences during a trip to Europe since the beginning of hostilities, Frank B. Gilbreth had his audience with him from beginning to end and withal made comments upon the situation which deserved serious thought.

On Thursday evening, the members and their friends assembled in the auditorium to listen to the symposium which had been arranged by the New York Section Committee on the subject of Aviation. There were four prominent speakers. Following the lecture those who desired went to the fifth floor to participate in the dancing and refreshments were served there as well as on the eleventh floor in the Society's rooms. The whole affair, while in a marked contrast to the more elaborate functions which have heretofore been held at the Hotel Astor or elsewhere, was pleasing to all who attended because of its simplicity and the fact that the chief reason for attending was the opportunity which it gave to meet other friends of the Society, and their friends.

Excursions were arranged for Wednesday, Thursday and Friday to several points of interest in New York and vicinity, and the plan, followed last year so successfully, of having comparatively few excursions, but trips of unusual interest, was again adopted. There were eight excursions, an account of which appears in the Society Affairs section of this number. Several of these were of interest to the ladies as well as to the men.

Not the least pleasing of the social occasions of the meeting was the tea served by the New York ladies in the Society's rooms on Wednesday afternoon, where at the close of the professional sessions many members were received.

PUBLICATION OF PAPERS

Most of the papers presented at the Annual Meeting have already appeared in the November and December issues of The Journal. In this issue will be found a comprehensive account of the discussion given at the various sessions and in the Society Affairs Section a further account of the entertainment features, excursions, etc. Papers which have not already appeared in The Journal will be published in comprehensive abstract form in early issues.

EDUCATION IN ENGINEERING

Presidential Address, 1916

By DR. D. S. JACOBUS

So much has been said and written of late about education that it might seem too worn a topic to bring before our Society, but having been a teacher of engineering subjects for over twenty years, and having for over ten years since that time been employed in what some are pleased to call the practical side of the engineering profession as distinguished from the teaching side, I feel qualified to pass judgment on certain features and trust you will bear with me if what I say seems more or less elementary.

Let us start with the professor—and let me say here that once a professor always a professor, provided one has felt the joy that goes with being in close touch with his students and in knowing that there is a mutual understanding and trust. Some are apt to class the professor as an impractical individual whose principal joy in life is to dream and idle away the long summer vacations, while others give him what is more nearly his just due. Let us look back on our own professors, those who taught us, and see what led to our respect and what qualities we would now regard as the most important. I feel sure most of us would not depart very far from the judgment of those who responded respecting the list which was prepared by the Carnegie Foundation for the Advancement of Teaching as the essential factors desirable in young engineers. The order of importance based on the replies received is as follows:

1 Character, integrity, responsibility, resourcefulness, initiative.
2 Judgment, common sense, scientific attitude, perspective.
3 Efficiency, thoroughness, accuracy, industry.
4 Understanding of men, executive ability.
5 Knowledge of the fundamentals of engineering science.
6 Technique of practice and of business.

As we grow older we see that the personality of the men more than any other quality left its lasting stamp, and that

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it is this more than anything else that causes us to look back with kindness and affection to our college days. Character is the first on the Carnegie list, and this as well as many other qualities that are to an extent independent of the course of study precede those that relate to the technical side of the course. In the discussion of engineering education the details of the courses are apt to be given undue weight, which is a grave mistake. System can never take the place of personality, and a given course that would be a success when taught by the right men might be a failure if taught by others.

Let us analyze the factors in the Carnegie list. First of all it is apparent that most of them apply to any profession and that they are not limited to engineering. Again, it might appear that one should succeed in a profession if he possesses the first factors in the list, even though he may not possess those included in the last two items. It would be a dangerous conclusion for a young man to feel that his success is assured if he has character and the other qualities which come near the head of the list, and that it is not necessary for him to have thorough knowledge of the technique of his profession. Such an unfortunate would soon find that the ethical qualities alone will not earn his bread and butter, and that a lack of knowledge in his profession will be an immense handicap.

What are the particular elements that spell success for a young engineer in addition to the elements that are common to all professions? Dear Uncle John Fritz once said that he could tell whether a young lad would be apt to succeed by watching him unobserved when sweeping a sidewalk. Yes! and we will all agree that much depends on what is in the lad. Eckley B. Coxe talked with me earnestly in the good old days as to what he considered the failure of some colleges to secure the right timber in their graduates. He compared the ordinary system of examinations to riddling the men through a series of sieves and throwing out the unfortunate fellow who had peculiarities that made it impossible for him to pass through the mathematical or other sieve. Mr. Coxe was a firm believer that there is a "something" required in the making of an engineer which cannot be gaged by an ordinary examination, and I remember well that he told me he employed some highly paid men who did not know an integral sign from a dollar mark, and that he knew of others classed as the best of graduates he would rather pay high salaries to keep out of, than in, his organization. What is the "something?" What is it that the old-time superintendent has in mind as he shakes his head sadly when asked how some young graduate is progressing. The lad may have character, judgment, and perhaps everything in the Carnegie list, or at least he may think he has, and yet our old-time friend, often from the land of the heather, knows there is something lacking. And we ask again, what is this "something"?

Would that I could define the "something." It includes such qualities as:

Taking a personal interest in one's work
Amenability to discipline
Perseverance under adverse circumstances
Cheerfulness and amity—the human side.

None of these appear separately in the Carnegie list.

Let us analyze these qualities. It will be seen that possibly a lad from a grammar school would be as likely to possess them as the college man. If this is so, then there is a lack in this side of the college training, and it is here that we should improve. Consider the first: "Taking an interest in one's work." In this the college man often fails. I have known of cases where on being censured for lack of accuracy the college man said that he could not take enough interest in the work as it was not up to his capabilities and could be done by any office boy; and often a bright office boy would pass him. The young man to succeed must take such an interest in his work that he will take pride in doing it in the very best way, be it what it may. He should be determined to hang on until the finish. The man who has an engagement that calls him away when he is asked to help in an emergency, seldom wins. The practical foreman will often keep the young college man he is trying out on monotonous work to determine his staying powers. Industry is given as an essential in the Carnegie list, but the determination and staying powers that count for success include more than simple industry. The man must be more than industrious; he must not only work hard and continuously, but be so interested in his work that he feels a personal responsibility in it. Further, the "industry" should be of the sort that is not governed by the clock, but which calls for many nights of labor, either in home study or in the field. Success is the fruit of hard labor achieved through the building up of many things into a grand and harmonious whole. The Good Book speaks of time-servers and those who work from the heart; there is no better criterion to distinguish between one who will fail and one who should succeed.

The second is "amenability to discipline." There is a lesser importance assigned to this than there should be in other as well as in teaching lines. The old-time preceptor with his hickory rod or stout ruler was but carrying out the home discipline where the word *obey* carried its full force. Perhaps the wave will change to bring back the good features of the old *régime*,—let us hope so. We certainly can and are doing much in our colleges to teach respect for authority and obedience to rules, but we should do more; let us not overlook this most important part of an engineer's equipment, and emphasize the importance of his being governed by these principles in the field.

The third is "perseverance under adverse circumstances," and the fourth, "cheerfulness and amity." The most unfortunate frame of mind a young engineer can get into is to feel that everyone is against him and that his efforts are not appreciated. I have often told the young men that those who select them take a pride in seeing them succeed. Believing a thing is so may often make it so, therefore the young man should encourage cheerful beliefs. To succeed, one should make friends of those about him. There is no surer way of making a man an enemy than to mistrust him. Great things can as a rule be done only through coöperation, and in the broad analysis the human side has much to do with success. "Study your man as well as the job" is a good motto to follow, but with it should be coupled a perseverance and cheerfulness that will induce the man to study you.

In applying for a position the young graduate will often injure his cause by inquiring too minutely respecting the prospect of advancement. Again, after being employed he may have the idea that in view of his special training his work should be in line with developing this training and that he should be given a certain preference over an untrained man. Such an attitude is bound to lead to discontent and misunderstanding. I have advised graduates many times to "size up" their chances before applying for positions and not to talk prospects, and have further impressed on them that they must enter the outside world on an even basis with their co-workers, and that any advantages they secure through education must come through the ability this education gives them to do better work than the others.

Having thus briefly reviewed the qualities necessary in an

engineer, let us consider the student. How can we bring out those qualities which we all agree are the most important. Character can best be taught by example, and the teacher must serve as an inspiration and guide. To teach effectively one must be a master of his subject, and this applies particularly to those qualities placed near the head of the Carnegie list.

We hear and read much respecting teaching methods. Methods are not all: the spirit which unconsciously develops is a most vital factor. I cannot fail to observe that there has been a great change in one respect since I was a boy. In my school days a failure to acquire a subject was laid to the student; now there is a tendency to lay it to the teacher. Much of this is due to the attitude of the parents. A fond mother once told me she thought it strange that no teacher could be found capable of teaching her boy mathematics, not realizing that she herself might be the greatest stumbling block through transmitting the idea that the fault lay anywhere else than with her son. A way never has and never will be found to acquire knowledge without study, and much of the trouble experienced by some students arises through a lack of study or a failure to appreciate the fact that the fault is their own.

Where the teacher is often at fault is in his failure to train the lad to study in a proper way. To memorize is the lowest form of study, and much of our present system may be justly criticised in this respect. A certain amount of memorizing is essential to "train the mind," as those who taught us used to say, but there is much in the doctrine expressed by that lovable professor, John E. Sweet, in the words, "What is the use of teaching a man a mass of material he is bound to forget?" We should develop initiative and encourage originality, and this cannot be done through memorizing or through any fixed course. It is here that a teacher who is worthy of his calling excels one who takes the easiest way. There is an easiest way in teaching just as there is an easiest way in studying, and both spell lost time and lost opportunities. The easiest way in teaching is to follow a beaten course and rely on the recitations and routine examinations in grading the men. To preserve the standard it is appreciated that the weaker men should be weeded out, and by so regulating the course that the weaker men fall by the wayside it might appear that the brighter men will remain and that there will be a "survival of the fittest." Such a course is fraught with the gravest dangers, as some of the best men may be dropped or may leave through being discouraged, and the college, though it may do good to many, may also do untold harm. Again, those who remain and graduate may have highly trained memories with little initiative and power of reasoning. The right way is for the professor to know the individual characteristics of each of his students and to be governed by this in deciding a case. Often if he can get at the root of a special difficulty it can be cleared away and there will be no further trouble. Still, there are cases where the student does not have an aptitude or liking for engineering, and in such instances it is a kindness to start him in some other line of work.

To accomplish the best results the course should be so laid out that there will be the right amount of time for rest and recreation. The student should be encouraged to spend a proper amount of time in outdoor exercise. A healthy and clean body is indispensable for a healthy mind and is even more to be desired than a trained mind. Just as soon as a course becomes so crowded that there is no time for anything but work and study, it will lose in efficiency, as there will then be no time for daily relaxation of the mind and for properly developing initiative. To obtain the best results the student must work enthusiastically and cheerfully, and if the course is such that he is constantly on the anxious seat, his perspective will become shortened and he will work at a disadvantage. We should train the student to work in the same way that he should work after his graduation. It is often remarked that students working their way through college stand surprisingly well, considering the amount of time available for study. We all agree that the man who does this has determination that makes him bound to succeed, but it is this determination that leads to a proper method of study and the clearing of his mind through thinking at times of entirely different subjects than his studies that makes his brain keen and quick. The students should be encouraged to occupy their spare time in some congenial way; there is nothing better than a good, healthy fad. But, it is asked, how shall we know that the spare time is used to advantage, and would it not be best to completely fill every hour of the day and thus, as some have said, keep the boy out of mischief? It is here that the human side of the professor must be brought into play, and to properly apply this side he must know his pupil and know him well. The classes must not be so large that it is impossible to obtain the intimate personal relation which is indispensable.

Recitations and examinations should be so conducted as to bring out more than can be memorized and to take into account the widely varying factors of temperament. It is far easier to lead and have the students follow than to call for initiative and guide them back if they depart from the right path, but the easiest way results mainly in training the memory, whereas the other includes the developing of qualities that are most apt to lead to success.

To teach engineering efficiently the professor should have practical experience. Sometimes this is acquired before the professor begins his career as a teacher; in most cases, however, the professor undertakes practical work in connection with his college duties. To secure the best results where the professor undertakes practical engineering work, the roster should be so arranged that certain of the professors dealing with the more practical engineering lines are given latitude in meeting the classes. One must not be misled into the idea that if a certain latitude is provided it will be an easy matter for the professor to undertake this work. He will find that to accomplish results he must often work night after night, as well as through the vacation periods, and unless he is willing to do this it is folly for him to endeavor to gain practical experience and a reputation in this way.

There is no enterprise that will reflect more credit on a college than undertaking properly conducted experimental investigations, especially if those suitable for the purpose are made the basis of papers presented to engineering societies or published in the technical press. The making of experiments and the issuance of reports carry with them grave dangers, in that there may be a tendency to do work for which the professor has not the proper capacity, and reports may be made that will throw discredit on his college. A professor should not be permitted to endorse commodities where the idea is simply to obtain his name, or worse than this, his name in connection with his college, for use in advertising matter; nor should he allow his name to be used in tests which may be of more value to the promoter than to the engineering profession. Above all, he must be careful in his reports and in his testimony as an expert not to bring discredit to his profession and his college by departing a hair's-breadth from the truth or by testifying in a way which will evade the truth. There is danger in any enterprise where responsibility is assumed, and here as in all other such enterprises success or failure is dependent

on the organization and character of the men. A great advantage, aside from efficiency in teaching, of having professors in close touch with the outside world, is that such professors can place many of the graduates in positions for which they are especially fitted. This naturally can only be done where the professor, in addition to having a large acquaintance in the practical field, also comes into intimate contact with the students so as to know their individual peculiarities and characteristics.

Let us now consider the broad aspect of education. "We live to learn" applies most truly to the engineering profession. We must continue to study and learn as long as we hope to be active and advance in our profession. Just as soon as one reaches a point where he does not appreciate the value of other people's views, just so soon will he come to a standstill. It has been truly said that a big man will take most kindly to suggestions and that only the little man will resent them. We learn from day to day and soon appreciate the fact that time spent at school is but the beginning of a lifelong course. How does the school course assist us, and what should it include to be of most use? How long a course should it be, and should we send our sons to college? In the replies respecting the Carnegie qualifications, knowledge of the fundamentals of engineering science and technique of practice and of business were placed at the end of the list. If the judgment of those who responded is correct, are we not taking too much valuable time for such training, and would it not be just as well to shorten the college course? It is an open question whether much could not be eliminated from the college course to advantage, provided special attention is given to teaching the fundamentals. Once thoroughly mastered, the student will always carry with him the fundamentals of physics and mechanics, whereas much that relates to special applications will soon be forgotten. Again, the college should graduate its men young enough to preserve the adaptability of mind which the younger man possesses to a far greater degree than an older. If the assumption is made that the fundamentals are thoroughly mastered and the student graduated a year in advance of what he would be should he study along a number of specialized lines, most of those who employ graduates would favor the younger man with a keen knowledge of the fundamentals to the older man with what might be a lesser knowledge of the fundamentals and more knowledge of specialized lines. The question of whether the school course should be shortened depends on how it is shortened. Shortening the time spent in college may not shorten the course of study as a whole.

As far as can be determined from statistics, the average age of graduation from college has not changed appreciably during the past century, being somewhat over twenty-one and a half years. It would therefore seem that, irrespective of what is taught, there are elements entering a college course which have led to men graduating at about this age. I believe it advisable to have a four-year college course, but I would make the entrance requirements and the course such that the students would be graduated at as early an age as has been and is the current practice.

I have taken the stand and firmly believe that our present entrance requirements do not accurately gage the ability of an applicant, and that it is a mistake to make the entrance requirements too high for an engineering college. High technical requirements may result in the preparatory schools specializing along narrow lines in an endeavor to have the student enter college at an early age, to the sacrifice of a broader education. Again, high technical requirements discourage those who have worked in machine shops and the like and later on desire to enter a college. I have watched and encouraged such men and appreciate how hard it is for them to bring their minds back to the different studies; still, once these men get the right hold, they make the best of students and later the best of engineers. Where I have expressed this view the question has been asked, "How can we select men for the colleges if we do not rely on examinations, and how can we secure as good men with lower requirements as with higher requirements?" My reply has been that, in addition to the examinations, each and every applicant should be met by a board, and all of the circumstances connected with his case considered. Further, the examinations should be given in a way that will bring out the reasoning powers of the students, which can be accomplished if each man is given an oral examination of some length. Here again we have the harder against the easier way, but I am firmly of the opinion that there is no easy way of doing good teaching.

There can be no doubt that for many classes of engineering work much in the average college course is not needed. In certain instances we might well give over some of the time spent in specializing to teaching the fundamentals, with enough application to secure a thorough drill and to give the students confidence in their ability to solve practical problems. Fundamentals can be thoroughly mastered only through application. Further, it has been my experience that in training the average mind the fundamentals must be approached from different viewpoints, and that there is a great advantage in several teachers presenting subjects requiring the fundamentals to be applied in various ways. A student may memorize all definitions and be able to solve certain problems in a routine way, but on viewing a principle from another angle from the one to which he is accustomed he may be completely at sea.

The aim in teaching should be to produce a man who will be the most useful to his fellow-men and to his country. Just as we give, so we receive. The fruit of usefulness is achievement, and the building up of achievement, success. We should above all consider the human side and aim to produce a broad man with spirit and determination. It is my firm belief that in many cases we could produce graduates who would more nearly meet our ideals by cutting out much from the present courses of study and by teaching more thoroughly matter already in the courses. The course should be broad enough to include some of the so-called cultural studies, and it further should deal with the business side of the profession. Dr. Alexander C. Humphreys was the first to introduce a regular course of economics in an engineering college, the course including accounting, depreciation, shop cost, law of contracts, specifications, appraisals and business methods in general. As an illustration of matter already in the course that it would be well to teach more thoroughly, I can refer to the writing of concise and logical reports in good English. To this might be added speaking on one's feet before a meeting.

To really know a thing one must have more than an abstract knowledge. Much can be gained by having the students make or witness experiments which verify or illustrate the principles. What a student does with his hands in connection with his head he remembers far better than knowledge which he has obtained from text-books or lectures. The courses in departments having laboratories should be so arranged that work in the laboratories is given in parallel with the work in the class room. There must be close coöperation between the departments, with this end in view. It was a part of my pleasant duty when teaching to review the fundamentals after they had been taught by others. Good results came through the use of

apparatus to illustrate the principles and in giving the students practice in the solution of many problems in which the principles had to be viewed from different standpoints. That the apparatus helped was evidenced many times by the students sketching out the principles as applied to the experiments before they applied them to a problem, which showed that they carried the principles through a visual recollection of the experiments. Again, the principles were applied over and over again in laboratory experiments. To thoroughly master principles the hand, sight, and mind must be brought into intimate harmony and brought into harmony many times, and unless this is done the student will not have an understanding that will make the principles dependable working tools.

Instructions for laboratory practice are often so complete that the students are led to such an extent that there is a failure to call for the proper amount of initiative. This may or may not be so with a given set of instructions, all depending on the way in which the teacher presents the subject. He may often economize much time by using properly prepared notes, and he may train the initiative by inspiring the students to follow up the details and bearing of the experiments. Special exercises where the students are required to determine certain quantities without the use of any instructions, either oral or written, or with few instructions, form a most useful adjunct, but here again all depends on the way in which the subject is presented. Too much should not be done in setting up laboratory apparatus for the students. The men should be encouraged to ask questions; where questions are not asked it is a sign that something is wrong with the method or the teacher.

Laboratory exercises form a useful basis for practice in writing reports. The best results are secured by returning all reports with carefully marked criticisms, and requiring the student to rewrite those that do not come up to the standard. It may often require two or three or even more rewritings to make a report readable, but if this method is followed up conscientiously it will result in vast improvement. Here again the method is not the easiest one. A lack of proper examination of reports soon results in a falling off in interest and in the effort of the student. There is nothing more discouraging to a student than to have his work carelessly examined, and in good teaching much time must be spent on this part of the work.

As to education in general, we all agree that our sons should be trained along well-balanced courses. The shop foreman who received only a grammar-school education will send his son to college, for he knows what it means to be handicapped through lack of training, and how hard it is to make up for that lack of training by studying at nights later in life after long working days; as study he must to keep in the race with the college-trained man. In many instances where I have worked long enough with the men at a plant to really know them, it has been touching to find how many, especially the older ones, appreciate the fact that they have lost their opportunities. Many a time such men have come to me and said that I should make it my duty to warn young men to get an education. Yet many of these men had all the qualifications in the Carnegie list except the two items which those discussing the list have classed as the least important. One does not have to turn to the successful man to find character; many a man who has missed his chance has noble qualities and is a prince at heart. We should not therefore belittle these two items, even though we agree on the importance of those that precede them, for their lack has led many a man to failure.

One of the greatest pleasures of the professor is to watch the progress of those he knew so well after they leave him. It is indeed interesting to see the boy in the man, for although his students may grow old, there are still the same traits and peculiarities. The professor has a grave responsibility in that he directs while the mind and character are in a plastic state and his imprint may mark the destiny of his charge. It has been truly said that training a boy is like growing a young tree: easy to direct if taken in time, but hard if neglected or if started in the wrong way. Again, boys develop like growing trees: some young, sturdy trees may outtop the others, some may be checked for lack of space for development and transplanting to some congenial spot may help. It would be a poor planter who would discard some thrifty, young tree that might not come up to all his ideas of symmetry. The good planter would so bend and train it that its development would overcome its faults.

Having outlined the general principles of engineering education, the question may be asked, how should we proceed to obtain the best results? I believe that much good would be accomplished if those who employ graduates would coöperate in laying out the courses of study. The visiting boards of some colleges are a step in the right direction, but we need something closer and more concrete than is secured through most such boards. The engineering societies could do most fitting and useful work if they would go seriously into the problem. What is needed is a careful consensus of the judgment of many. A single man or a small group of men might have radical ideas which might do much harm if enforced. Even though an idea may be essentially good, care should be taken that the pendulum is not swung too far one way or the other, or the course will be unbalanced. All of us who have taught know of the frequent requests made by engineers, usually graduates of the colleges, that instruction be given along particular lines which have been of importance to them, and that should even a fraction of such requests be complied with the course would soon be overcrowded, or if other matters were dropped would soon consist entirely of specialized branches. The demand for instruction along particular lines has resulted in the courses of technical colleges being crowded at the expense of efficiency, and no additions should be made unless these seem desirable after a thorough study of the course as a whole to make sure the added matter will not displace something more valuable or result in a lesser degree of thoroughness in some more important branch.

We often hear the statement that something should be added to teach common sense. If by this is meant adding something to keep the student awake to the fact that there is much more for him to do than memorize and that he should keep his mind alert to grasp and coördinate facts and essentials, the suggestion is a good and basic one. The idea that there is a lack of common sense in graduates of colleges is sometimes overcarried. Often the one making the statement has a mind so fixed that he regards a graduate who does not look on a thing in the exact way he does as lacking in capacity. He wrongly regards the failure to follow fixed methods in reasoning as a lack of what he considers his own good common sense. The very failure to follow fixed methods is a safeguard which has been cast about the young mind to insure advancement and progress. Were the world to follow along the lines laid out by our older friend with his highly prided but set ideas, we might soon be in a rut that would prevent all advancement, whereas the young man, though he may fail, may also win through starting out enthusiastically in new and unknown fields. Let us therefore forgive the young man if he makes mistakes in matters that seem self-evident, and remember that the very freedom of his mind is the greatest safeguard for continued progress.

Summarizing, I would make the following suggestions:

1 That there be a closer cooperation between the engineering colleges and those employing graduates, and that the engineering societies be encouraged to work along this line.

2 That the technical requirements for entrance to colleges be lowered rather than raised, that preparatory schools be encouraged to give more attention to teaching good English and to giving a broad general education, and that applicants be also judged as to their initiative and general make up in deciding whether they should be admitted.

3 That the courses be so arranged as to train the initiative and develop the human side; that the students be taught to work in a cheerful and efficient way; that there be proper time for daily relaxation of the mind and that the students be encouraged to use this time to the best advantage.

4 That the professors get down to hard work with their students and know all of them well enough to be thoroughly acquainted with their personal characteristics.

5 That the professors in practical engineering subjects have practical experience so that they can speak with authority.

6 That professors in charge of practical engineering departments be encouraged to undertake practical engineering work, and that their college work be so arranged that they can be relieved from meeting classes when the engineering work makes this necessary.

7 That special attention be given to teaching the fundamentals of engineering science, even though this may result in the elimination of certain specialized branches.

8 That greater practice be given in the writing of concise and logical reports in good English, and in speaking on one's feet.

9 That the students be encouraged to confer with the professors, and that regular hours be provided for this purpose, all to the end that the teachers may extend a helping hand where needed and that there be a mutual understanding and trust.

TRIBUTE TO JOHN E. SWEET AT ANNUAL MEETING

As a tribute to the late Dr. John E. Sweet, Past-President, Honorary Member and a founder of the Society, who died on May 8, 1916, the regular business of the Annual Meeting was suspended at 12:30 p. m. on Wednesday, December 6, when a memorial service to Professor Sweet was held in the Auditorium of the Engineering Societies Building.

Prof. John H. Barr presided at the exercises, and the members of the Council and of the Council-elect, and the past-presidents of the Society took seats upon the platform. The Chairman announced that the ceremony would open with an address by Mr. Worcester R. Warner, Past-President of the Society, and Capt. R. W. Hunt escorted Mr. Warner to the platform. Mr. Warner paid the following tribute to the memory of Professor Sweet:

MR. WARNER'S TRIBUTE

In honoring the memory of Prof. John E. Sweet we stand at the shrine of one whom to know was to admire and love—of a personality instinct with qualities that live to bless the world endlessly, through perpetuation in the lives of others.

To all members of The American Society of Mechanical Engineers he was known as the revered founder and third president of this Society.

As long ago as 1880 I, myself, received a letter from him in which he outlined the scope and benefits of such an organization and invited me to become a charter member.

In those remote days the term Mechanical Engineer had a very limited application. It did not appear in college courses or degrees. There were some Master Mechanics and Master Builders and Draughtsmen; but to secure sufficient members as a nucleus for his proposed organization, Professor Sweet had to invade the ranks of Foremen and Machinists—and there, I may add, is where he found me and some others.

Recently he wrote: "Likely the most important thing I have done was to set the ball rolling for the organization of The American Society of Mechanical Engineers, of which there are between four and five thousand members scattered throughout the inhabited surface of the world." As he was proud of the founding, justly so may we be proud of the founder.

Professor Sweet left a brief and very characteristically modest outline of his life history from which it appears that he was born, of plain English parentage, in the village of Pompey, near Syracuse. His educational advantages were few but he and a brother developed marked taste and aptitude for mechanics. "I was always at making something," he says. Not unnaturally, therefore, he eventually learned the carpenter's trade, from which, as he says, his "mechanical life ran into architecture," and he adds that there are in Syracuse several buildings designed by him. Whimsically he explains that as "the Government at the seat of war at that time was giving jobs to those who wanted to stand up and be shot at, which was a job he 'didn't hanker for,'" so, in 1862, he went abroad and "visited London, Paris, Switzerland and Italy." For nearly two years thereafter he had employment in England. On his return to America he invented his very ingenious but commercially impracticable machine to supersede movable type—the forerunner of the linotype. Then he undertook bridge construction and tells how it was while he was building a bridge at Ithaca that "President White and Mr. Cornell came around one afternoon" and asked him "to meet the Cornell Board," from which resulted his appointment as Director of Shops in Sibley College. The six years, from 1873 to 1879, during which he taught there, were full to overflowing of activity in the interest of his "boys," between whom and himself existed those remarkable bonds of regard and affection expressed in their long series of annual gatherings with him in recent years. "At Cornell," he says, "we were constantly developing new things: absolutely perfect surface plates, straight-edges, squares and angles, standard gages — by the use of the measuring machine which we built (the first ever built in this country) and which read to the ten-thousandth of an inch and enabled us to judge the forty-thousandth. Visitors to the University were always shown our shop and the wonders of the work we were doing interested the greatest of them all. Mr. Cornell was a constant, interested visitor while he lived. General Grant, John Hay and hundreds of others came." "In conversation with Henry Ward Beecher," he adds, "I casually remarked that an ordinary college graduate was not much use in a machine shop and he said he guessed I had never seen one in a pulpit!" Another incident that diverted the young professor, he thus describes: "We built certain

lathes, and, among other new things, all the bolts and nuts that had to be changed to meet conditions were made to be operated by the one wrench. Showing it off to a friend, he said, 'What in the world would you do if you lost that wrench?'" With deep feeling he sums up that period thus: "The best thing we made or helped make at Sibley, I suppose—or hope at least—was a lot of valuable men." From these fine men, "Sweet's Boys," have proceeded such answering testimony to the worth of their instruction by this tireless, inspiring teacher as constitutes, it seems to me, his most perfect tribute and imperishable monument.

One of them, Dean Smith, of Sibley College, writes me: "My memory pictures Professor Sweet always at work upon something that should contribute to the training of the students in his charge; and no matter how busy he was, he was always ready to give his attention to any one who sought his instruction or advice upon any matter whatever." "One thing he said has always stuck in my memory," adds Professor Smith. "It is so characteristic of the man. He said: 'When you go out into practice you will not be paid for what you know but for what you can do.'"

Another of these former students, Mr. J. E. Johnson, Jr., has written a masterly appreciation of Professor Sweet which will shortly appear in *The American Machinist*. To it I am indebted for certain details and the extracts from Professor Sweet's reminiscences. Much stress is laid by his students on Professor Sweet's ingenious applications of graphics to replace the higher mathematics of his subject. Mr. Johnson mentions this interesting instance: On one occasion during a call from some professor the latter spoke of the very difficult problem in geometry which the mathematicians had just succeeded in solving, namely, that if three circles of different diameters are drawn in any position in a plane and a pair of tangents are drawn to each side of each pair of circles and prolonged to their intersection, the intersecting points of the three pairs of tangents will lie in a straight line. Professor Sweet thought this over for a few minutes and said: "Yes, certainly, I can see that that is true." The other professor said: "I guess you don't understand, Professor. This is a very difficult problem and we have just finally accomplished its solution. I don't think it is as obvious as you think it is." "Why, yes," said Professor Sweet, "of course it is obvious. Instead of three circles in a plane, take three balls lying on a surface plate. Instead of drawing tangents, imagine a cone wrapped around each pair of balls. On top of the three balls lay another surface plate. It will rest on the three balls and will necessarily be tangent to each of the three cones. The apexes of all the cones must lie in the intersection of two surface plates, and as the intersection of two planes is always a straight line, the apexes of the cones will lie in a straight line. It seems to me that this is perfectly obvious." So it was to a man who could think in those terms, but to how many of us, no matter what our mathematical training, would it be "obvious"?

At the Centennial Exposition in 1876, the notable feature of the Sibley College exhibit was Professor Sweet's Straight Line Engine, constructed at the college shop. As a marked departure in design from previous types, it attracted much attention; the more so since, when tested out, it developed a high efficiency. Encouraged by these facts, the inventor decided to leave the teaching profession and to devote himself to the manufacture of his engine in his home city of Syracuse. So the Straight Line Engine Co. was organized in 1879, with Professor Sweet as President—an office he held until his lamented death—and there Sibley College post-graduates and others of "Sweet's Boys" received their advanced practical training.

Many present, beside myself, must remember the kindly sentiment, "Visitors Always Welcome," cut in the stone over the entrance door of the factory, and, like myself, must have put it to the test more than once, only to find that welcome ever ready. And the straight-line engine itself was a familiar friend, too. We installed one in our first shop, Swasey and I, and used it until we needed more power. Then it passed to Brashear, in whose shop it is working steadily still—a tribute to the inventor's sound sense and feeling for right design.

Professor Sweet's name and fame became so well known that engineers and inventors made "a beaten path to his door."

It was his pleasure to commend and aid those who possessed merit. Just as ready was he to wisely direct those who came bringing heretical ideas in opposition to the fixed laws of mechanics. In such cases his keen sense of humor often played a kindly but convincing part. On one such occasion an inventor, after demonstrating an elaborate model, asked, "Now, Professor Sweet, what do you think of it?" Instantly came the characteristic reply, "Well, it seems to be a mighty good way to do a thing that doesn't need to be done." I recall, in the days when inventors tried to apply ball bearings to everything from bicycles to the axis of the earth, one such went to him to explain the merits of his new ball bearing for buggy axles. Professor Sweet listened attentively and then said to the proud inventor: "The ordinary buggy axle is of steel, about 7/8 in. diameter, nicely fitted to a cast iron sleeve and, presumably, well oiled. If you place such a buggy on a new, smooth floor, and with a sensitive spring scale, determine how slight is the power required to move it, you will see that, if your ball bearing saved it all, it wouldn't be worth while." He followed this statement by saying, "The resistance to moving vehicles is mostly on the ground and can be best overcome by making better roads." This now seems like prophecy, in view of the fact that the State of New York has, since then, spent over one hundred millions of dollars in improving its roads.

Thousands of young mechanical engineers discover the great loss of power by the use of the crank in the steam engine and are then subject to attacks of the rotary-engine fever. Most of my hearers have doubtless prescribed for this malady and accomplished cures. So did Professor Sweet. For, when one thus afflicted came to him with a splendidly worked out design, the cylinder but half the usual circle, and enthusiastically invited his approval, Professor Sweet said cordially, "It is the very best rotary engine I have ever seen, for you have at the outset, thrown away half of it. Now all you have to do is to throw away the other half." Then we may be sure he gently put that young enthusiast back on the right track to real progress. This characteristic helpfulness to others held good to the very day of his death. For another of his "boys," Mr. Wm. C. Brown, tells me that on the morning of that day—it was the eighth of last May—a man from Texas, whom he had never heard of before, walked into the Professor's office to ask advice about a valve motion he had invented. When it had been explained but before Professor Sweet had an opportunity to express an opinion, his carriage came and he was obliged to go home to lunch, making an appointment for the man to return at a later hour. That afternoon the fatal stroke occurred and Professor Sweet was taken home by Mr. Brown, in the latter's car. On the way, though suffering intense pain, he told Mr. Brown about the stranger's errand and begged him to see the man when he returned and explain to him just why his valve motion was of no value.

Here is the great human note, without which even the harmonies of Heaven would be poor.

In these latter years Professor Sweet had enjoyed much travel. Of this he writes: "I have crossed the Atlantic fifteen times, have been in ten seas, twenty two countries, and in too many rivers, bays and cities to enumerate. I have been four hundred miles South of the Equator and half way to the North Pole." So he took a warm interest in world politics, especially as affected by the present war of nations. This is the theme of several personal letters written to one of his very favorite "boys," Mr. F. G. Tallman. Recalling Professor Sweet's sentiments concerning the Civil War we are prepared to find him saying: "I have said, and said it years ago, that 'Prepare for war in times of peace' is the worst sentiment in the English language, and if anything was necessary to prove it, the present war does it. Men fight more for glory than anything else and there would be no glory in taking an unprotected country but a disgrace to the people who would do it. I believe this country would be in a safer condition without a cent's worth of arms, armaments and forts than with the best possible of those elements." These are vigorous words from a man of 82. Several letters are in the same vein. All express, at more or less length, his utter detestation of war and the specious excuses other men make for it.

As I turn the pages of this very private correspondence, kindly sent me by Mr. Tallman, I find one letter in quite another and a very amusing vein. I quote: "Some two weeks ago I got thinking about what was the first thing I ever made that I could remember about—and it was a boot-jack that I made somewhere about 1840, or when I was eight years old. And I called to mind the fact that I did then what I have always tried to do since—make it better than the ones made before." Then the writer tells how, being up at Pompey a few days before and mentioning the boot-jack, some one "went out in the wood-house and brought it in" and, he continues, "I have it now in my office. Wherein it differs from others is this: the old, or, in fact, all others, have a cleat under near one end, to hold that end up. In the place of the cleat, I have two holes through and put in two pins which I let project out from each side, so the jack is right side up whichever is put on the floor. As an evidence that it was used in the days of boots, the back end is worn tapering and the forked end has been worn by the boot heels. The point is that I did then what I have always tried to do since—*make the thing better*. But getting other people to adopt my notions has been as barren of results as my notions about preparedness."

Likewise, in his reminiscences, Professor Sweet writes: "I cannot call to mind ever starting on a job without thinking out how to make it better than it had been done before." The engineers of the world can set themselves no higher task than such a motto imposes, nor hope to accomplish it more fully and nobly than did Professor Sweet that which he undertook.

Simple and modest and self-effacing as he was by nature, honors sought him—not he them. In 1914 the John Fritz medal was awarded to him "for his achievements in machine design and for his pioneer work in applying sound engineering principles to the construction and development of the high-speed steam engine." In the same year Syracuse University conferred upon him the honorary degree of Doctor of Engineering. But, as has been truly said, these honors, great as they are, are less lasting than will be "his influence over men, to cause them to think straight and live honorably."

The man of whom such things are true need make no claim of his own. In life he is revered. In death, we bring him the homage of our hearts.

The Chairman expressed the Society's indebtedness to Mr. Warner for this appreciative estimate of Professor Sweet. He then introduced another pioneer of the Society who was associated with Professor Sweet in his early days, Capt. R. W. Hunt. Captain Hunt said in part:

CAPTAIN HUNT'S TRIBUTE

"Blessed are those whose works are such that every day and every moment of that life has been to make their fellow men better and happier, and such was Professor Sweet. His life was as simple as his mechanical ideas, and just as accurate in its greatness and in its purity. To know him was to be blessed, and certainly his influence exerted upon those who came in contact with him, and left as a beneficence to those who follow him, is of a character that makes the world worth living in.

"His achievements were not of a startling kind. His successes did not bring to him great fortune, but each one made men better and happier, and the fact that following the years of his teaching he established a brotherhood of love among men who continued to pay tribute to him until the day of his death was an achievement of which any man should be glad and proud, and sufficient to content any man."

The Chairman then called upon Prof. Albert W. Smith, Dean of Sibley College, Cornell University, who was one of the Sweet boys in the early days of Cornell, and was afterward superintendent of the Straight Line Engine Works.

DEAN SMITH'S TRIBUTE

Professor Smith said he counted it one of the pleasures and privileges of his life that Professor Sweet was his teacher in Sibley College and his employer in the Straight Line Engine Works, and that there were two things which characterized his knowledge of Professor Sweet: *first,* his clearness of thought, and, *second,* his deep human sympathy. Dean Smith continued:

"As I said once before in public, Professor Sweet all of his life carried a little sharp needle to prick hot-air balloons, and then when he saw the balloon collapsing, his sympathy for the man who had brought it to him was so great that he would explain to him a way to blow balloons so that they could not be punctured.

"I want to tell one story that has not been told here this morning. The Professor was especially proud of the Straight Line engine because, although it was a high-speed engine, it ran silently. One day, a man from Syracuse came to the works, and a Straight Line engine was on the skids ready to be shipped. This man was not an engineer. He came in and the Professor greeted him, and he said to the Professor, looking at this engine, 'I see you are still making drop hammers.'

"It seems to me that in human life there is only one cardinal sin, and that is selfishness. All others are simply outgrowths or modifications of this one sin. It is the one of which Professor Sweet was guiltless all his life, for he was the kindest and most unselfish man that ever offered help and sympathy to harrassed human mortals. I am proud of the fact that it was given to me to be one of Sweet's Boys."

The Chairman in conclusion said that it seemed proper to those who knew Professor Sweet and loved him so dearly that this memorial should be characterized by extreme simplicity and brevity, and with these tributes the service closed.

MISCELLANEOUS SESSION, WEDNESDAY MORNING

At the first Miscellaneous Session of the Annual Meeting, at which Dr. D. S. Jacobus presided, the following five papers, contributed by local Sections of the Society during 1916 and published in The Journal, were read by title:

Steam Safety Valves, George H. Clark, contributed by the Boston Section.

Efficiency of Propulsive Machinery and Late Developments in Naval Engineering, H. C. Dinger, contributed by the Philadelphia Section.

Standardization of Power Plant Operating Costs, Walter N. Polakov, contributed by the New York Section.

Report of Efficiency Tests of a 30,000-kw. Cross-Compound Steam Turbine, H. G. Stott and W. S. Finlay, Jr., contributed by the New York Section.

The Design and Test of a Large Reclamation Pumping Plant, G. C. Noble, contributed by the San Francisco Section.

MR. ORROK GIVES FORMULÆ FOR THE PROPORTIONING OF SURFACE CONDENSERS

George A. Orrok then presented a paper entitled The Proportioning of Surface Condensers, in which he enunciated the following principles:

a The law of temperature rise in a condenser tube is of the exponential form, with 0.875 (0.9 or 0.8, perhaps) as the exponent

b It is not necessary to take viscosity into consideration in designing where the water temperature is 65 to 70 deg. fahr. and the vacuum is 28 in. or over

c Critical velocity may likewise be neglected, since all condenser velocities are far above it

d For velocities obtaining in condenser practice the coefficient K may be taken as the 0.6 power of the velocity

e The reduction in heat transmissive power due to the presence of air in a condenser is very approximately covered by the use of a term $(P_s \div P_t)^2$ as a reducing factor of K

f For design work the value of K may be reduced once for all to account for the cleanliness of the tube and the material itself

g The value of K will then be reduced to somewhere between 300 and 400 for design purposes, say 325 for average good working.

Mr. Orrok presented the following formulæ covering the application of the results of his experiments to the design of surface condensing apparatus:

If P_v = absolute pressure in condenser = 29.92 — (vacuum — 0.2 in.)

t_s = temperature of steam corresponding to vacuum

t_0 = initial temperature of condensing water

t_1 = final temperature of condensing water = t_s — 5° for close work, ordinarily = t_s — (7° to 10°)

λ = total heat of steam at t_s

q = heat of the liquid at t_s

Then, ratio of condensing water to steam condensed is

$$R = \frac{\lambda - q}{t_1 - t_0}$$

Also, pounds of steam condensed per hour = W, and weight of condensing water used = $Q = WR$.

One-inch tubes (No. 18 B. W. G.) being taken as standard on account of advantages generally conceded to that size, the number required in one pass = $n = Q \div 990 V_w$, where V_w is the velocity of flow, averaging 8 ft. per sec. (7 to 10 ft.).

The length of water travel (l), or the total tube length, may be found from

$$l = \frac{30.8\,Q}{325\,V_w^{0.6}\,n}\left[(t_s - t_0)^{0.125} - (t_s - t_1)^{0.125}\right]$$

and the total tube surface (S) from $S = 0.262\,nl$.

The cross-sectional area of the condenser (sq. ft.) is equal to ($n \times$ number of passes) $\div$ 60, where 60 is the average number of tubes occupying 1 sq. ft. of tube-plate area. The length of the condenser = $L = (l/m)$ + depth of water boxes, where m = number of passes.

The author said, in presenting his paper, that the data in it were ten months old, but that he had heard of no experiments since which would cause him to change anything in the paper. He said that at the present time we unfortunately lack experiments to confirm our conclusions regarding the air question, and there might one or two things come up within the next few months to cause him to change his opinions. If so he would come back later and say that his paper was no longer correct.

William Kent, in opening the discussion, said he had no fault whatever to find with this paper, except that it needed an appendix, and he hoped Mr. Orrok would next year give another paper supplementing this one.

The principal question he wanted answered was: Given, say, a 1000-hp. engine, with 10 lb. of steam per horsepower, which would make 10,000 lb. of steam, and with 29.5 in. of vacuum and 70 deg. fahr. temperature of circulating water, how many square feet should be put in the condenser, and how should the square feet be arranged? The temperature of the condensing water, the vacuum, and the number of pounds of steam to be condensed are the only things we have to begin with, and the two things to be found are the number of square feet and the arrangement of the heating surface.

Wm. D. Ennis thought that if the author would explain the statement: "The law of temperature rise in a condenser tube is of the exponential form, with 0.875 (0.9 or 0.8, perhaps) as the exponent," the surface capacity could be readily determined.

Thomas C. McBride said that a number of condensers had been built in which the circulating water was heated in the neighborhood, taking an actual instance, of from 70 to 95 deg., but now we find it desirable to force a lot more water through and lower the average water temperature and thereby increase the total amount of heat transmitted per square foot. That brings up the question of the length of tube possible with the increased amount of water, as it influences the horsepower of the circulating pump.

He put up on the blackboard his own equation for determining surface, which checked up because with it the amount of surface multiplied by the length traveled through by the water was constant.

Geo. H. Gibson and Paul A. Bancel wrote that they thought that the author has given more attention to the devising of algebraical formulæ than to explaining the fact, which is clearly patent, that single-tube experiments and practical condenser results are 100 per cent or more apart.

Values of the coefficient K varying from 470 to 630 are mentioned as experimental results. Upon proceeding to put down principles which can be used in designing, however, the author says "The value of K will then be reduced to somewhere between 300 and 400 for design purposes, say 325 for average good working." As a matter of fact, coefficients equivalent to 300 have been attained for years in old-fashioned condensers without the grace of new-fangled formulae and with tubes packed 100 or more to the square foot and only 3 or 4 ft. per second water velocity, whereas the author recommends about 69 tubes to the square foot and 8 ft. per second water velocity. If all the new formulae get us no farther than this, why formulate?

The conclusion is unescapable that what takes place in an individual tube surrounded by pure steam is, in the actual condenser, submerged and obscured by some other factor or factors. Has sufficient study been given to the flow conditions on the steam side of the tube?

Just as there is a best tube length for the water flow, so there is a best tube-bank depth for the steam flow. As condensers grow in size, it is not correct merely to make them deeper in proportion as they are made wider. The best depth must be determined and increased capacity obtained by spreading out in the other dimensions. Steam lanes in the tube bank do not solve the problem, for they are like by-passing water directly from the cold-water box to the warm-water box; some of the heat-transmitting surface is by-passed by the lanes and becomes stagnant and inactive because of accumulation of air. Another solution which has been proposed, viz., to keep every tube in the condenser bathed in pure steam summer and winter, heavy loads and light loads, by pulling a larger proportion of the steam through into the air pump, leads to an excessive power consumption by the latter.

Mr Bancel supplemented the above discussion by considering the effect of size of condenser on efficiency. He said that condensers are getting bigger and bigger nowadays, and it has been assumed that the condenser would be more efficient in large sizes. One reason for this was that the turbine is more efficient in large sizes, but the problems that come into condenser design are very different from those that enter into the case of the turbine.

M. C. Stuart presented a comprehensive written discussion in which he gave the results of his own analysis of the author's data. Some of Mr. Stuart's conclusions were:

"Undoubtedly the data presented show conclusively that the heat-transfer factor did vary as a function of the mean temperature difference between steam and water. The runs used to reach this conclusion, however, included only those in which the steam temperature was constant and the inlet-water temperature varied. A set of runs may sho wthat the heat-transfer factor varies with the temperature difference, but this does not mean necessarily that the variation is *because* of the temperature difference. At constant steam temperature, small temperature differences correspond to high actual water temperatures, and it is altogether possible that the variation obtained by Mr. Orrok was due to the variation in actual water temperature, rather than to the variation in temperature difference.

"I agree that for the narrow ranges of temperature existing in condenser work (from 70 to 90 deg.) the effect of viscosity need not be considered. It would also appear that the effect of varying temperature differences need not be considered, especially in view of the evidence that the heat-transfer factor varies with actual water temperature and not with temperature differences.

"As to the relation of heat-transfer factor and velocity, I find that the plot of velocity *vs.* heat-transfer factor on log paper gives a line which is decidedly curved, and which indicates an exponent varying from 0.5 to 0.6 in the formula $U = CV^n$ over the velocity range from 2 to 8 ft. per sec."

"The author chose 8 ft. per sec. velocity only because this is usual. At a velocity of 8 ft. per sec. the friction drop amounts to 10.73 ft. of water and the total length of tubing amounts to 3250 ft. per million pounds of water per hour. By increasing the velocity to 12 ft. per sec. the total length of tubing may be reduced to 2570 ft. at the expense of an increase in the friction drop to 25.24 ft. of water. The writer is not advocating the use of any particular velocity, but simply placing emphasis upon the fact that the proper choice of a velocity should be given more consideration."

G. L. Kothny, in a written discussion, stated it would be interesting to hear what amount of air leakage in pounds per hour should be assumed per 100 sq. ft. of surface when using 325 as the value of K. He thought an attempt should be made by condenser manufacturers to agree on the maximum and minimum amount of air leakage permissible for certain sizes of condensers, and that the establishment of such standard figures would give a better basis for comparison of the efficiency of different types of condensers. It would be interesting to hear from Mr. Orrok if he has any data referring to the maximum and minimum amounts of air leakage in pounds per hour for different sizes of surface condensers, such as 5000, 10,000, 25,000 and 50,000 sq. ft. cooling surface.

He suggested that, to avoid misunderstandings, the symbols used for making condenser calculations should be agreed upon or determined by a standard committee of members of the Society engaged in condenser work.

Alphonse A. Adler entered into a lively discussion of the formula given by Mr. McBride, criticizing it on the score that it was physically inconsistent. Professor Kent and Mr. McBride joined in and the discussion became a question of meaning of a dimensional formula.

The author said in reply to the query of Professor Ennis regarding the exponent $\frac{7}{8}$, that in the closure to the discussion of his paper before the Society three years ago he showed three dimensional diagrams which would make clear what he meant.

What we would like to know about a condenser is whether, plotting the temperature rise of the water against the length of the tube, the arithmetical rise is true, the logarithmic rise is true, or the exponential rise is true. On that depends the whole mathematics of the thing. The reason this is non-dimensional, as Professor Adler says, is because it works on the arithmetical mean. You can have a thousand tubes one foot long, or one tube a thousand feet long, and get the same result in the condenser.

He thought Mr. Gibson had mistaken K for U. K is the coefficient, while U is the heat transfer, and that makes a big difference. The heat transfer is two, three or four times what the coefficient is. We get heat transference in a single tube up to 1200 to 1400, and in the condenser up to 700, 800 or 900, but the coefficient is rarely much over 400. The reason why we cannot get the high coefficient at low load on the condenser is that we do not have the heat to transmit. We have a large temperature difference, and therefore the value of U to the coefficient is very small always owing to that.

As to the depth of the tube bank, he said he would like to go into the question of the velocity of steam amongst the tubes, but it was a long subject and was covered pretty well in his original paper.

Regarding the criticism as to the velocity of water he took

in the tubes, he said he had assumed the customary velocity. The actual velocity to choose is a commercial question, depending on how much you are willing to spend for pumping power.

PROF. BRECKENRIDGE AND MR. PRENTICE PRESENT PAPER ON TESTING HOUSE-HEATING BOILERS

The second paper presented at this session was by L. P. Breckenridge and D. B. Prentice, on The Testing of House-Heating Boilers. In this paper the authors proposed a standard method for testing this class of boiler, a type of apparatus which has not yet received the attention of the Power Test Committee of the Society. The paper was presented by Mr. Prentice.

James W. Nelson made a motion that this paper be referred to the Power Test Committee of the Society for consideration for incorporation in the Rules for Conducting Performance Tests of Power Plant Apparatus, which was seconded and carried.

Geo. H. Barrus, C. M. Garland, Roy E. Lynd, C. B. Thompson, Max Friedlander, Allen Hubbard and William Kent contributed written discussions to this paper, the salient points of which follow:

Geo. H. Barrus, as a member of the Power Test Committee, thought it might be taken for granted that the Committee would welcome any suggestions for amendment to the Power Test Report such as the authors brought forward. He hoped, furthermore, that this paper would lead other engineers to study these codes with a view to pointing out any possible deficiencies.

C. M. Garland stated that this type of boiler and furnace has been notoriously uneconomical in the appropriation of the heat liberated by the fuel, and it is largely due to Prof. Breckenridge's initiative along these lines that the inefficiencies of these boilers have been brought to the attention of the manufacturers, engineers, and to the government experiment station. The result is that manufacturers have given the matter of efficiency serious thought, and house-heating boilers of excellent efficiency are now built.

The testing of this boiler is radically different from the testing of the high-pressure boiler as used for power and larger heating work. It is therefore desirable that a different code should be provided for the testing of these boilers. The one proposed by the authors would seem to meet the requirements of the different conditions. A heat-value unit for a standard measure for one foot of radiation would be a most desirable standard.

Roy L. Lynd was satisfied that tests made by competent engineers in accordance with the code outlined would be about as complete and accurate as it is possible to get them.

He thought it would be well to eliminate the term House-Heating Boilers from the code, and substitute Low-Pressure Heating Boilers.

As the proposed testing code is essentially a code for evaporative tests, we are not concerned with boilers for hot-water heating and hot-water supply. The new code should therefore cover all boilers used exclusively for steam heating and should be so entitled. The A.S.M.E. Boiler Code in Section 2 does not limit low-pressure heating boilers to 2000 ft. or less, and we should not so restrict the testing code.

He criticized the authors' definition of a foot of radiation, and suggested that a better arbitrary value than 242.6 B.t.u. per hour would be 250 B.t.u. per hour.

C. B. Thompson wrote that, if he had read the paper understandingly, its argument was that boilers are overrated because there has been no well-established or standard testing code, and hence errors in tests have led to errors in computing working capacities. With this he could not agree, as the code presented is only one of many by which boilers may be tested that will show practically the same results. It is when the tests are computed to determine the boiler's capacity in terms of square feet of radiation that guesswork is employed. The computer can give the capacity at which the boiler will operate for any unit of time if he knows the full capacity. Without this all-important item he is adrift in a fog.

If the capacity of house-heating boilers were computed something like the following, there would be less complaint of overrated boilers, because many buyers do not understand that the rated capacity is at the boiler outlet:

	Sq. Ft.
Capacity Cast-Iron Radiation	800
Add for Covered Pipe	150
Total Boiler Load	950
Coal will last, hours	9

Then give the chimney size required and the purchaser can select what he wants without outside assistance.

Max Friedlander, in his written discussion, contributed a new method for a *continuous* determination of the heat balance of house-heating boilers, which, so far as he knew, had not yet been published elsewhere. A description of this method will be given in a later issue of The Journal.

Allen Hubbard considered, in his written discussion, that if the manufacturers would rate their boilers on the basis outlined by the authors, the public and the business generally would be greatly benefited.

William Kent thought that the method of rating proposed seemed to leave out a most important factor—the grate surface, or the amount of coal that should be burned per square foot of grate surface.

Mr. Kent also proposed the figure of 250 B.t.u. for the square foot of radiation, instead of 242.6. This figure has long been used by heating and ventilating engineers as a standard equivalent for an average square foot of radiation.

The author promised to reply to the discussion in a written closure, which will be published later.

WATER PURIFICATION VS. BOILER COMPOUNDS DISCUSSED IN PAPER BY MESSRS. SCOTT AND BAILEY

The third paper presented at this session was that by Arthur C. Scott and J. R. Bailey, on Water for Steam Boilers—Its Significance and Treatment. The point in this paper was that the use of *boiler compounds*, except in plants of relatively small size, is less efficient and more expensive in preventing trouble than methods employed for the water purification before it enters the boiler.

William Kent objected to one statement in the paper, that the waste of fuel in a boiler caused by scale is proportional to the thickness of the scale, and claimed that the author's figures illustrating this were fifty years old and, moreover, rested on no authority whatever. He stated that the loss in heat due to scale on the tubes may be absolutely insignificant.

He commended what the authors said in condemning boiler compounds, but thought this statement might have been made even stronger.

W. T. Alliger[1] commented on the statement: "As a matter of fact, purification of water is partially obtained in most

[1] Harrison Safety Boiler Works, 17th St. & Allegheny Ave., Philadelphia, Pa.

cases by heating it to the approximate boiling point, but the hot process assumes that with steam enough to give a temperature of 200 deg. fahr. or over, sufficient soda ash is added to the feed water to just satisfy the alkaline earth sulphates and chlorides and any acid present, and the water is then satisfactorily purified." That might have been true several years ago when the practice was low temperatures with very little overload. But with the present development in boiler practice, where we carry very high overloads and high steam pressures, the statement is not correct. With the present practice, we require water as good as can be obtained, consistent with the amount of money we can spend in getting the results. In the most efficient plants they have even gone so far as to evaporate the make-up water, but in ninety-nine plants out of one hundred that is not permissible for economic reasons.

With a hot-process system you can get better results in purification than by any other means. In many cases he had seen results where the scale-forming impurities have been reduced to as low as one grain, in one case to half a grain, and in some others to about three-quarters of a grain. These results are controlled by the temperature. If you can operate your hot-process water softener under slight back pressure, say up to 5 lb., the results will be improved.

The authors take up the question of foaming, but there is probably as little known about the causes of foaming, as little proved on the causes of foaming, as anything connected with the operation of boilers. Personally, he was inclined to believe that the collection of suspended matter at the surface of the water has a greater influence on foaming tendencies than the constant breakings of the soluble salts, provided they are kept within reasonable limitations.

Written discussions of this paper were presented by Geo. H. Gibson, M. F. Newman and F. F. Vater, respectively.

Mr. Gibson considered that present water-softening practice was well summarized by this paper, except that the authors did not appear to be familiar with the latest development in hot-process softeners, which have made a radical advance, due to recent improvements in chemical feeding devices. Milk of lime is now fed as easily and as accurately as soda or caustic soda, or trisodium phosphate could be fed before. That chemical or combination of chemicals which will give the desired results at the least cost, all operating conditions being taken into consideration, can therefore be used in all instances.

Chemical reactions are much more rapid and complete in hot water than in cold water, as any one can satisfy himself by taking a sample of water, dividing it into two parts, heating one sample to the boiling point while leaving the other cold, and then adding to each the exact amounts of softening reagents theoretically required for the transformation of the scale-forming substance. There will immediately appear in the hot water a coarse, granular precipitate, which soon settles to the bottom. With most natural waters, no effect at all will be apparent in the cold water for ten or fifteen minutes, and even then only a slight haze. In due time a very fine precipitate will begin to come down, the sedimentation becoming complete, however, only after four to six hours. Even then, if the cold sample be heated to boiling, further precipitation will occur. This action is frequently observed where water from cold-process systems is passed through feedwater heaters.

In the hot water, complete reaction is also obtained with a smaller excess of reagent than in cold water, and overdosing is not necessary in order to reduce the total solids closely to the limit imposed by the solubility of the end-products, that is, of the substances into which the scale-forming matter is transformed by the chemicals. In fact, the manufacturers of hot-process softeners regularly guarantee to reduce scale-forming solids in solution to less than 2½ grains per gallon, and in actual practice the total solids in the treated water are frequently reduced to below 1 grain per gallon, sometimes to less than ½ grain per gallon.

The discussor here described an apparatus by means of which the softening reagents are fed with great accuracy and sensitiveness and which has been developed from his suggestions by the Harrison Safety Boiler Works, of Philadelphia. The description will be published later.

F. F. Vater's discussion was a defense of the hot process of water softening, which, he said, offers possibilities not obtainable by the cold process. He objected to the author's classifying this process with such devices as live-steam purifiers and boiler compounds, on the ground that the cold process would be more appropriately classified with these.

M. F. Newman, on the contrary, claimed that the most highly efficient water purification is carried on without dependence upon heat. The main factors in boiler purification, he wrote, are not heat, soda ash and blowing, with possible filtration, but accurate softening and purification carried out independently of the variables encountered in the irregular flow of water through the heater and the uncertain degree of precipitation within the heater. The authors attributed foaming and priming chiefly to a concentration of alkali salts, giving secondary consideration to silt, organic matter, loosened scale, lubricating oil, etc. It had been found, however, that in the absence of substances in solution which form precipitates upon concentration, water containing alkali salts could be highly concentrated without any appreciable effect on the steaming quality of the water.

This writer also discussed in a comprehensive manner a number of other points in the paper, and his discussion will be published in extended form later.

The discussion of Messrs. Scott and Bailey's paper was continued at the Miscellaneous Session on Friday morning, when Geo. L. Fowler discussed the paper orally.

Mr. Fowler said that it seemed to him that all of the formulæ given by the authors were such as could be found in any book on water softening. Ordinary ingredients like carbonate of iron and magnesium and sulphate of lime and magnesium we have known how to treat ever since Clark published his famous work almost a century ago. It seemed strange to him that one of the authors should have skipped over the ingredient which occurs in almost all boiler water—organic matter—which, in his opinion caused more trouble in such waters than anything else. He instanced the case of a certain railroad in which the metal in some boilers corroded very rapidly under conditions apparently the same under which other boilers did not corrode at all. It was naturally suggested that the fault was with the metal. In some cases this was found to be so, but in others, upon analysis of the boiler water, the latter was found to be no more like the feedwater than black is like white. Something resembling an alkaline solution was found to be in the water.

Building a small boiler and evaporating the analyzed water in it revealed the fact that the trouble was with organic matter in the water, which decomposed under high steam pressure.

Mr. Fowler thought that every case of boiler feedwater needed special attention. An analysis of the raw water could not be trusted to, and the only thing to do was to see what was going to happen to the water when it was evaporated under the same conditions to which it would be subjected in the boiler.

INDUSTRIAL SAFETY SESSION, WEDNESDAY MORNING

At this Session of the Annual Meeting there was presented for consideration a Proposed Code of Safety Standards for Cranes, which had been prepared by committees selected from a large number of representatives of important industrial interests and of insurance companies, inspection bureaus, etc., under the direction of the Industrial Commissioner of Pennsylvania. The Code in question is intended primarily for electric traveling cranes, but its provisions are designed to cover jib, monorail and hand-power cranes insofar as the various sections apply. The first half of the Code deals with details of design and construction, and the remainder with rules for crane operators, floormen, and repairmen.

In opening the Session, Chairman John H. Barr announced that the policy of the Sub-Committee on the Protection of Industrial Workers, under whose auspices the Session was held, was to confine itself strictly to the preparation of codes for safeguarding machinery, leaving propaganda work on the safety movement to other instrumentalities. The Code presented was to be considered a basis upon which should be finally developed a Code that would be adequate, make all necessary provisions for safety, and at the same time not be so drastic as to be beyond reason. The hope of the Committee was to formulate Codes that would be adopted and approved by state governments, resulting in uniformity of legislation. With the latter obtained, manufacturers would be quick to build in the safeguards which are now left to the user to provide.

At the request and in the place of Dr. John Price Jackson, who was unavoidably prevented from being present, Prof. A. M. Greene, Jr., then read the text of the Code in full. Commenting thereon, he expressed the opinion that the factor of safety of 5 specified for parts other than gears and complete hoisting mechanism was rather low, unless allowance was made for impact. He also believed that the reference to the use of cast iron for brackets should be limited to brackets supporting shafting, and that the specific purpose for using wire mesh should be stated. He desired to ask if a gong that automatically sounds when a crane is in operation would be advisable, and also just what the meaning of "properly" was in the expression "properly lubricated."

In a written communication, R. W. Hicks suggested that the word "approved" used in several paragraphs of the rules for general construction be omitted altogether, or that authority of approval be vested in some organization suitably equipped with apparatus to determine the merits of various devices that are apparently acceptable.

H. M. Mowery submitted a brief written discussion urging that, in view of the slipping hazard, the Code include a statement to the effect that "All tread surfaces, and particularly stair treads, shall be so constructed and maintained that slipping on them will be prevented."

Replying to the queries of Prof. Greene, R. A. Medina[1] stated that the recommendation of a safety factor of 5 represented the consensus of opinion of the Committee. In regard to using cast iron for brackets, he thought it would be well to employ a modifying adjective in order to avoid any misunderstanding. He explained the use of wire mesh in covering openings and thus preventing bolts, tools, etc., from falling to the floor below. He thought an automatic gong, sounding all the time, would have little effect, as the men would soon get used to it and ignore it.

Henry A. Hale, Jr., remarked on the absence of any injunction in the Code as to the type of hook to employ in hoisting a load. In his opinion, the hook should be of an improved type, having, if possible, a handle at the back so that the floormen would not have their hands squeezed or crushed in attaching it to the load. As to manual signals, he thought that they were not apt to attract much attention, particularly when the crane operator was at some considerable distance from the man signaling; and it was very desirable, therefore, that whistles of a proper sort be used in such work.

Prof. F. R. Hutton called attention to several places in the Code where the English might be improved and ambiguities removed. He found that in one place a factor of safety of 5 or 8 was specified and in another that for the brake drum it should be $1\frac{1}{2}$. Either it should be stated that the apparatus designed has the factors 8 and 5, with the exception of the brakes, or that brake factor of safety does not come under the limitation of the earlier paragraph. In the paragraphs dealing with warning signals, it should be made plain that "approved" means "approved by State factory inspectors." With respect to the provision of guards for gear wheels, he was of the opinion that the idea would be more strongly presented by specifying that standard guards should be provided to all existing cranes where practical. Replying to Prof. Greene's query on the paragraph dealing with lubrication, he thought that it would be well to omit the word "properly," leaving it to the foreman to see that the work was done satisfactorily. Referring to the provision that hoisting brakes should be tested, he thought it desirable that the frequency of such tests be specified. He found that in two of the rules the word "hitch" was used. To his mind, while "sling" was a much more general term, he believed it would be better to use both words.

The Chairman, commenting on the remarks of the preceding discussor, thought that the word "hitch" was more comprehensive than "sling," and would include both the operation and the appliance used. But it was well in such things that there be no confusion as to the meaning intended.

A. D. Risteen said that in his opinion the Code should include instructions in regard to starting to lift loads gently. Also, that the highest object over which the crane had to pass should be painted white on the top, so that it would stand out conspicuously against the miscellaneous background of dark objects underneath.

It was stated by H. M. Elder that in the works of the American Locomotive Company the crane operator is signaled to by means of an air whistle; the operator knows the location of this whistle, and looks and sees the man giving the signal. With regard to starting to lift loads gently, it would hardly do to specify this, as it would prevent those having a.-c. crane motors from using them. As to equipping with an approved limit switch, he had to say that his company had experimented with a number of such devices, both purchased and of their own construction, and had not yet found one that satisfied the crane operator and the electricians.

A. H. Blaisdell thought that gongs were often likely to be unheeded and that it was good practice to have the floorman precede the load and warn people out of the way. He believed that a crane out of order or under repair should have a red flag hanging from it; that a crane operator should be

[1] With Independence Inspection Bureau, 137 S. Fifth St., Philadelphia, Pa.

provided with a megaphone, and that there were advantages in using hooks that had been painted white, especially on night shifts.

According to J. W. Upp, it was very evident that both manufacturers and users of apparatus were earnest in their efforts to safeguard the workmen, and to provide apparatus that would give the maximum of protection without unnecessary complications. As a manufacturer he was interested in the discussion, for everything that could be done to make uniform the regulations governing any class of apparatus was a distinct help to the user.

Prof. F. R. Hutton spoke of his visit earlier in the week to Washington, at the instance of the Council, to represent the Society at a conference summoned by the State of Ohio and its officials and the Labor and Factory Commission. Here he was informed that little by little the Ohio State Boiler Code was being withdrawn and that promulgated by the Society being advanced all the time, and that it would be but a short period before the A.S.M.E. Code would be the only one used. The whole atmosphere of the session was so definitely favorable to the incorporation of the technical recommendations of the Society, that it looked to him as if very substantial progress had been made along the line of recognizing that the Society was a body which, by its position and methods of arriving at results, was free from many of the difficulties that often came up to trouble legislators, where they were not sure that business organizations were not behind recommendations with respect to the scientific principles or facts underlying a Code.

In closing the oral discussion as the representative of Dr. Jackson, Mr. Medina stated that the Code had been purposely drawn in a broad and general manner, for the reason that a very specific code would be at the same time very bulky. In Pennsylvania, to his knowledge, no limit-switch device had been approved by the Factory Department, possibly because the Code had not officially gone into effect. Undoubtedly, however, the Department would soon have to say "yes" or "no" to various devices now available. He agreed with Mr. Elder that it was exceedingly difficult to find a limit switch that met the needs of everyone interested, and thought that this was a matter upon which the Committee could well afford to hold a separate session.

MISCELLANEOUS SESSION, WEDNESDAY AFTERNOON

At the second Miscellaneous Session of the Meeting, which was also held in the Auditorium, and at which Dr. Jacobus presided, three steam-plant papers and two papers relating to the flow of fluids were presented and discussed. One of the steam papers, that by Victor J. Azbe, was one of the two papers recommended for honorable mention in the Junior Prize Paper contest for 1916.

MR. PRATT REVIEWS PRACTICE IN THE UTILIZATION OF WASTE HEAT IN GENERATING STEAM

The first paper presented was by Arthur D. Pratt, entitled The Utilization of Waste Heat for Steam-Generating Purposes. The paper dealt with the principles underlying this subject and gave a general survey of what has been accomplished in this line in which it is today possible to generate steam successfully from gases whose temperatures are as low as 950 or 1000 deg. fahr. It also considered the problems involved and the results obtained with waste-heat boilers in connection with copper-refining furnaces, cement kilns, open-hearth steel furnaces, beehive coke ovens, zinc-refining furnaces and furnaces of various types, both generative and non-generative.

Alex. G. Christie said that in connection with the cement-mill work, the noteworthy point brought out in the paper is that there is not only a large reduction of fuel consumption by the utilization of this waste heat, but also a better dust recovery, and in some sections this latter is a question of considerable importance.

The performance of waste-heat boilers described seems to depend largely on high gas velocity being maintained by an induced draft, and that, naturally, leads one to question whether the same principle could not be applied to the standard boiler.

Three written discussions of Mr. Pratt's paper were presented by L. D. Ricketts, Warren B. Lewis and B. N. Broido, respectively.

Mr. Ricketts' discussion was a confirmation of the conclusions of the author regarding two of the installations described in the paper, supplemented by information concerning the amount of power recovered at a typical waste-heat plant.

In Mr. Lewis' discussion was given a description of a plant using waste-heat boilers in which the transfer rate is low, illustrating the other extreme from the plants described in the paper. In connection with the heat-transfer rate Mr. Lewis wrote: "It is true that the velocity of fluids over heated surfaces is a great factor in the transfer rate; it is also true that the greater the velocity the greater the pressure drop, and that the amount of the pressure drop allowable is determined by the cost of producing that pressure drop. Furthermore, the use of a high transfer rate is to reduce the cost of installation, and the reduction so obtained must be sufficiently great to offset the increased cost of power employed in overcoming the excess pressure drop."

Mr. Broido wrote that waste heat is also very often used in Germany to superheat steam; that in cases where, for some reason, superheaters cannot be installed in the boilers, or circumstances require the superheater to be near the engine, independent superheaters are recommended, and in such cases superheaters heated by waste gases are the ideal installation; they do not need the frequent and careful attention which independent superheaters with their own furnaces require. The superheat temperature can be easily and quickly regulated with a damper in the gas inlet. The superheater pipes remain permanently clean outside.

This writer gave a description, with illustration, of a superheater system he had designed and installed for utilizing waste heat from coke ovens and open-hearth steel furnaces.

MR. PIGOTT DESCRIBES GRAPHIC METHODS OF ANALYSIS USED IN DESIGNING STEAM POWER PLANTS

R. J. S. Pigott presented the second paper of the session, entitled Graphic Methods of Analysis in the Design and Operation of Steam Power Plants, a proposal for designing power plants based upon anticipated load curves, which he introduced in the following terms:

"This paper is the outcome of an attempt to standardize to some degree the process of designing steam-power plants. For the past few years I have been engaged practically exclusively in power-plant work, and what struck me, up to the time when this method which I am to present was developed, was what you might call the sloppiness in the methods used in designing steam power plants. Most of the problems have been settled by opinion rather than fact, by inference rather than methodical pursuit and analysis, and inasmuch as we are spending so much time nowadays in systematizing our management in other directions, there is no reason why we cannot systematize and standardize our method of designing a thing like a power plant.

An attempt was made, therefore, to utilize the water-rate curves and input-output curves to a greater extent than heretofore, and to combine them. The method is based on the use of the input-output curve for each piece of apparatus employed in the plant. It is not sufficient to take the isolated loads on separate apparatus to determine what will be the B.t.u. consumption per kw-hr. of the combined plant. If you are to find out what is the change occurring with a variation of load factor or variation of maximum load, you must find out what is the combined variation in units making up the plant, and the only way that this can be done with any sort of simplicity is graphically."

Walter N. Polakov called attention to several other methods than that of using the Willans lines as advocated and used by Mr. Pigott. He said that the limitation of analysis of the prospective working of a power plant which is contemplated to be built for New York City purely by the Willans method has the disadvantage, which Mr. Pigott touched upon himself, that it does not cover entirely other factors, for instance, financial factors, that are just as important and sometimes more important than the thermal efficiency of the equipment of the plant.

Norman G. Reinicker said he had used the same scheme the author proposes without quite so much trouble, by plotting the feedwater demand, as indicated by venturi meter readings for the same load over various numbers of days, and he had found that the effect of putting on another turbine would show up in that curve. This method saves the testing of various machines, and gives a rough calculation, at least. The graphical method is valuable where you can predict the load curve accurately, but in some plants it is hard to predict what may be expected.

James W. Parker said that the assumption had been made that the purpose of an auxiliary power system in a power plant and of the feedwater arrangement is primarily to obtain auxiliary power. The problem, as he saw it, is to heat your feedwater under all situations. At all times it is desirable to generate as much auxiliary energy as possible in the heating of your feedwater. If it is possible during the period of light load to take power for your auxiliaries from the main bus, and during the period of heavy plant load to transfer that from the auxiliary generator, if you have such an installation, to the main bus, you can use your main electrical system as a reservoir for the storage of energy, so to speak, and at all times have the cream of your auxiliary steam turned into auxiliary energy.

Two particular statements of the author brought out considerable discussion. The first of these was that in the Remington plant the average flue temperature for the month was below 400 deg. fahr., and in a case such as this a fuel economizer is out of the question. The second was that in the case of the Interborough plant the economizers were already installed and were removed simply because they obstructed the draft, and the high ratings required meant that they would have to be eliminated for the sake of the draft.

Dr. D. S. Jacobus and Messrs. Albert A. Cary, George H. Gibson, Sherwood F. Jeter, James W. Parker and Arthur M. Greene, Jr., participated in this discussion.

Joseph Harrington took up the question of size of combustion chamber which the author had said he had studied and which he cited as an additional factor in getting the flue-gas temperature down so low.

Albert A. Cary thought that the size of combustion chamber is not a fixed quantity but should be varied according to the amount of volatile matter in the coal.

The author replied to the various points raised in the discussion. As to the question of size of furnace, he said this depended more on how well you were mixing your gases and how long they were allowed to stay at high temperature before throwing them against the comparatively cold boiler tubes.

In reply to Mr. Polakov, he said that in one example in the paper an attempt had been made to make the graphical method cover the financial end. The maintenance and labor were considered and were balanced against the fixed charges.

MR. AZBE MAKES POINTED STATEMENTS IN REGARD TO WASTE OF FUEL IN POWER PLANTS

In a paper entitled Power-Plant Efficiency, Victor J. Azbe called attention forcibly to the preventable wastes in power plants, especially of the smaller or industrial types, these wastes aggregating about 30 per cent and being due to lack of foresight and business ability, improper design, and improper management and inefficient operation.

Summarized, the author's statements regarding wastes in power plants were:

"Lack of instruments to show whether a plant is operating efficiently is responsible for 10 to 20 per cent or more waste of fuel.

"The greatest and most neglected loss in the average boiler plant is from excess air.

"Economizers are not used more generally because their value is not realized. They are economical in small as well as large plants and the initial investment is usually warranted.

"To save the heat wasted by dirty boilers, pure or properly treated feedwater should be provided. It also saves in cost of cleaning and repairs and increases length of life and safety of the boiler.

"Preheating of furnace air is advocated as capable of easily saving 5 per cent.

"Many power plants that have economical prime movers have auxiliaries that are so uneconomical that the efficiency of the whole plant is greatly reduced.

"For industrial and heating purposes low-pressure steam should be used, reduced through turbines, engines or pumps; in other words, exhaust steam should be used. Using reducing valves to lower steam pressures, while not a waste of heat, is a distinct waste of power.

"About the most wasteful power plants are ice-making and refrigerating plants, often because of low load factor and sometimes from ignorance of proper handling of the machinery.

"Among economical prime movers, uniflow engines, locomobiles and exhaust-steam turbines are specially mentioned, and more general use of superheated steam is urged. Pro-

ducer gas plants, gas engines and Diesel engines also should find much greater application.

"More economical plants are necessarily more complicated and require better operating men. One-sided development such as inventing more efficient machinery should be balanced by educating the men to properly handle it.

"The greatest efficiency possible in a power plant is a good deal a matter of proper operation and management. Most power plants could make large savings this way, and there are exceptionally few where some improvement could not be made without purchasing new equipment. To obtain full benefit from the equipment on hand the men operating it must be made more efficient.

"Efforts should be made to obtain a government standard engineers' license law all over the United States, and the men should have facilities for getting the education necessary to meet stricter requirements.

"In agitation for smoke prevention it would be quite as much a public duty to save fuel loss as to avoid public nuisance. Many plants are wasting more fuel since operating smokelessly than before, because of using more excess air.

"It is suggested that The American Society of Mechanical Engineers form a Committee for the Prevention of Fuel Losses and General Betterment of Power-Plant Conditions, to devise ways and means whereby the best results could be obtained."

Mr. Azbe's paper drew out a voluminous discussion, not so much in the way of criticism of the author's statements, but more in the nature of general agreement with his views, the discussion resolving itself into the question of how best to put the author's recommendations into effect.

Practically everyone present agreed that power plants were wasteful, but some attributed the waste to the plant owners, some to the engineers and firemen, and others to some other factor. For instance, Joseph Harrington contended that the question of how you are going to improve the operating efficiency of a power plant was not one of apparatus, of equipment or of instruments, or anything of that kind, but was a question absolutely of the human element. Mr. Harrington considered that an incentive has to be supplied for the man at the end of the line; how this is to be done he did not know, but the matter must be adjusted with regard to all the surroundings and is one requiring judgment, tact and perseverance. He thought that something should be done for the compulsory education of the fireman and that a bonus system of some kind would supply the incentive which they now lack.

Strong exception to this contention was taken by Walter N. Polakov, who considered the trouble to be not with the fireman but with the owner or manager of a plant. How can the fireman do good work if he has not a competent leader? If the management or owner does not appreciate the importance of studying the processes involved, if he does not take into consideration the psychology of his employee, if he does not care to make a small investment for approved instruments, you cannot blame the fireman. In other words, if there is to be an educational campaign with the object of protecting our national resources, primarily fuel, the beginning must be made at the banking end, not in the fireroom—at the money end and not with the coal passer.

Edward A. Uehling took a middle course, attributing waste in power plants not altogether to the owners or entirely to the fireman, but partly to the lack of proper instruments. For example, the first instrument usually put in a boiler plant is a draft gage installed in a flue or stack. This is of no use whatever; the only draft gage of any considerable value is a double differential draft gage put on each boiler to give the resistance through the fire as well as that through the boiler.

P. C. Idell thought that one way to make the paper bring results would be to have an appendix giving summaries from different lines of business, showing how preventable waste had been dealt with and the waste overcome.

A. D. Baldwin suggested that the conclusions reached by the author be brought to the attention of the plant owner; he said he had had the pleasure of meeting both the engineer and the owner, and believed that today the engineer is converted without question.

R. J. S. Pigott, Wm. B. Jackson, E. N. Trump, L. C. Roberts, Albert A. Cary, H. R. Cobleigh, F. A. Wardenburg, Professor Estey, Irving E. Moultrop, Sherwood F. Jeter, Wm. F. Schaller, John Hunter, R. B. Clapp, Wm. H. Kavanaugh, A. M. Feldman, Frank L. Strong and D. S. Jacobus continued the discussion of the paper, which centered around specific cases of performance and the deficiencies of power plants which had come within the discussors' experiences.

In a written discussion of Mr. Azbe's paper, W. S. Gould considered that the author had overlooked the most essential point, namely, the character and quantity of the fuel used. It seemed to him useless to discuss the dollars-and-cents losses in any power plant when nothing is known or said regarding the fuel. Coal is too often considered simply as "coal" and assumed to be of some average quality. This is obviously an error. Illinois coal, to which Mr. Azbe evidently confined himself, varies greatly even in the same district and from the same mine. So it is with coal from every district.

At the close of the discussion of his paper, Mr. Azbe made a motion that the Society form a Committee for the Prevention of Fuel Losses and General Betterment of Power-Plant Conditions, to devise ways and means by which the best results could be obtained in power-plant operation. This motion was seconded by Mr. Hunter, who added to it that the committee be requested to publish from time to time the results obtained in the big power plants of the country, so that the membership of the Society might be kept familiar with the progress of the art.

THE ADVANTAGES OF THE IMPACT TUBE AS A MEASURING INSTRUMENT STATED BY MR. MOSS

The next paper presented was a discussion of the fundamental principles, arrangements for actual tests and formulae for impact tubes, by Sanford A. Moss. This discussion enumerated the advantages of the impact tube over the pitot tube, enunciated the law of the impact tube and gave its proof, deduced the impact-tube law for gases, and illustrated typical impact-tube arrangements. It demonstrated the use of the impact tube in calibrating the venturi meter and the orifice, and also for the exploration of irregular jets and for measuring the discharge of high-pressure air by means of an orifice and impact tube, etc.

In a written discussion, Victor R. Gage stated that the work done on blower testing in the Sibley College Laboratories verified some of the conclusions drawn by Mr. Moss in his valuable paper. In this work it was found that the impact tube gave reliable and consistent results, not subject to error from slight misalignment or from stream lines not parallel to the pipe walls. Difficulty had been encountered in obtaining a satisfactory method for determining the pressure head, or the so-called *static* pressure of moving fluids.

John L. Alden also presented a written discussion agreeing in general with the author's conclusions. He stated that the impact-tube law given is merely a restatement of the law of conservation of energy; in other words, the kinetic energy of the jet may be transferred into potential energy in the impact tube with only the immeasurable loss in the tube itself. Such a conclusion should be expected, as the impact tube is primarily an instrument for measuring energy.

The oral discussion of this paper was opened by Mr. Pigott, who gave his own experience with this class of work. Mr. Pigott said:

"One thing that seems noticeable in the nozzle is that for very high velocities the curve should not be too sharp, so as to induce too much of the stream neck to open still further than the nozzle. It is not so much the effect upon the average velocity ultimately, or upon the rate, as the effect upon the impact, making vibrations in the jet similar to those of imperfectly designed steam nozzles. I suppose in most of the work for which these nozzles were used that would hardly occur.

"I am very much inclined to agree with Mr. Moss as to the valuable feature of the single static hole in the pipe rather than the use of the pitot tube. The pitot tube suffers from two very pronounced disadvantages. One is you are never sure that current is flowing past it in the right direction, except you have some device for accelerating the flow, which invariably smooths out the eddies.

"A further disadvantage is that the static openings have not been decided upon definitely. We have had eighteen designs of pitot tubes, but they seem to have simmered down to the type used by Mr. Trump, with pin-holes in the side, the Taylor type being pretty much discarded; but it is quite certain from Mr. Moss's tests and my own, that the static hole in the side of the pipe will give accurate results on pressure, provided it is not in a place to take the sweep in a curve.

"There is one practical feature which can be overcome. Everybody desires to have a section of straight pipe on which to apply the pitot tube or the disk orifice or anything else that is used, even the venturi meter. That is inconvenient to get in many actual installations.

"It occurred to me when we were anxious to test the blowers installed in the 59th Street Station of the Interborough Rapid Transit Co. with forced draft, that a scheme somewhat like the spacer used in egg boxes would be the thing to kill eddies in a pipe, and that proved to be true.

"You can place a pitot tube or impact orifice right up against the exhaust from such a screen, and you cannot find any appreciable difference over the cross-section of the pipe.

"I have used the same scheme in connection with different pitot tubes for measuring steam. The use of such a screen will eliminate the necessity for having a long run of straight pipe up to the measuring device, whatever it may be—they are all sensitive to the same influences, and even the venturi meter feels the influence of eddy currents on the other side. If you use this device, or give it a straight pipe, the venturi meter does give the most consistent results in the measurement of the amount of steam or the measurement of the amount of water used in a plant.

"Next to that for general robustness of reading would come the disk orifice, and last the various forms of pitot tube, and if pains were used to get an absolutely satisfactory form, and pipes were led to the tube, consistent results might be secured. The fault is not in the pitot-tube device, but in the way it is handled.

"The pitot tube suffers from a disadvantage for steam and water measurements. In a pipe line you must deal with small pressure drops, and the pitot tube has the smallest pressure drop of any of these devices, and consequently any leakage is very much more important in the case of a pitot-tube device than in the disk orifice or venturi meter, which deal with larger pressure conditions. If it were not for that, I think the pitot tube, with the static arrangement in the pipe, could compete in most cases with the venturi meter or the disk orifice."

F. J. Richardson asked Mr. Pigott if he had found any difference in the velocity pressures where the velocity was low or high in using the screen, and Mr. Pigott replied he had not.

In reply to a further question of Mr. Richardson, Mr. Pigott said that where he had no room to make a long radius elbow in a pipe to reduce eddies, he avoided the friction drop by putting in a series of fins or turbine blades to direct the flow.

A form of device used on compressed air through a wide range of velocities was described by G. G. Crewson, who had tried out a number of forms of impact tubes. The peculiarity of this device was that the tube extending into the pipe was in the form of a vee, at a small angle, not over 30 deg., facing the flow. With this Mr. Crewson obtained more uniform results over a long range of flow than with any other types he tried. He attributed this to the fact that the tubes set up more or less disturbance in the flow of air themselves, and by making this long vee he could get the point of impact into the undisturbed flow as near as possible.

Wm. H. Kavanaugh gave an example from his own experience of a straightening device to take care of the swirl of water coming out of a standpipe used to water locomotives.

Edgar Buckingham pointed out that the devices mentioned by Mr. Pigott were quite often used in wind tunnels employed for experiments on the aerodynamic properties of aeroplane models. The egg-container device is used in almost all wind tunnels for getting rid of eddies and making the current as nearly straight as possible.

Regarding the turbine-blade device, in the Goettingen wind tunnel, where a fan is employed for pumping air around in a closed circuit, the place is rather small and there is not much space, and consequently they use in the corners turbine blades to save the space.

MR. REYNOLDS GIVES VALUABLE DATA ON THE FLOW OF STEAM AND COMPRESSED AIR

The fifth and last paper of the afternoon was by Herbert B. Reynolds, on The Flow of Air and Steam Through Orifices. The paper was in two parts, the first covering the flow of air through orifices, including a study of pitot and venturi meters for measuring compressed air, and the second the flow of steam through orifices at low pressures.

Mr. Pigott led out the discussion of this paper by extending the thanks of the Research Committee's Sub-Committee on Steam Meters to the author for the data in his paper, all of which he regarded as exceedingly valuable. He said Mr. Reynolds' paper will add to the data as to which is the best measuring device, but it is certain that both the disk orifice and the venturi meter present pronounced advantages over the plain impact tube for ordinary measurements about the power plant.

In connection with the practical use of the devices described, Mr. Pigott said his own experience tended towards the venturi tube, provided serious eddy currents are not allowed to enter into the up-stream side of the tube.

The disk orifice has one advantage which may offset, in the majority of cases, its chances of somewhat smaller accuracy. Suppose in installing a plant you provide for the maximum load to be obtained eventually in the steam, or compressed air, or what not, and put in a meter service to measure the flow. If you put in a venturi meter you spend an item of $200 or $300 in a tube for a 10- or 12-in. line, and the readings, after the first few months or a year, are very low and within accurate range of the recording instrument. The disk orifice for this purpose is particularly convenient, in that, in a couple of hours, when the vacuum is down, you can substitute for one size of orifice another size, and have the same recording instrument, and get high accuracy for low loads.

E. D. Thurston asked the author if he had had any experience in using venturi meters in parallel, not necessarily putting two on at a time, but a bank of venturi meters between two headers used in different machines as the demand for air varies. He himself had once used four tubes in a bank and found that with three shut off there was a record on the manometer indicating a slight pressure at the throat.

Frederick N. Connet explained this by saying that if there is a dead end beyond the venturi meter, a dead end at pulsating pressure, there is a constant vibration of the air back and forward from the throat, and a slight differential will be obtained, although there is no flow.

Mr. Connet described some experiments made at Providence in which air was measured in a somewhat simpler way than that described by Mr. Reynolds. The feature of these experiments was a method of measuring the pressure drop through the venturi meter by an electrical method whereby decrements of pressure could be measured with much greater accuracy than could be done by watching a large pressure gage.

A. G. Christie said he had checked the results in Mr. Reynolds' paper against some careful tests made a number of years ago on some Taylor tubes. The coefficient for the Taylor tube placed at the center of a 12-in. pipe was practically 0.8, and as far as he could interpolate from the curves in Mr. Reynolds' paper for a 2-in. pipe, the latter's value was 0.77. The similarity in the value of the two tests on entirely different sizes of pipes struck him as remarkable. In Mr. Rowse's paper in the Transactions of the Society for 1913, the coefficient for an impact tube placed at the center of the pipe, and using a hole on the side of the pipe for the static, was the square root of 80.

Another point in the paper which impressed him was the statement that below a certain number of cubic feet discharge the readings of the pitot tube were unreliable. He checked that over, and estimated that the velocity at which the readings became unreliable was practically 30 ft. per sec. He also checked the same thing in Mr. Rowse's work, and found he was getting results with considerable accuracy as low as 20 ft. per sec.

The question of the swirling effect in a tube was taken up by E. G. Bailey. He said he did not think it was generally appreciated how much this effect amounts to; cases had been found where, in the center of a pipe, at certain velocities the velocity is only 15 per cent of what it would be expected to be with a true elliptical flow, showing the centrifugal force due to the helical motion in the pipe to be enormous. When you get that into the throat of a venturi, there is nothing to stop the helical motion; in fact, its angular velocity is accelerated, giving an impinging force against the opening.

S. A. Moss thought the author had really presented data that showed the venturi meter to be much preferable to the plate orifice, and gave his reasons for arriving at that opinion.

The mathematics of both Mr. Moss's and Mr. Reynolds's papers was discussed by Edgar Buckingham, who said that many who are not familiar with the formulæ given, and similar ones for thermodynamic flow, have a higher opinion of them than is justified. For instance, essential conditions to the validity of Mr. Moss's formula for the velocity of a jet do not exist in practice. In such a formula so many assumptions have to be made that the ideal case to which it applies is far different from most actual cases, and therefore it is not surprising if the formula is not justified by experimental results. The moral is that the engineer, who often despises theoretical work, should not despise the theoretical formula, because he is applying it to a case to which the physicist knows it is not supposed to be applied.

TEXTILE SESSION, WEDNESDAY AFTERNOON

The Textile Session of the Annual Meeting of the Society was held on Wednesday, December 6, at 2:30 p.m., under the auspices of the Sub-Committee on Textiles, Charles F. Plankett officiating as Chairman. Three papers were presented at this Session, the first of these being one by Arthur N. Sheldon, entitled Heat Transmission through Various Types of Sash, in which the author gave particulars of experiments made with different types of wood and metal sash, both with single and double glazing, and of others to determine the cause of condensation in double-glazed sash and means for its prevention.

In opening the discussion of the paper, F. J. Hoxie inquired if any experiments had been made where two sash were placed some distance apart, and the space between them heated. Theoretically, he thought that it might be a good idea.

William Dean stated that he had found that one of the difficulties manufacturers experienced was that the holes in the sash let in dirt, which accumulated on the inside and made it almost impossible to clean it without taking out the glass. He believed that most of that dirt came from the inside. If a hole were put in the outside, with the colder air coming in from that side, he thought the condensation on the inside would be materially lessened, if not done away with. In the Bates Manufacturing Company's mill a double-glazed new sash was used, with ventilating sections in the sawtooth, which could be opened at times, and he believed when they got the colder air inside that it lessened the condensation more or less on the interior surface, which would bear out the result of Mr. Sheldon's test, that an outside opening would be preferable to an inside; but that presented the problem then of keeping the dirt and dust and water out, keeping it from getting into the air space, which no doubt could be worked out.

Charles H. Bigelow inquired to what extent double glazing was being used in factories, and also how much condensation there would be on the inside of a concrete roof, which was also likely to cause trouble, and what steps could be taken to prevent it at a reasonable cost.

In reply the author said that double glazing was used to quite an extent, not to so great an extent with steel as with wood, on account of the additional cost of double glazing

steel sash; and that additional cost, as described in the paper, sometimes worked out to a disadvantage, and it did not pay to do it. No doubt there would be a saving on wood in this locality of about 32 per cent, and there was no question about that being a paying investment. As regarded protecting the concrete roof, hair or cork insulation could be applied to reduce the heat loss.

William W. Crosby recalled particulars of a building of considerable size where steel sash were double glazed with about 1/4 in. of space between, and only about two-thirds of the usual amount of radiation was supplied, and only about one-half of the usual amount was in use on the coldest days. The building had a very cold exposure.

W. R. Cobb[1] stated that his firm had probably done more double glazing than any other in the country, and for twenty-three years had done more or less experimenting along that line. There was no doubt a great saving in coal by the use of double glazing. The principal objection to it was the accumulation of dirt between the two layers of glass, and if he were building a factory, he would want the double sash at least, so that one could get at all sides of the glass to clean it. His firm built hotbeds with double-glazed sash, and in the coldest weather they required no mats or shutters.

R. W. Weed desired the author to state his experience in comparing a double-glazed steel sash with a double sash. He had found that the great heat loss was due not to conduction through the glass, but to leakage around the cracks, etc., and that the heat losses would run around 80 per cent, whereas that due to conduction would be only about 15 per cent. For that reason he believed that the double sash was preferable to double-glazing sash, because it furnished a double insulation.

In reply the author stated that there was no doubt that two windows, a storm window outside of the regular window, would prove more beneficial as far as heat losses went than double glazing: but the double glazing was less expensive. In Canada they triple-glazed, with three lights, in refrigerating plants, etc.

D. Seabury stated that the double sash had an advantage where it was desired to put prism glass on the outside, as it gave a chance to keep it clean.

The author, in reply to a question by the Chairman, stated that the tests on heat transmission were made before the holes were put in the lights of glass. Later, they bored the different lights of glass with these holes, and then experimented further with regard to condensation, regardless of heat transmission. The holes were only about the size of a lead pencil, and placed near the bottom, so there could have been but very little heat loss through them.

A NOVEL METHOD OF STUDYING SPONTANEOUS IGNITION DESCRIBED BY MR. HOXIE

The second paper to be read was one by Frederick J. Hoxie, entitled Spontaneous Ignition Studied by Means of Photographic Plates, in which the author stated that various substances undergoing slow oxidation gave off hydrogen peroxide, which latter was capable of making a developable image on a photographic plate, the intensity of the image being roughly proportional to the rate of absorption.

Opening the discussion, Ira H. Woolson asked the author if he had discovered any difference in the activity of charcoal due to the variety of woods from which it was made; whether wood that contained resin, for instance, had any different activity upon the plate, as compared with the wood that did not contain resin.

The author, in reply, stated that he had found certain varieties of wood were more active than others, but that some other specimens of the same variety were not active, so that he was not inclined to generalize very strongly on that point.

C. P. Beistle[1] stated that charcoal made from beech, birch or maple was more liable to spontaneous ignition than that made from other woods. He thought the real cause of the risk in charcoal was due to the process rather than to the wood used. Most charcoal nowadays was made as a by-product of making wood alcohol and acetate of lime, and almost invariably retained a good deal of volatile matter. Formerly, charcoal was burned anywhere from seven to fourteen days, and was very hard and very dense, and almost free from spontaneous heating.

Leonard Waldo stated that he had had a case come up of an ignition of flash powders, and was very much bothered to find some simple way by which the rate of oxidation of magnesia, for instance, could be determined, so that it could be known what was taking place. He desired to learn whether oxidation of powdered metals, either with or without the presence of an oxidizing substance, would be shown by the author's orthonon plates, by simply putting the metal in contact with the plates and letting it stay there awhile exposed to the air; also whether there were any publications that gave extended lists of temperatures of ignition. If the gradual oxidation of metal could be shown, either in steels or lighter metals, by simply putting them on a sensitized plate, and developing the plate later, this would be a most important contribution to the technique of oxidation.

The author, in replying, said that he had never heard of any experiments being made on magnesium, but knew of no reason why they should not be made. In regard to the ignition points of different substances, there was quite a lot of information available. To say, for example, that the ignition point of wood was 500 deg. did not mean anything, for the reason that that particular wood had been exposed to light, whereas if it had been strongly charred, the point might have been changed materially.

Christopher H. Bierbaum desired to learn whether the photographs had been made by placing the substances in close proximity to the plate, or whether lenses were used, and also what plates. One question raised was whether the oxidation actually was in direct proportion to the actinic effect upon the plate. The chemistry of it was that we started with bromide of silver on the plate. The bromine, being a strong oxidizer, produced that salt in the presence of the actinic ray, so that it would readily change from a bromide to an oxide. That was done during the development. Was it not possible that it was all entirely due to the ionic potential of the substance? The question was whether it was actually due to actinic rays or vibrations in the hypothetic ether, or to the presence of ionic emanations, or a chemical change.

The author replied that the action was purely a chemical one. Apparently most any rapid plate could be used, but a slow plate could not be used successfully. Some exposures had been made on Lumière X-ray plates, a very rapid plate, and some were made on the standard orthonon, also a rapid plate, but in no sense were they photographs. The first impression was that this was a radio-active phenomenon, that it was an emanation from some substance, very much like the X-ray, but this had been found to be incorrect. One experi-

[1] With Lord & Burnham Co., 30 E. 42d St., New York.

[1] With Bureau of Explosives, American Railway Association, 75 Church Street, New York.

ment tried was to take a glass and put it over the object which was giving off the emanations, but there was nothing to indicate that there was really a substance coming off. If that had been a remarkably short wave of light, it could possibly have had a similar effect. He thought the active agent present was hydrogen dioxide. It was well known that hydrogen dioxide, when put in contact with a photographic plate, would make a developable image. The active agent might possibly be some other form of active oxygen, but ozone, without the presence of water, did not give this action.

Mr. Bierbaum thought that in the experiment made with the covered glass, if the author had taken a cover glass made of quartz crystal, and found that in one case he had the effect and in the other case he did not, he would prove it due to short waves, because the extremely short actinic waves would pass through quartz and produce actinic effects which were not possible through glass at all. He thought the author's experiments on this point were very interesting, because they seemed to indicate that the presence of ionic emanations produced the same effect as the short actinic wave.

The Chairman said that, in the interest of the cotton manufacturers, he would like to ask the author whether he had discovered that there was a material change in cotton fiber by the slow oxidation mentioned in the paper, which it was said is going on at all times, sometimes being on the outside of the bale, and having a moisture and temperature differing from that in the interior of the bale. And whether it had been found true that after a long time the staple was weakened on account of the oxidation which had been going on, possibly for years, before the bale had been opened for use.

The author, replying, said there was little doubt but what the strength of the staple had suffered. A common sight in almost any cotton mill, where pieces of sheeting were used for window curtains, was that where the moisture touched a curtain it turned brown, and had every appearance of being as thoroughly burned as if it had been in contact with hot iron; this was doubtless due to the oxidation which had taken place because of the combination of moisture and light. He had often found cotton and linen, linen particularly, which had been subjected to a comparatively low temperature, after a good period of years, that had every appearance of being as thoroughly charred as though it had been in contact with a hot stove. Doubtless that was due to the amount of moisture it contained. Mr. Hartshorn, in his classical work on moisture in cotton, mentioned the fact that cotton which had been submitted to changes of moisture and dryness for a considerable length of time seemed to lose its property of absorbing moisture, and of following the law which he had shown to exist for other cotton. Last year Prof. Naumberg, of the Institute of Technology, had made some further experiments along that line, in which he collected some old cotton that had been exposed to the air for a long time, and found that it reached an equilibrium to the atmospheric moisture at quite a few per cent less. Apparently, this was not a question of fungus growth, but was purely a question of the chemistry of cotton.

The Chairman remarked that cotton eighteen or twenty years old was now coming on the market because of the present high price. The question was whether there had been a very serious deterioration in the interior portions of the bale, by reason of combustion that had been going on slowly, but over a long period of years; whether it was really deteriorated so that it would be unfit for use, or suitable for the uses for which such cotton would be apt to be used. He also desired information as to cotton fabric piled in storehouses in bales. Many times discoloration was found on the part toward the windows. Was it true that there would be a deterioration of the strength of that fabric, and would the color indicate that the fabric itself had been injured by its storage, where it had received the rays of light?

The author, as to the first question, was inclined to believe that the staple would be found to be weaker, and, under certain conditions, considerably so. He thought that if the discolored cotton were boiled in caustic it would become as white as ever, but there would be less cotton, and that the process could be repeated until there was not much cotton left. Doubtless the action had something to do with the temperature. If the storehouse were kept at a very low temperature, it would no doubt reduce the action, but to what extent he did not know.

Replying to inquiries as to how the substances were exposed, he said that in the case of articles of wood they were placed in direct contact with the plate, but the oils were kept a little distance away, to avoid getting oil spots on the plate. The nearer the object to the plate the stronger the action was, and therefore it was desirable to get it as close as possible.

In regard to the photograph with a part marked "screened from sunlight," he would say that he took a piece of wood into a semi-dark room, so that the amount of actinic light was negative, and planed off the surface which had already been acted on by light. He then placed on it a piece of tinfoil which had a square hole cut in the center, and then placed it in the sunlight. Where the tinfoil was the sunlight did not strike the wood. He then took this into the dark room and removed the tinfoil and exposed the wood to the sensitive surface of the plate, and then developed the plate. The part of the wood which had been screened from the sunlight had practically no action on the plate, showing that it was a peculiarity of the wood which had been acted upon by sunlight.

Mr. Bierbaum stated that if the author had proceeded to expose part of a diamond to daylight, and then produced the same thing—he understood the diamond would have the same effect — the part exposed to sunlight would have a similar effect, that is, its actinic effect on the photographic plate would be the same. In that case there would be no chemical change, it would be purely an emanation.

MR. PERKINS DISCUSSES METHODS OF ELIMINATING VIBRATION IN TEXTILE-MILL BUILDINGS

The final paper of the Session was then presented by G. H. Perkins, its title being Vibration in Textile-Mill Buildings. After stating the nature of vibration in textile-mill floors, the author dealt successively with the causes of such vibration, the objectionable effects it produced, means for its elimination, and precautions to be observed when textile machines are mounted on rigid floors.

Charles H. Bigelow, in opening the discussion, recalled one building, erected about nineteen years ago on piles, that swayed back and forth in time with two 1200-kw. engines, 75 times a minute, so much so that the window weights could be heard to rattle back and forth in their casings. The actual movement of the corner of the building in relation to a pile of lumber 50 ft. away on a marsh was 3/8 in. When the two engines were running, the motion would come to be a maximum, and then would cease as the engines opposed each other. In another building he had found a 4200-hp. engine, under which the whole foundation moved around about 1/2 in.; this was stopped by anchoring the foundation to other parts

of the building. It was certainly a serious matter. How much actual power was lost in the machinery he could not say.

W. W. Crosby asked that further information be given by the author as to the curves shown in the paper, and that the plane of vibration be defined. He also desired to know whether the looms were driven by motor or by belt. He would say that he knew of a certain concern which had several foreign mills, built of rigid construction, with steel beams and brick arches, and they had hesitated about building a new mill with heavy beams and plank, as we did our slow-burning construction, because they thought it would be so full of vibration that the machinery would not last. After several years' operation, he had been told that as yet no undue wearing of parts had been detected which might be ascribed to vibration.

Henry A. Hale, Jr., stated that it had been found that the accidents to employees in spinning and weaving operations were largely due to carelessness. He thought nothing engendered carelessness more than fatigue, and if by eliminating vibration this could be cut down, and thereby the number of accidents, it appeared to him that the resulting economy was something that could not be overlooked. Additionally, the effect of vibration on operators was to slow them up in their work.

Ira H. Woolson inquired of the author whether vibration was a matter of common complaint with the operators—whether it was physically objectionable to them.

W. W. Crosby stated that he had heard of employees making serious objections to working on floors which were too rigid. Help that had been working on wooden floors had raised all sorts of objections because they had been put to work on concrete floors.

The Chairman stated that he had learned from the author of one mill where they still had, after fifty years, some wooden frame looms, and those looms were heaving in all sorts of ways every time the lathe moved, and still the treasurer of that mill said he was getting the best cloth from those looms, better than from the modern heavy looms, and that one could see the loom heave at all times, with every oscillation of the lathe. The Pemberton mill, in Lawrence, which collapsed completely in 1863 or 1864, was a very rigid building and only three years old, and it collapsed completely; and it was a question whether any building had been known to collapse from vibration. It was a rather interesting point, and the building apparently must have been well constructed to have shown as much rigidity as it did on all the floor surfaces in the mill. There were peculiarities arising from this question which made it an exceedingly interesting one. It was particularly important to the cotton and other textile industries to know whether to be alarmed by the oscillation that they found in their mills, or to know if their mills were too rigid that they might collapse, or that they might not get any better results, even psychologically.

In a written discussion, Maurice Deutsch[1] stated that it was often asked why English mills made such good yarn out of poorer cotton than used in America. The answer to this, he thought, lay in more rigid construction of the mills and the special attention given to the cushioning and arrangement of machinery. In a sawtooth weave shed in England, he knew of looms standing on flagstones and running at 220 to 225 picks per min. Just how rigid a structure should be, would depend upon the material fabricated and other conditions, but for textile mills he thought rigidity of structure should be sought for, and the detrimental effect of vibrations minimized by the proper application of composite absorption material between the machines and the structure.

It had been found that vibrations having a frequency of about 15 per sec. and a double amplitude of about 0.002 in. had generally been the cause for complaints made by occupants of houses in the vicinity of railway trains or certain types of machinery, also that a frequency of about 7 per sec. and a double amplitude of 0.0012 to 0.0016 in. could just be felt.

The important question of the human susceptibility to vibration was one to which little study had been given in this country. In England, however, some very interesting observations had been made by Mr. Digby and Capt. H. R. Sankey.

How far beyond the limit of perceptibility the vibrations recorded by the author were, might be somewhat appreciated when compared to the observations of Prof. E. E. Hall, of Berkeley, Cal., that when the frequency was 2 per sec. the double amplitude had to be approximately 0.004 in. before it could be felt. From many observations made in buildings the discussor had found that amplitudes as low as 0.002 in. when the frequency was over 10 per sec., were a genuine source of annoyance to occupants. It had been found that vertical vibrations damped out much more rapidly than did horizontal. The latter were more apt to produce detrimental effects to the structure, while the former might produce the greater effect on the machines and fabric.

Morton C. Tuttle,[1] in a written communication, gave numerous interesting and instructive particulars of experiences brought out in the course of the investigation of the effects of vibration now being conducted by the Aberthaw Construction Company. So far as the investigation dealt with textile mills, it seemed to show that vibration tended to increase the power requirements of machinery and to limit the speed of operation and hence the output. There was a certain diversity of opinion among the correspondents reporting, but this, it appeared, depended upon the type and character of building. It was made quite evident, however, that the most serious cases of vibration were found in old buildings or those unsuited for use as textile mills.

The author, in closing the discussion, replied to Mr. Crosby's queries, stating that the records given in the paper showed longitudinal vibration only. He gave particulars regarding the type of drive used for the various banks of looms, and called attention to the record taken at Station 1—about 50 ft. from a group of electrically driven looms, which showed that the vibration was transmitted undiminished in amplitude through the floor.

As to the question asked by Mr. Woolson, in all cases that had come to his attention, new help generally found vibration quite objectionable, but after a time they became accustomed to it. There were certain mills to which he went occasionally where he would not care to work himself for any length of time, and he felt a certain apprehension just in passing through them.

If he had understood the discussion of Mr. Deutsch correctly, that gentleman had indicated that if we should decrease the amplitude by making a more rigid building, it would be possible to increase the frequency: but he thought if Mr. Deutsch attempted to run 104-in. looms at more than 100 picks per min., he would be in trouble, no matter what sort of building he was in. It did not mean that these looms could be run up to 200 simply by installing them in a rigid building, such as they had in England.

[1] Civil Engineer, 50 Church Street, New York.

[1] Secretary, Aberthaw Construction Company, Boston, Mass.

TOPICAL DISCUSSION ON MANAGEMENT

It is the custom of the Society occasionally to hold meetings without regularly prepared papers, for topical discussion and the interchange of experiences. Such a session was arranged by the Committee on Meetings for Wednesday afternoon of the Annual Meeting, on Recent Developments in Industrial Management. There were three other sessions in progress at the same time, and it was necessary to assign to this session the small meeting hall on the twelfth floor of the building, seating less than one hundred. By actual count there were one hundred and twenty-five present throughout the afternoon, with a total attendance of perhaps two hundred, and much of the time there was not even standing room,—this in evidence of the very general interest in the subject of management.

COÖPERATION OF WORKMEN, BY E. E. BARNEY

The first discussion was by E. E. Barney, of the Remington Typewriter Company, on How to Secure the Coöperation of Workmen. He said that coöperation must mean more than "working together"; it must mean working together with common interest toward a common end which, when attained, should be mutually beneficial. In analyzing his subject he made a unique comparison of the laws of physical science with those of human nature, referring to the following phenomena and properties of matter: Density, specific gravity, heat, light, magnetism, and electricity.

For example, he said that *density* in physics referred to the mass of a body. Among mankind we also had density,—the mass,—the untrained, unskilled, the hopeful and the discouraged: a mass welded together, but alive and struggling, like a bar under tension.

Heat, he said, was positive; it caused most substances to expand. "Let us try the effect of heat or warmth on our associates, the workmen. Warm them with human interest. . . . Men are susceptible to sincerity, but often are slow in absorbing the warmth of sincerity. Like the metal which expands when plunged into the fire, they often shrink and resist the glow and warmth for fear of the motive which may lie hidden behind it."

Magnetism was a force easily likened to the qualities necessary in coöperation. One could not expect a workman to lead in the spirit of coöperation—he had not been trained that way. Too often the magnet of plausible argument which at first attracted him proved a repellant force when the real motive of selfishness became exposed.

Electricity was a subtle power which demanded control. It was the central conscious or unconscious thought which affected our acts toward those whom we would control or influence. In the development of organizations, cables were led from the central power to points where the power was needed. With ideas and ideals as the central power it was possible through proper mediums to convey these great distances; but make one break in the direct line, i.e., let one man of the direct organization fail to transmit the current of standards sent out from the head, and we would fail in delivering beyond that point the vital fluid on which depended the success of our hopes.

In conclusion, the speaker contended that to secure the coöperation of the workmen one must, as in the old colored woman's receipt for rabbit pie, "first cotch your rabbit,"—the mass,—the men. One must select the individual and classify him according to his ability; warm him with the interest he deserves; enlighten and train him to the advantage of both; attract him by fairness and consideration; and make sure that one's organization was carrying the proper message of the spirit of coöperation to and beyond the workmen, who were the most valued asset of any industry.

THE VALUE OF HUMAN RELATIONSHIPS IN INDUSTRY

In discussion of Mr. Barney's remarks, R. B. Wolf said that in scientific management one must study the forces which had been outlined, scientifically. When dealing with men and attempting to direct them in these operations, we were dealing with something in which the realm of facts found in natural law did not exist; in other words, man was a free agent. In dealing with material things there was a realm of facts which conformed absolutely to law, as in the conversion of water to ice at thirty-two degrees. We knew that such things always happened in that particular way. There were, however, many ways by which water could be reduced to a temperature of thirty-two degrees, as by carbonic acid gas, or by moving it northward to a colder climate. To obtain such change in conditions the will of a human being was essential. Man was the instrument for creating the conditions through which the natural law could operate, and must be reckoned with in that aspect and given more freedom and liberty for the exercise of his creative faculties.

W. S. Rogers, who said that for "twenty-eight years he had been a member of our venerable Society," but nevertheless was the "youngest one present," spoke at length in a reminiscent and anecdotal vein. Throughout he emphasized the importance of the *man* as an asset in organization, and gave many illustrations from his own experience to show that success and contentment for all concerned had come from a consideration of the human factor.

Thirty years ago his friend and preceptor, John E. Sweet, had built a special machine which the speaker went to see, and after inspection remarked, "It is a success." "No," said Uncle John, "I have made a big mistake. I should have built a man first."

Mr. Rogers related how in 1896 he went to Cincinnati on a two years' contract to take charge of an "old scrap pile of a plant" which was losing money. At the end of the contract they were making twenty per cent dividends, and the owners complimented him highly for the things developed by a mechanical engineer. As a matter of fact, he "had not used any mechanical brains whatever." He had simply studied and experimented with the men. He had not added a single new machine nor made a single new jig. Neither had a man been discharged nor a man added to the payroll.

Twelve years ago he had the desire of his life in a plant where he did not have to ask a man on the board of directors what he should do. The cash capital "was $14.95 and they could not borrow a cent." Today the plant was a great success and its stock was selling for "six times its original par value."

This was accomplished through coöperation with the men to make them feel that they were a part of the organization. Houses were put up, which they were assisted in buying. Profit sharing was introduced, and payments were made monthly, a plan he had learned in England. A shop legislature was introduced, with a House which met in the superin-

tendent's office and a Senate in the manager's office. In case of necessity they met jointly. No man could be discharged without bringing the case to the House, and if possible another place would be found for him in the works.

A special training school for employees was started. Charts were introduced in the House for showing the output of production. Once a month there was a meeting of the entire force, at which the different men or departments were shown where money was lost; and how such loss took money out of the other partners' pockets and how it might be rectified.

The trend of Mr. Rogers' remarks was that no matter how fine the buildings, how modern the machinery, nor how refined the system, all were worthless unless the man was considered of the highest importance and brought into the closest possible union with his employer. Buildings, machines and systems could always be replaced; but good labor must be evolved, and once destroyed takes years to replace.

GRAPHICAL CONTROL ON THE EXCEPTION PRINCIPLE. BY FRANK B. GILBRETH

In introducing the subject of the use of graphical charts in industrial establishments, Frank B. Gilbreth outlined the possibilities of eliminating waste through the use of the exception principle in management. No cost system, nor chart system, can be considered really satisfactory unless it fulfils the following requirements; i.e., it must determine and show:

1 What the quantities of individual outputs should be (prophecies of outputs).
2 Prompt records of individual outputs.
3 What the costs should be (prophecies of costs).
4 Prompt records of costs.
5 Causes of fluctuations and deviations of outputs and costs from prophesied outputs and costs.

It was obvious that the foreman, or other functionary, should see promptly all the records of output in his particular department. The time of the over-foreman, however, who might have several departments under him, was too valuable to attempt to examine all the records of all the men, and he should be supplied with information in concise form, such as was often furnished by "averages."

While ordinary averages had their use, their value was slight compared with the benefits which might result from concentrating the same attention on those individual cases which brought the average away from the ideal.

From causes marked on the chart it might be found that the worker's slow output was due to the lack of proper tools; to the routing system having failed to give him proper materials in the right quantities, in the right sequence, at the right time; or to the man's not having been properly instructed; to there having been an unwise selection of the man or the machine, or both, for the particular job, etc.

The worker, also, would be more careful not to do anything which was not expected of him, because he would know that the exception would surely be noticed by those higher up and would interfere with his chances for promotion or transfer to work of a more desirable kind. Knowledge that they might be investigated would create a tendency on the part of the foreman and the workers to coöperate with others whose work affected theirs, or who in turn might be investigated.

These charts, with the "exclusion zones," enabled the executive to eliminate the motions required for general oversight and inspection until a place on a chart was brought automatically to his attention where he could actually help those below him and furnish them with better instructions for handling their work more efficiently; or for making such changes as would naturally result in promotion, or the selecting or shifting of individuals better fitted to do work elsewhere. The possibilities of relieving the executive of unnecessary motions and of enabling him to be more efficient in his own work were not exceeded in the case of any manual worker.

STANDARDIZATION IN INDUSTRIAL MANAGEMENT. BY SANFORD E. THOMPSON

In introducing the subject of standardization, Sanford E. Thompson said that whereas apparatus and objects used in manufacturing had been extensively standardized, machinery had been improved, plant layout perfected, and in many cases the personnel of the managing force carefully selected, the standardization of the processes of manufacture were as yet almost ridiculously crude. We found laborers selecting their own shovels regardless of the class of earth, or the adaptability of a long or short handle, and we saw them using shovels in whatever way they saw fit. Workmen were not only allowed to select their tools, but allowed to utilize their material and to do the job in any way they chose. It could not even be said that they used their "initiative"; they simply followed in a rut, often a very deep one, worn out by their predecessors on the particular job in the particular shop.

Those who had given thorough consideration to modern industrial methods appreciated that there was one best way to do each job and that every operative ought to handle every piece of work by this standard method. Some might not agree with this, perhaps, because they emphasized too strongly the difference in make-up of different operatives; but the tendency was towards standardization. Not until we arrived at standards in methods of performing individual operations, as well as standards for the layout and general handling of the work, could we hope to have a properly managed plant.

Referring to stop-watches as an element in the study of methods, the speaker said that while they were a necessity for standardization, if they were used simply to find the time in which an operation was being performed, instead of the time in which it ought to be performed, they were comparatively useless. It was the getting at the proper methods and determining the proper tools and machinery by scientific study that meant real saving in time and material.

For example, in piece work where a level rate was maintained employees were all following the slowest and poorest man, and the management was helpless because it did not know the best or the quickest way. By giving definite instructions in all classes of work, just as was being done in many cases of machine-shop work, it was possible for the majority of the men to learn instead to work at the speed and by the methods adopted by the most highly skilled.

In certain kinds of work, standardization might be practically the whole thing. It was amazing how standardization simplified certain processes which had been considered so variable as to make it impossible to produce uniform results. A good example of this was in the cooking of sulphite pulp. The wood came to the digesters, which were large steel tanks, perhaps 12 ft. in diameter by 30 ft. high, where it was cooked under high pressure in bisulphite of lime liquor. Formerly it was the universal belief of all pulp manufacturers that on account of variations in moisture, differences in quality of wood, variations in the character of the acid, and many other variables, the largest of which was designated as "pure cussedness," uniform

lengths of time for cooking and a uniform product were impossible to obtain. Cooking, in other words, was an occult process known only by a few experienced men, and even with those experienced men operating the digesters, variables were impossible to allow for. Now, as a result of standardization which involved the manufacture of bisulphite liquor as well as the cooking process itself, it had been found possible to produce pulp from ordinary wood coming from various sources, which from the paper mill standpoint was practically uniform in quality, and to bring off the cooks at lengths which varied by not over five or ten minutes.

The standardizing in the digester house consisted essentially in determining the curves of pressure and temperature which should be followed during the process of cooking, giving these definite standards to the men handling the digesters and requiring them to follow the standards set. In order to obtain the most uniform results, however, it was found advisable, and very effective, to make definite records of just how much each cook varied from the given curve and give a bonus for maintaining the curve. Similar plans had been found very effective in other classes of work, illustrating very clearly how useful was the form of bonus payment for maintaining quality at a high standard as well as in other cases of maintaining standards of output.

A SPLENDID EXAMPLE OF COÖPERATIVE AND SERVICE WORK FOR EMPLOYEES

A. J. Baker, who was in attendance at the Annual Meeting as representative of the Cincinati Section, quite won his audience by the pleasing account which he gave of the Employee's Service Work of the Cincinnati Milling Machine Co. He said that he had conferred with a friend about the relationship between manager and employee, who remarked that he believed the main function of the people who adjusted this relationship was to arrange so that the employee could take home twice as much money as he did before; and in thinking it over he admitted that it came the nearest of anything to summarizing the whole result that it was desired to attain. If the amount in the pay envelope were doubled, everybody was happy; but if substantial progress were not made in this direction, no matter what the system, nothing would really have been accomplished.

At his plant the combination of the premium and bonus systems was used, although he believed their characteristics were so obscured that the founders of these, Mr. Halsey and Mr. Taylor, would disown them.

With this arrangement there was an inducement for high-grade men who did not content themselves with just reaching the standard time set, as well as for the standard man who just measured up to the time-study limit; and for the man who had secured his job under false pretenses and who was not worth the money he was being paid, there was an inducement to work up to the point where he *was* worth the money. As a result it has been possible to hold the organization together in a very satisfactory way during the period of labor trouble that has been expensive for Cincinnati manufacturers. That, he said, was the starting point of the special relations that had been established.

In the study of men and conditions, it was decided that the physical condition of the employee became a most important element, and a physician was hired and established with headquarters, who at once assumed the position of intermediary between the officers of the firm and the men in the shop. It was aimed as far as possible to return somewhat to the old feelings and close relations that used to exist between employer and employee, but which it had often seemed impossible to maintain under present industrial conditions.

It used to be that the apprentice was a member of his employer's family and the relationships were, of course, satisfactory. At the other extreme was the paternalism now practiced by some of our large organizations which, Mr. Baker felt, was not entirely in keeping with the institutions of this country, particularly if it extended to the time outside of office hours. His firm limited itself to investigation of the man during shop time, and, since it was difficult for the president, vice-president and other officials to attend to their business duties and also to act as the intermediary who would bring about the important personal relations which were desired, this trust was given to the physician, who, by virtue of his office and the character of his work, would be a very suitable and satisfactory man for the purpose.

It had proved that as many as 250 cases were sometimes treated in a day in a plant employing only 1600 men. They did not come necessarily because of serious illness or injury, but often because of minor things with respect to themselves or members of their families. The physician was thus close to the men and was often consulted on matters not related to personal health.

Among the matters investigated was the question of food. Oakley, the suburb where the works are located, had inadequate lunch facilities, and the men who did not live in the vicinity either brought a lunch with them, which they ate cold, or else went out to a saloon. After analyzing the situation it was decided to purchase a complete set of utensils, refrigerators, counters, etc., which were turned over to the employees, who were told to use the equipment for operating their own lunch room. They appointed a committee to purchase their own food and set their own prices; in short, they had a representative organization with which the management was not connected in any way, and it was extraordinarily successful. Starting with a patronage of 60 or 70 a day, there were now about 450 who secured their lunches there.

Here again the physician came in, for he was able to suggest to the men the dietetic value of certain foods and to assist them not only in securing good nourishment but in reducing the cost. By this means the health of the employees undoubtedly had been helped. A mutual-aid association was also started which the firm was supporting financially, but which was run by the employees and to which they contributed through a special fund for sickness benefits. Here again the physician, having the confidence of the men, was in many cases able to forestall serious illness.

It was surprising how many of the men were found to have incipient diseases unknown to them, which the physician discovered and was able to treat successfully because of their early discovery. Further, he could very frequently state to the superintendent that a certain man was not physically fitted for the kind of work he was doing, which would lead to his being transferred to a department adapted to his condition, thus saving the money lost in breaking in a new man, and winning the gratitude of the one who was transferred. No man was discharged without having the medical department look into the situation, and it must also be with the consent of the superintendent. As a result of the careful investigation it was often possible to find the cause of the failing and to put the man in some other department where his peculiar make-up would not conflict with that of the foreman of the department.

Referring to a remark by Mr. Rogers to the effect that one should "study to make them believe they are a part of us," he said it was an ideal expression of what the firm was trying to

do. While his own statement at the outset as to the financial end was a little more cold-blooded, in the end they were trying to make the men believe they were a part of them, and not only believe, but that they actually were a part of them. That was the whole thing. In order to encourage this attitude, records were kept. The speaker outlined a plan for paying a monthly or quarterly bonus, according to the average output of production per man, in addition to the extra earnings which a man would receive from his own individual increased production.

Mr. Baker further referred to the labor situation in Cincinnati more than a year ago, when a strike was declared in many of the plants in the downtown section of the city and where in the different plants the strike was more or less successful. Later, the attempt was made at Oakley and not over 30 or 40 men responded, and within a short time there were more men working than ever before. Without any suggestion or assistance from the management the responsible men in the shop got together and went over the whole situation and decided that it would be for their interest to combat the strike. An anti-strike committee was formed, which was most influential in averting the threatened labor troubles. Thus the men with whom these better relationships had been established fought for the firm when the occasion arose.

AN APPEAL FOR THE DURABLE SATISFACTIONS IN LIFE FOR WORKMEN AS WELL AS EMPLOYER

Richard A. Feiss, who came into the meeting as Mr. Baker was speaking about personal relationships in his organization, testified to the excellent spirit which he knew existed there, and which he said was as fine as in any plant in the country but one, and that one was his own.

While democracy was one of his hobbies, he felt that the durable satisfactions in life did not necessarily come as a result of any one scheme of organization or system. The tendency among business men and engineers was to think that when they had a good thing it was the only thing in the world. That was not true. If one analyzed Rogers' profit-sharing plan, or Gantt's method of paying bonuses, or Thompson's method of paying premiums, they would be found simply to be different methods for accomplishing the same thing, and their success would depend upon how they were worked out and what was the spirit back of them. In his own plant they were using a type of piece-rate system, by which he was sure that all of his 800 employees were as much partners as were Mr. Rogers.' The employees themselves did not pass upon the hiring of others, because he and they did not think they were competent to do so. An expert was employed to study the question and to pass upon them. He believed democracy which was subject to expert rule was the coming democracy and the one which America would have to adopt in order to become efficient.

He said that people work for two things: they work for money and they work for other satisfactions, such as contentment. If one thought they worked for money alone, let him try to get away his own employees: and if one thought they worked for the other thing, he might try to hire them without paying them.

The dollars-and-cents proposition must be looked after at first so that the workmen may procure those things which mean home and a decent standard of living,—and even a higher standard of living, because a man who stagnates is like a flower which grows no longer but fades, withers and dies. It must be realized that everybody, whether customer, worker or boss, must make progress and have an ever-increasing share of the things of the world; and then the important principles must be realized that the greater fruits of industry are only procurable by greater productivity and that greater productivity is only obtainable by mutual coöperation.

EFFICIENCY FOR THE MAN HIGHER UP

H. L. Gantt said that a lot of people had been talking efficiency and getting up fine charts, and when asked what they did with them they would say that they did nothing. We were all making charts to show how efficient the workman was, but very few were making charts to show how efficient the management was. There might be workmen doing something that did not need to be done at all, and doing it very efficiently. Until our efficiency system reached up to the executive and we could measure the efficiency of our executives with the same degree of accuracy that we now thought we were measuring the efficiency of the employees, it would not amount to very much.

Mr. Gantt referred to the Valuation Session to be held the next day and said that most of the valuation by accountants and financiers gave the valuation of bricks and mortar and machinery; but he had noticed in Mr. Polakov's paper to be presented, on Valuation of Industrial Properties vs. Valuation of Industrial Methods, that the value of machinery was not in the machinery itself but *in how it was used*,—in other words, in the human element behind it. Mr. Rogers had told about the little old plant that had gone to pieces and when he took it was not paying expenses; but by putting men and brains into it he got something out of it. How would public accountants have valued that plant before Mr. Rogers went there, and afterwards? They did not know how to do it and engineers must tell them how. Until we could measure and value the human element we would not be able to get anywhere in this work.

GENERAL DISCUSSION

By way of comment on the different systems of paying wages—premium, bonus, piece work, etc., W. S. Rogers raised the question of what was the distinction between a bonus and a tip. Were we tipping our men to do good work? At his plant the men were not paid on this basis for doing good work. They were partners. Every month they went to the bulletin board and read the comparison of sales as well as the comparison of their day's or month's work with the previous day or month. In response to an inquiry as [illegible] times, when he might have to lay off help, Mr. Rogers [illegible] that this had not been necessary. His [illegible] in times of business depression he ha[illegible]

W. O. Platt offered himself as [illegible] man who does not use charts." He [illegible] did not even have a time clock. T[illegible] a small business the question would [illegible] one must have in order to put in [illegible] Mr. Gantt's charts. He might be told that [illegible] age in efficiency by having [illegible] percentage by not using stop watches, no experts to analyze the motions of his men; and another percentage by having no time clocks. While he said he must admit that he was older than some who were present, and perhaps less active, he had found that every one of the devices or expedients mentioned took time and energy, and that unless this fact was considered the system would get top-heavy.

The point was made by A. R. Burnett that graphic charts such as had been mentioned as being prepared for the informa-

tion of the operatives should be used also to bring the executive closer to the details of the work. In reply, R. B. Wolf explained that he was using such charts to show the men what they were accomplishing and what was the progress of their work. This gave them the factor of interest and joy in their work, about which Mr. Feiss had spoken. He thought it was not necessary for the executive to be informed upon all the records contained in these charts, and a great many of them are not seen by the executive unless there is some particular thing for him to see.

The discussion was closed by David Myers, who said that he had dealt with one phase of efficiency, that which related to the factory power plant. He put forward a formula which seemed to him to sum up the whole situation very simply in two factors: the efficiency of any process was equal to the equipment modified by the human factor.

MACHINE SHOP SESSION, WEDNESDAY AFTERNOON

The Machine Shop Session was called to order by H. K. Hathaway, Chairman of the Sub-Committee on meetings for Machine Shop Practice, for the reading and discussion of two important papers on Standardization of Machine Tools, by Carl G. Barth, and A Proposed Plan for the Activity of the Machine Shop Practice Sub-Committee, by H. K. Hathaway. The audience was pleased to allow Mr. Barth an extension of the ten minutes' allotted time for the presentation of his paper. He gave his arguments with spirited energy and conviction, and illustrated his talk with lantern slides and deft sketches on the blackboard.

The object of Mr. Barth's paper was to enlist the coöperation of the Society in encouraging machine-tool builders to adopt certain standards for machine tools. He believed that a universal speed series should be used by all machine-tool builders for all machines such as lathes, boring mills, milling machines, drill presses, etc. His ideal of the generally accepted geometrical progression of speed is represented in the progression:

$$1 \quad 2^{\frac{1}{4}} \quad 2^{\frac{1}{2}} \quad 2^{\frac{3}{4}} \quad 2 \quad 2\cdot2^{\frac{1}{4}} \quad 2\cdot2^{\frac{1}{2}} \quad 2\cdot2^{\frac{3}{4}} \quad 4 \quad 4\cdot2^{\frac{1}{4}} \ \ldots\text{etc., or}$$

$$1 \ 1.1892 \ 1.4142 \ 1.6818 \ 2 \ 2.3784 \ 2.8284 \ 3.3636 \ 4 \ 4.7568\ldots\text{etc.}$$

His views on speeds hold also for feeds, except in the design of lathes in which the feeds for plain turning are obtained as a constant fraction of the screw-cutting feeds.

While the adoption of a standard speed series for all machine tools would be a step in the right direction, it would have to be accompanied by the adoption of a standardized amount of power.

For lathe centers, drill-press and milling-machine sockets, the speaker unqualifiedly recommended the universal adoption of Brown and Sharpe standards. He recommended the universal abandonment of the tang as a method of driving drills. The Barth key, with two sides beveled at 45 deg. and subject only to the crushing pressures, was adopted by himself some years ago as a drill drive.

Mr. Barth was extremely anxious that his paper be discussed freely by all present at the meeting, and the opportunity was taken by a few. William Kent's endeavors to learn why the Barth key was not supplied with beveled sides on both shank and socket sides resulted at last in a satisfactory answer after a keen competition at the blackboard and a threshing over of fundamental principles.

Adolph L. De Leeuw said that Mr. Barth had plainly showed how a good geometrical progression could be worked out and that it was an absolute necessity in all machine tools. Large boring mills, however, might be better without the geometrical progression as, when a large flywheel is turned, there is need for cutting at the rim and at the hub, but nowhere else, 90 per cent being cut at the rim and 10 per cent at the hub. Hence, the speeds should be bunched together to be correct for working at the rim and hub.

The time had come when the proper geometric speed series ought to be more closely studied. The attempt made by Mr. Barth to point out a geometrical progression which would be universally applicable deserved the highest praise. Personally, he believed that the progression as laid out by Mr. Barth was about as good as could be got under the conditions and with the knowledge we have at the present time.

The speaker regretted that there have been no investigations made on the art of cutting metals except for lathe work and for roughing cuts. Also, whereas everything possible has been done to study the matter of changing speeds on lathes, practically nothing had been done to provide for the necessary speeds and feeds on planers. The experiments on cutting angles had been carried on only through a small range. He said that he had personally made some little experiments with tools at an angle of not more than 25 deg. and found some very surprising results. He believed that if the Society as a whole would stand behind such efforts as Mr. Barth had spoken of, to standardize the range of feeds and speeds, much could be accomplished.

In an oral discussion, Harry V. Haight said that he agreed with Mr. Barth in the matter of belt feed. It had been his experience in the building of some two hundred lathes for munitions work that a 3-in. belt was sufficient to supply any demand for power and that any series of geometric progression of feeds could be obtained by changing pulleys. In contrast to this experience is that with expensive drill presses which were idle so much of the time because of broken gears.

MR. HATHAWAY OUTLINES HIS PLAN

Appointing Ralph E. Flanders to the chair, Mr. Hathaway took the floor for the presentation of his paper. Impressed with the fact that technical and scientific societies should be agencies through which constructive work leading to the development of a profession should be carried on, he proposed a definite plan of action for the Sub-Committee on Machine Shop Practice. He held that the sub-committee should classify the members of the Society with respect to the phases of machine-shop practice on which they were qualified to present papers, and should make a consistent effort to secure such papers.

A second and even larger undertaking would be the prosecution along predetermined lines of research that would result in definite advancement of the art. At present this is left almost entirely to the enterprise of individuals or companies, with no coördination of effort. Such work is now undertaken by committees of men whose time is so fully occupied by their own affairs that they can at best give an insufficient amount to the problem in hand. It would be better if the Society could employ experts who might give their entire time to investigation and research. A classification of machine shop practice had been worked out by the author and ap-

pended to the paper, arranged on the mnemonic system and so designed as to permit of easy expansion.

The interest in Mr. Hathaway's proposed plan was plainly evidenced by the discussion, written and oral, which followed its presentation. Mr. Flanders read three discussions, from Henry Hess, Robert C. H. Heck and R. J. S. Pigott. It is understood that the complete discussion will be published later.

Henry Hess pointed out that there are within the Society a number of committees which should concern themselves with the projects outlined in the Hathaway paper. The Committee on Technical Research is the logical agency to which investigation and experimentation should be entrusted, special sub-committees being appointed for definite tasks. A Research Committee is in existence but inactive, the Finance Committee having awarded it, unasked, "the munificent sum of $300" during the past year. The various Standards Committees sometimes concern themselves with certain phases involving research, but in too haphazard and uncorrelated a manner to secure the best work at the least cost. Special committees are occasionally appointed to deal with definite subjects, and could be aided by an adequate Research Committee.

Mr. Hess suggested a general supervising committee, not one that actually carried on research. It should originate or pass on projects for research brought to it, and advise the Council of the advisability of the Council's creating sub-committees, each to deal with a special line only. It would supervise the work of the sub-committees and the expenditure of the funds allotted to them, and strive to secure coöperation of other committees.

In closing, Mr. Hess said that it had been recognized by at least one engineering society that research of this character is quite within its functions, that it should be coöperative rather than left to individual effort, that it could be effectually carried on by such coöperation, and that effective aid and coöperation for the general benefit could be secured also from private interests that are quite ready to recognize that though their aid is to some extent altruistic, it is also directly beneficial from a personally selfish standpoint.

Prof. R. C. H. Heck made a plea for systematic information on cutting speeds, feeds, etc., not the extreme results of experiments that point the way to the future, but good routine average practice in up-to-date shops. This should be in the nature of handbook information, with due statement that practice is progressing and that quantitative values are subject to change. . . . What is wanted is, perhaps, a collection of well-selected examples rather than too definitely stated conclusions from such data.

R. J. S. Pigott, in full agreement with the attitude of Mr. Hathaway, stated that the principal difficulty in the way of getting adequate results accomplished is due to the utter lack of coördination between the various individuals and societies undertaking scientific investigation. One of the principal reasons for the comparative inefficiency of American manufacture is due to the attitude of secrecy which has all too frequently been taken.

Of the great mass of information on machine-shop practice available only a small amount has been collected by isolated investigators. A committee as outlined by Mr. Hathaway, having proper authority and a reliable system of effort, could do a great deal toward rendering this information useful to all engineers. The committee, to accomplish results, must be handled more like an operating company than a council of advisers. Mr. Pigott favored the Dewey rather than the mnemonic system of classification.

A. R. Shipley expressed himself as heartily in accord with the Hathaway paper. He dwelt upon the fact, brought out in the paper that engineers and men in charge devote too much time to the perfection of the design of their product and not enough time to the production of that product, a fact which is the cause of mismanagement in the machine shop.

Speaking of the small amount of literature dealing with machine shops to be found in the Society's publications, he said that more articles of a less technical nature are needed. Many papers given before the Society cover too large a field, and do not deal concretely enough with a specific subject. He believed that some such plan as outlined in the Hathaway paper would go a long way toward solving many of the difficulties which confront most manufacturers of machinery.

Henry J. Eberhardt suggested that the classification of data from technical journals, scientific transactions, foreign publications, etc., should not extend back further than one year at the outset, in order to determine how valuable further research into the past would be. He foresaw a possible danger in starting a large museum of ancient practice.

A much better method of using the committee would be to coöperate intimately with the Research Committee and to suggest to the commanding officers of U. S. Arsenals, Navy Yards, and others in Government service, and to the students in post-graduate technical work, the use of mechanical equipment in those various institutions for definite research work and tests. He cited the case of an inventor interested in the use of aluminum rather than bronze bearings for a steel shaft, and the impossibility of finding proper authoritative data. Tests made by the inventor himself would be narrow in their scope, but a well-planned test, using different diameters and a wider range of materials, might lead to practical discoveries.

The great opportunity for the Committee would be to bring before our members each year the best results of the past year's experience in typical shops. It was his hope that some such plan might be in full operation very soon.

"I wish to give this paper my hearty commendation and hope that Mr. Hathaway will keep on with the good work," said William Kent in opening the oral discussion. Mr. Kent believed that the machine-shop branch of the mechanical engineering profession had been given too little attention. The work to be done by the proposed Committee was to ask questions. Ten thousand questions might be asked of the men in the different shops, but it would first be necessary to have a secretary and a card index. Then, with questions asked and distributed around, it would be possible, perhaps, to have ten answered per year.

Mr. Kent favored the mnemonic system, which allowed 8000 combinations of three symbols, whereas there were only 999 possible with the Dewey system.

John J. Ralph thought few people knew how to buy machine tools. The prejudices of the buyer and the persuasiveness of the seller entered too greatly into the purchase. Nowhere was there a list of the basic facts which should be considered before a tool is bought. The various types of machine tools are not even known in the average shop. Catalogs and trade-paper advertisements constitute the principal source of information. There should be a standard method of testing machine tools for accuracy. There being specifications for the test and acceptance of boilers, why not for machine tools?

Elmer H. Neff suggested that The Journal devote a page per month to questions on machine-shop practice which required answers. He was certain that the results of experiences sent in response to the questions would bring the desired information.

Wm. T. Magruder commended the paper and said that the Gas Power Committee sometime ago had attempted similar work, but without results. The colleges would be glad to cooperate with the manufacturers if the latter would come to the colleges with their problems. If the problems were larger than could be undertaken by a single institution, they would be solved piecemeal by several of the colleges working together.

Other discussion of a commendatory character was offered by Chas. J. Simeon, Carl G. Barth, and others.

In closing, Mr. Hathaway explained that he could not then answer the points brought out in the discussion, but that his formal closure would appear later in the Transactions. He did suggest that the Committee must distinguish between questions of design and machine-shop practice. It should confine itself to questions of practice.

FIRST VALUATION SESSION, THURSDAY MORNING

THE First Valuation Session of the Annual Meeting was held on Thursday morning in the Auditorium, Vice-President Henry Hess acting as Chairman. Three papers were presented for consideration and, since all of them dealt with the same general subject, were read in succession before the discussion was opened, the first two by their authors and the last by the Secretary, in the absence of the author. The first paper was by J. G. Morse, entitled Accurate Appraisals by Short Methods, in which the author described the method of appraisal developed by the Associated Factory Mutual Fire Insurance Companies, which combines approximation with theory, and is much shorter than one necessitating a complete and elaborate detail. The second paper, by Prof. John H. Gray, was entitled How Does Industrial Valuation Differ from Public-Utility Valuation? and dealt with the valuation problems growing out of governmental attempts to regulate the various public-service industries. The final paper, The Relation Between Perpetual-Inventory Value and Appraisal Value, by Charles Piez, emphasized the necessity for determining proper rates of depreciation in order to establish true costs of products.

MR. GANTT OPENS THE DISCUSSION

H. L. Gantt, being called on to open the discussion, said that things had so changed in the world in the last two years that a great deal that Professor Gray said, he thought, was a little out of date. It might be good law, constitutional, and proper, according to our viewpoint of a few years ago, but we were thinking in different terms today. The war had taught Europe something. England had just made a change and put Lloyd George at the head of the Government. They had brushed aside the powers that had controlled, and had put the power in the hands of the man they believed most capable of "delivering the goods." Our laws and our regulations would have to be so adjusted as to produce the greatest possible values for the community. England, to save her life, had been obliged to do that.

We were in a class with England, and had not learned from the war as England had. If we were ever confronted with the same problem that England was, our salvation would come through the men who knew how to do things, and a solution of our problems would be in the hands of our engineers rather than our financiers.

Professor Gray's paper related to a condition of affairs when the financier was the supreme power in the world. Today the engineer was successfully disputing that power with him in the warring countries.

No theory of valuation would be complete in the future unless it took account of the value of the engineer, and Professor Gray had left this entirely out of his calculation.

A. E. Flowers asked for a definition of the term "reducing balance" employed in the table of depreciation rates in Mr. Piez's paper.

In the absence of the author, Carl G. Barth explained the term, stating that if a machine was worth $1,000 today, and it was depreciated 10 per cent on the reducing balance, it merely meant $100 for the first year, and 10 per cent for the second year, and that left 90, and the amount would never be entirely extinguished. If a machine depreciated 10 per cent a year, however, its value would be wiped out in ten years.

Speaking to the papers, he was convinced there had not been a single improvement made on the accounting and cost system that Mr. Taylor invented twelve or fourteen years ago. Mr. Taylor had started out with the idea that the simplest way of proceeding was to get a cost that was such that the difference between selling price and cost price was absolute profit. There was no question about that being the correct point of view. He wanted nothing to go into the cost except the things that had been expended or lost in carrying on the business.

Regarding Professor Gray's paper, Charles Whiting Baker thought it incorrect to state that the reason for establishing public regulation of utilities had been to stop speculation. It had been the shippers, the travelers, the people who bought gas and electricity, who rode in the railway trains and cars, who were behind the great movement that demanded public utilities should be regulated, rather than innocent purchasers of worthless securities. He was unable to understand why Professor Gray did not accept the cost-of-production theory of valuation, as it seemed to him to lie at the base of our whole work of valuation. In all our valuation work it was necessary to go back to this theory. Suppose a manufacturing concern were to issue a balance sheet showing what its property was worth, based on its earning power. Now, its earning power would vary from year to year, and every competent appraiser knew that the only safe way to value an industrial property or a manufacturing property was to value it at what it would cost to replace the buildings, put the machinery back there, and duplicate the plant as it originally stood. Why? Because in the nature of the case some other competitor might come along the next day and duplicate the property and go into the business; so the only safe way for a fair valuation was to base it on the cost of reproduction.

DEFINITIONS DEALING WITH DEPRECIATION

In a written discussion of Mr. Morse's paper, Harry Barker[1] contrasted the high and burdensome costs of public-utility appraisals with the moderate figures resulting from the use of the author's method. In his opinion, the pioneer utility appraisers had felt impelled to present an impressive array of evidence and to substitute for experience and ac-

[1] Associate Editor, Engineering News, 10th Ave. and 36th St., New York.

cumulated data a logical system of scrutinizing property details. The older commissions, however, should have accumulated by this time sufficient data to be able to adopt the author's methods if that were deemed desirable. It would be helpful to learn how the author would apply his methods in cases in the utility field where the effect of seeking out original conditions of construction might change the valuation result by 100 per cent or more over figures based on present conditions as superficially indicated.

Turning to Mr. Piez's paper, Mr. Barker said that the fundamental term "depreciation" had become so involved in a maze of differing definitions, that even when engineers endeavored to use it quite technically it conveyed different ideas to different persons. In an attempt to harmonize some of these differences he had been led to study the various meanings attaching to the term, and had found that it was possible to clear up matters by employing six definitions, having different shades of meaning, which definitions he appended.

In a written discussion commenting on the possible value of a valuation, L. K. Frank[1] said that it was not improbable that industrial property might be subject to public regulation of return on investment before the close of the century. The Federal Trade Commission was advocating the adoption of accounting methods by the manufacturers of the country, which in many instances would call for valuation work, and upon the care and industrial statesmanship of the engineers involved would depend the future course of this movement for social control of industry. Social progress was inevitable, and it was open to the engineers to play a part in this movement, the importance of which could scarcely be measured.

The Chairman called on Dean M. E. Cooley, who, among other things, said that he felt a degree of responsibility concerning the use of the word "depreciation" in connection with appraisals. It came up in connection with the appraisal of the Michigan railroad properties in 1900, and had come to play a very important part in the decisions of the various State Commissions since organized; a most unfortunate part, he might add, for it was not entitled to have the use that had been given it, and should be discarded in certain classes of investigations. For example, there was now in process of solution a valuation problem of a very large utility property not far from New York, which involved the depreciated value of the property as observed. It was a complex electric light and railroad property, involving many plants, old and modern. In the old plants the machinery was about ready to be discarded, and the machinery of the new plants substituted. The question was as to the value of the machinery to be discarded. It had perhaps been valued by observation, being 20 or 25 years old, at, say, $180,000, and the question raised had been whether that was a fair value. So an investigation had been made to determine its present real or commercial value, comparing it, in an economic way, with the machinery of a new plant. Considering the distance between the two plants, the necessity for constructing transmission lines, and the necessity for wiping out in a sinking fund or otherwise whatever value there might be in the old plant, the commercial value of the old plant today, instead of being $180,000, was about $360,000!

DEPRECIATION NOT INVOLVED IN RATE CASES

The word "depreciation" had no place whatever in the investigation of a rate case. For example, a railroad was made up of a vast number of elements, all new in the beginning and each having, say, 100 per cent value. After a few years the elements—ties, rails, locomotives, cars—wore in various degrees, and were replaced by new elements. After, say, twenty-five years this property would come to a stable condition and would continue to exist in perpetuity in a condition less than 100 per cent for each of the elements, but in a condition which might be expressed, say, by 80 or 85 per cent. It could be demonstrated very conclusively that to attempt to maintain such a complex property at a higher percentage than what we call its normal percentage would be a waste of money, because elements would have to be thrown away or discarded before they were worn out. Also, if the property were maintained at a very much lower percentage it would be equally a waste of money, because the property itself would be endangered and the business which it could do would be diminished. The property could, in this 80 or 85 per cent condition of efficiency, render the maximum service which it was capable of rendering. To obtain it in a normal condition, expressed by 80 or 85 per cent, we had had to expend 100 per cent. Therefore, that was the investment, and it could not be had for anything else. If there was 100 per cent investment in that property standing at 80 or 85 per cent condition, as we value it, there being, say 15 or 20 per cent depreciation, then we should allow in a rate-making case 100 per cent, and depreciation would have no purpose whatever in the problem.

The word "depreciation," however, did have value in other cases, and it might have value in a rate-making case where, for instance, the financial policy of the company had involved the laying aside of money which the English would call a "sinking fund" to back up the difference between the 100 per cent and the 80 or 85 per cent. If the earnings had already been sufficient to enable that to be done, then perhaps we should take the 80 or 85 per cent for the rate-making purposes rather than the 100 per cent, but in America we took our sinking fund in the form of dividends.

THE PRODUCTIVE LIFE OF A PLANT

L. S. Randolph stated that he had had a great deal of difficulty with the word "depreciation," and in figuring out such questions attacked the problem in the beginning by assuming that a piece of machinery or plant could be so repaired or renewed as to do the work as well as when first erected. After that it was a question, first, of using the word "obsolescence," and then the term "productive life," or, in other words, what would be the productive life of a plant, and that, he thought, would have to be laid aside to return the value of the original investment of the plant when the productive life had ceased. He had come across some cases—in agriculture—where apparently the productive life was infinite, and where there was actually appreciation of value. Sometimes legal enactments would abruptly cut off the productive life of a plant.

Engineers, Morris Knowles thought, should be very much interested in such a paper as Mr. Morse's, because the fact was obvious that appraisements were costing enormous sums of money. There was much unnecessary refinement, and in the end the people, the rate payers, were paying for these things. In Pennsylvania all matters of fact were referred to an Engineering Board consisting of one engineer appointed by each side and the chief engineer of the Commission sitting as chairman. Engineers when they faced each other across a table understood whether each one knew what he was talking about, and they did not have to count all the bolts and nuts and gaskets which were used in a steam pipe to determine that a certain number of boilers cost so much money. They could

[1] 15 Dey Street, New York.

persuade each other, and it was different from trying to persuade an attorney or the Court.

He would like to differ from Professor Gray in one respect, and that was that valuation in amount necessarily depended on the purpose. The report of the recent case of the Los Angeles electric situation went into that thoroughly, and showed if you could affect the rate as to value for rate-making purposes, this value should be used for other purposes. Certainly in the case of a purchaser the value would control, because he would not want to pay any more for the property than what he thought he might get out of it if it were subjected to regulation.

Referring to Dean Cooley's remarks about depreciation, he thought that if a depreciation fund was in existence, then the property was entitled to earn on 100 per cent; but if the utility had not that fund on hand, but had pocketed it, it would not be carrying out its trusteeship to the people, and therefore depreciation should be deducted.

In regard to the question of valuation on the basis of cost of reproduction of a plant, William Kent stated that there were some cases where he thought it might not apply very well. For example, what had been the valuation of the power plant of the Interborough Rapid Transit Company two years ago, when it had been equipped with magnificent alternating-current generators driven by engines of the very highest type known, and these engines were as good as new, for all practical purposes, and had cost $1,000,000, or twice that, probably? On the cost of reproduction you would say that you would value that plant on the basis of those engines in use, but if the owners of the plant had decided that these same engines, good as they were, were using more steam than more modern engines or turbines would use, and it had been necessary to throw them out and put them in the scrap heap, and spend two millions of dollars to replace them by turbines, then what was the valuation of the plant before the contract for turbines was made? It certainly was not the cost of reproducing the plant going into the scrap heap. Some allowance for valuation would have to be made on the reproduction basis.

It seemed to him that we had not arrived at any proper theory of valuation because we had no leaders of thought on this subject who represented the public. We had had court decisions by judges who were not experts, but who did the best they could with the limited light they had, but no authoritative statements by leading lights representing the public at large, and that was what we were looking for. He thought we could get such a statement some day from engineers rather than from lawyers. It was a question of strong common sense rather than of the traditions of law. What was needed was a few strong and intelligent students of the matter who would put their ideas together and get the question solved on the basis of exact justice between all the parties concerned, especially justice to the community that paid the bills.

TWO KINDS OF OBSOLESCENCE

Oberlin Smith said that his rule was that things were worth what it would cost to reproduce them tomorrow if they were burned today in their present condition. With a plant all new, it would mean the cost of a new plant. That might be more, or less, than what the plant and its contents had cost. They might have appreciated or depreciated since they were new. On everything new it was necessary to find the percentage of obsolescence and take off that percentage, but in a machine shop it did not pay to have that value too low, as the tools were not efficient unless they were kept up, as Dean Cooley said, to 80 or 85 per cent efficiency, so that they did work, and to rate them at that was evidently fair. The principle of obsolescence might put them down to nothing.

There were two kinds of obsolescence. One kind would be the tool not being up to date, and we could apply that theory to a certain extent, so if it were likely that the tools would have to be altered or repaired, that should be taken into account in the valuation. The other kind of obsolescence was the change in the demand for the product. Certain things would be in fashion at one season, and then become obsolete, and the tools for making them, although as good as ever and in absolutely first-class condition for performing their functions efficiently, would be of no use for their special purpose; and so we had to take into consideration, and be on the lookout constantly for, the obsolescence of tools which in themselves were up-to-date and efficient, but for which there was no employment.

Some people depreciated a set of machine tools ten per cent each year, and that soon made them worth one-half or one-quarter of their original value, when they were as good as ever. His rule had been to allow a certain small amount for depreciation each year and keep the tools in good order. If a tool was run down and needed repairs, or an additional part was applied to it, then it was worth more at the end of the year when repaired, and perhaps 50 per cent of the original value spent on it, and it was not right to keep depreciating it right along. It was worth as much as when new, and under this method of allowing for depreciation we kept the inventory jumping up and down.

The public utilities were an entirely different matter—they were things which had a value outside of the actual plant value. The plant value of a concern might be 80 per cent of its original cost, say, or anywhere up to 100 per cent, and the concern might be sold out at a 200 per cent valuation because of surplus which had accumulated by extra profits, unpaid dividends, etc., so that the commercial value of the plant should not be taken as the actual value, the mechanical value of the plant, because the plant itself could be reproduced for the 100 per cent, and all this extra was in the form of good-will. If a plant sold out for 200 per cent of the cost, it would be because of earning power, and earning power had to be taken into account when we valued the plant for the market for selling it, or perhaps for taxing it. We should consider that a plant was not necessarily more valuable because of its great earning power, for that earning-power increment belonged in what he termed "good-will" or anything we would like to call it.

DEPRECIATION PURELY AN ITEM OF OPERATING COST

Accountants and engineers, thought W. L. Whittlesey,[1] should have the same point of view of operating facts, and an accountant might be excused for saying that depreciation was an item in operating cost, for it was not anything else. If depreciation meant anything it was an item of operating cost and nothing else. The idea of a public-utility corporation was that it should do two things: it should enlist and develop ability within its ranks, and it should give service to its patrons. In the future the problem of regulation might be taken up in that way, but the trouble was, of course, that the lawyers took it up as a matter of property, and so there were such expensive valuations as that of the New York Telephone Company, costing $3.00 per thousand of value; but the idea

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[1] 15 Dey St., New York.

there had been to do a thorough engineering job, to head off any inquiries of this sort, and to put an end to a situation that had been dragging along for about ten years. Another valuation fact lay in the change in the price of copper; this, every one knew, had tripled within the last year or two. A few years ago corporations had had a base figure of 16 or 17 cents per lb., and talked about writing down the fixed value of assets which depended on the price of copper, as the valuation was too high, and now the valuation was about half the market price!

Oberlin Smith thought that the best way to thresh the matter out would be for the Society to appoint a committee, perhaps a permanent one, on valuation, and work in consonance with other societies. In his opinion there should be a distinction between the mechanical value of a plant and the commercial value, the increment being placed on franchises and the earning power and various things of that nature. This was not a time to make valuations, because the whole country and the whole world were in an abnormal state, and no present valuations would be indicative of what they might be after the war was over.

Referring to the paper of Mr. Piez, in which he presented a schedule of depreciation in rates, John L. Harper said that financiers often asked their engineers to present to them certain factors for determining the amounts to be written off each year, depending on the conditions existent at the time, and it was along that line he wished to inquire of the author as to his method of determining these factors in relation to the salvage values, and the fluctuations in actual values of the materials covered in the several items.

Edward W. Bemis,[1] in a written communication dealing with Mr. Morse's paper, stated that in his opinion, unless both sides agreed, the side not giving a detailed appraisal would be at a disadvantage; and that only great reputation on the part of the appraisal company would enable a short-cut appraisal to stand up against a detailed one. Unfortunately, most of the appraisal companies of large reputation had applied such high overhead charges and so strongly endorsed going value as to be looked on with distrust by cities. Personally, he believed that where both sides exhibited a coöperative spirit, short methods could be employed which would yield justice to all concerned.

DETERMINING THE VALUE OF A PLANT

In a written discussion of Mr. Morse's paper, Chas. T. Main said that for the purpose of purchase or sale, for condemnation, or for establishing a fair cost value for accounting purposes, it was unnecessary to make elaborate schedules of all the items in a plant; oftentimes a rough approximate value per unit, such as a spinning spindle, was near enough, if the plant was what could be termed standard.

The first step in determining the value of a plant was to ascertain its replacement cost, and then to compare this with the cost of a new plant constructed on modern principles, the output of which would be equal in amount to, and of as good quality as, that of the existing mill. A comparison should then be made of the cost of running the two mills, and if the organization of the existing mill could be so changed as to make it as efficient as a modern plant, the cost of such change would be deducted from the replacement cost. If it could not be changed, the greater annual operating expense would have to be capitalized to some reasonable per cent and the capitalized sum deducted from the value new.

[1] City Hall Square Building, Chicago, Ill.

After thus determining the value of the plant, if new, account had to be taken of depreciation. To be safe in accounting, it was necessary to mark off each year an amount that would fully cover all possible decrease in values from age, wear and tear, and obsolescence; but if this were carried too far the value on the books would become less than the true value, therefore revaluations should be made at stated periods, say every five years, at which time the write-off for obsolescence for that period, at least, might be readjusted and corrections made for decided changes up or down in replacement values and for any extraordinary repairs or renewals.

In a general way he had found that the useful life of the common types of machinery that had been run about ten hours a day, had received the usual good care, and had not been superseded by machines that would render them unprofitable to run, was about 30 years for cotton machinery and 50 years for woolen and worsted machinery. Well-designed and substantially built mills, when properly kept up, should be good for 100 years.

In appraising a property in operation, there should be added to the physical value the "going concern value," or the amount required to get it started so that goods could be marketed. This amount was made up of (1) interest during construction; (2) engineering expense; (3) interest, depreciation, taxes, and insurance for the period required to start up the mill and get the goods on the market; (4) cost of starting up; and (5) allowance for wastage and damage to product. He had found that for the sum of the first three items it was safe to take 10 per cent of the replacement cost, and for the remaining items, 5 per cent, or a total of 15 per cent.

Chas. W. McKay,[1] in a written communication discussing Mr. Morse's paper, outlined a method of manufacturing-plant appraisement patterned after current practice in public-utility valuation work. He also said that, while the author's plan of appraisal by short methods might satisfy his clients, or his employers, who had sufficient confidence in his judgment and knew full well that he would be able to substantiate his valuation in the event of a call for claim adjustments, nevertheless it was quite probable that insurance organizations would be somewhat loth to accept valuations made by outside engineers and based upon the author's rather broad-gage methods. And it was probable that an engineer in submitting a short-method appraisal would experience considerable difficulty in getting the court to accept it in the event of a law suit over the value of a manufacturing property or in using it as a basis for capitalization. He thought that the auxiliary building equipment, such as elevators, piping and wiring, should, so far as possible, be considered a part of the building rather than as a part of the machine equipment. While some of the appraisals prepared by the so-called appraisal companies contained needless detail, the short-cut methods of Mr. Morse, on the other hand, seemed to him to be a little too approximate in their nature to warrant their general adoption for engineering valuations. Probably there was a happy medium between the two plans, which could best be reached by observing, and to a certain extent copying, the methods adopted in the public-utility appraisement field.

COMPROMISE WITH UNWARNED INVESTORS NECESSARY

In a written discussion of Professor Gray's paper, Robert L. Hale said that, unfortunately, people had been permitted to invest in public-utility companies with the expectation of get-

[1] With McMeen and Miller, Engineers, 1454 Monadnock Block, Chicago.

[illegible] ry to induce investment. As a [illegible] to permit these unwarned investors [illegible] in the enjoyment of the returns for which [illegible] did not prevent us from adopting a [illegible] warning [illegible] investors as to just how much they would be permitted to earn, and of preventing the value of [illegible] from becoming more swollen than it now was. He desired to emphasize the fact that the problems dealing with warned and unwarned investors were entirely dissimilar and should be treated separately.

In regard to past investors he thought some form of partially unsatisfactory compromise necessary. If the courts meant that they were entitled to a fair return on the exchange value of the entire business, then no reduction in net earnings was permissible. But if they meant to permit a fair return on the exchange value of the "property," and meant to distinguish the value of the property from that of the entire business, then the cost of replacing the physical property with an equally efficient substitute would throw light in some cases on the value of the property as distinguished from that of the entire business.

When it had been decided how much return should be permitted to any public utility, there was no reason why anything more than that return should go to it for accidental reasons. It therefore seemed best to permit a rate which would be pretty certain to result in a return as great as that which had been decided on as permissible, and then to hold the company responsible to the public for all the excess above that return, either by paying it back into the public treasury, or by putting it back into the plant without adding to the amount on which it should earn a return in the future.

Discussing the paper by Mr. Piez in a written communication, Robert J. Hearne said that the subjects of inventory, cost, and valuation were so interwoven that they should be treated together. Too many valuations, he thought, were colored by future prospects. On the other hand, one could not ignore present conditions. While abnormally good now, a new basis for valuation would arise with a change in times. Valuation had to be recent to be of any good.

In actual practice, extending over many years, he had found it practical and necessary for the purpose of inventory to make (1) an estimate of actual cost, (2) a conservative valuation for his own guidance, and (3) a valuation for insurance purposes. He thought that the work attempted by appraisal companies should be done by one's own employees. At the best, outsiders could only deal in figures, not facts; they could not possibly know the business itself. They did have a value, however, in detecting fraud and incompetence.

Properly kept, a perpetual inventory was a time saver and a daily corrector of values and costs, and kept everything up to date. It took some trouble to install and some thought to keep going, but it paid. He had had over 15 years' experience with a method that was adapted to almost any business, that saved time, trouble and expense and that could be applied to a new business very easily and to an old one a little at a time. The discussor then described in detail the method mentioned.

AUTHORS' CLOSURES

J. G. Morse, in closing the discussion on his paper, said that the fact that there were so many different opinions in regard to depreciation, and what should be considered depreciation, made it all the more unnecessary to go into detail. As to the cost of his appraisals, he thought the range was from 15 to 25 cents per $1000. He had been asked to outline his procedure in the case of an industrial property. He understood that in Vermont, in appraising the telephone company, they measured the length of every pole and put a different price on each pole where it varied six inches in height. He would have taken an average price per pole, and ascertained the number of poles to the mile and the number of miles of line the company owned, and obtained the value by using that factor. He would have averaged the poles and wires in that way. In the case of a railway valuation, he would take the track at so much per mile; he would take the trestles according to their construction and classify them into different types, at so many dollars per lineal foot. In short, he would go over the property, naming a unit factor on every part of the property and apply it; going into detail in each individual case for one sample only.

Prof. John H. Gray, in closing the discussion on his paper, began by saying that anyone who thought that railway capitalization did not affect rates, should recall the traction history in New York and Chicago between 1899 and 1907. The things that started the movement toward regulation were, first, fluctuation in rates, and second, the enormous fortunes made by speculators. They were the red rags that stirred up the agitation.

As to the cost-of-reproduction theory, he did not accept it, first, except as it served to put the value up with the social growth, and therefore to give the benefit of the unregulated industries to the people who were fortunate enough to have bet satisfactorily upon the rapidity of the social growth, because it was absolutely inconsistent with any regulation at all. In the second place, he did not accept it because, if he understood the development of human society, in the long run it would conform, not to the precedents of the law, as someone had said, but to the necessities of economic and social life. The cost of reproduction arrived at something that anybody who understood the situation and was dishonest wanted to find. In the next place, it was primarily a subject of cost, and if our social system was to be organized on the basis of cost and mere speculation, we would go to the bow-wows, and we had better get down to the facts. He was opposed to the cost of reproduction because no one wanted to reproduce one of these important properties. In the next place, there was no human experience on which to base an intelligent estimate as to how long it would take to reproduce the property, or how much it would cost.

We all agreed that the public utilities were necessary for the maintenance of our civilization on its present basis. The company wanted its monopoly guaranteed, and wanted its monopoly profits. In the final analysis we had got to have the industries carried on, and if we allowed private capital to do it, we should have to allow a rate of income that in the long run would induce men to put in capital enough to meet the requirements of these enterprises and to meet the needs of the growth of a progressive state of society. It had nothing whatever to do with value. It had to do with the contribution of money and service, and service could not be measured in money. The State did not allow them to discontinue service. When land went up in price they were not allowed to sell the land. The land was dedicated to that particular purpose, and in many utilities it had been acquired by the company with a limitation for a particular purpose, and not by the exercise of eminent domain, which was a controlling element.

In reply to a question by Clarence H. Tolman in regard to the capitalization of losses, Professor Gray said that if we were going to hold the company down on the present law to what was called a fair rate, both the custom and the tendency

were to make that rate uniform. The tendency, therefore, was to hold the company down in prosperous times to the average rate. In lean years, though, there would be losses. That being the case, he would say that the public had got to guarantee the losses, provided they were not vicious, fraudulent, or grossly reckless, for if they were not compensated for in some way, capital would cease to come in and the service would suffer. The viciousness of the cost-of-reproduction proposition, and the viciousness of all intangible propositions, was not that the man ought not to have some compensation, but in the method of giving it. That was what was wrong, and this method of cost of reproduction, in his judgment, had been the reason for one of the most powerful movements toward public ownership, and he assumed his hearers knew that the traditions of the organization of our Government were wholly inadequate and too antiquated to manage business effectively; but he thought these losses should be set up in an amortization account, and should have a temporary larger rate of income, but should not be permitted to disturb the capitalization.

SECOND VALUATION SESSION, THURSDAY AFTERNOON

The Second Valuation Session was likewise held in the Auditorium, and was called to order by Chairman Hess, at 2:15 p. m. Two papers were offered: the first, by Walter N. Polakov, entitled Valuation of Industrial Properties vs. Valuation of Industrial Methods; and the second, by H. L. Gantt, on Productive Capacity a Measure of Value of an Industrial Property. The procedure of the morning session was followed, both papers being presented before discussion was begun.

In his opening remarks, made in lieu of a formal presentation of his paper, Mr. Polakov referred to the Chinese custom of the bridegroom paying for the bride, in accordance with her worth, a ransom to her parents. That ancient practice, it seemed to him, prevailed in our day when we put the value of the plant in accordance with the equipment of these plants, and neglected to consider what the plant was capable of doing for society. The modern financier seemed to have difficulty in getting rid of the habit. The other day his opinion had been asked as to how much more equipment a certain mill would require in order that appropriation might be made for it. It was desired to increase the output from 13 tons a day to 40 tons a day, and an actual test had proved that they had the capacity to produce from 60 to 80 tons a day, but for some reason or other they had not done it. That was evidently due to a lack of method. How we were to appreciate or appraise this method, and the methods in vogue, seemed to be a question which should be answered before we went into the question of how much of the equipment was necessary, and what part of it we knew how to use, and what part of it we did not care to use, for some reason or another. The substance of the matter was that people had not yet realized the fact that those who did not know how to run a business for the benefit of the industry should be denied the privilege of running it at all.

Cases were known of important railways that employed their extensive equipment but 20 per cent of the time, leaving it idle 80 per cent of the time on account of poor planning. Certain electric railways, for some reason or other, had preferred to keep their power plants and equipment idle two-thirds of their capacity and buy power from outside sources for double the price that they could develop it for themselves. Yet this idle equipment was, in fact, not an asset, but a liability to society. Some one had to pay for it—the consumer—and in his judgment it was the duty of the engineer to reverse this condition of affairs as much as he could.

MR. GANTT'S INTRODUCTORY DISCUSSION

Mr. Gantt, on being introduced, began by saying that inasmuch as the value of an industrial plant was measured by its ability to produce values, such a plant, which was not operated, had not actual but only potential value, and actual value was conferred upon it only when human intelligence and industry were added to it to produce the results for which it had been created. The fact that industrial plants were created in order to make some article which could be sold at profit, or to render some service which could be sold at profit, amply justified the statement that their value was dependent upon how they performed their functions. One might therefore divide the value of a going industrial property into two classes—that of the potential or static value of the plant itself, and that of the dynamic value of the organization operating it. In the past, the former had been given attention by accountants, almost to the entire exclusion of the latter, in spite of the fact that the stock-market prices and sales values of plants actually, though indirectly, reflected both values combined. If we would get a clear conception of a going plant, we would have to find the means of measuring the value of the operating organization, which had often far more to do with its successful operation than the particular constructions and equipments of which it was composed.

In the operation of an industrial property, it was seldom that all the expense incurred during any one month could be utilized to advantage; but if we could find how much was utilized and how well it was utilized, we could get some idea of the efficiency of the management. How well the money used was used, was indicated by the cost of the article produced; but there had, in general, been no indication as to what became of expense incurred but not utilized. How much expense was incurred but not utilized, and why it was not utilized, were vital factors in any attempt to measure the efficiency of the management: hence it was to these questions that we gave special attention in this paper.

At the Buffalo meeting last year, he had read a paper on the relation between production and cost, wherein he had contended that the true cost should include only those items needed to produce the article, and that any other money expended while these articles were being produced for any cause whatever should be charged to some other account. People were pretty generally keeping an account of the money expended for producing articles, but in few cases were they taking care to find out how much money was expended that did not produce anything.

We were all familiar with the fact that idle machinery cost money, even when it was idle. Interest on the money invested, taxes, depreciation, insurance, etc., all went on whether the machinery was used or not. The value of a plant was very materially influenced by the amount of the above items that were unused or unusable.

This was a factor which was directly in the control of the management, and did not in any way concern the inefficiency of the workman, but it was a real factor in the valuation of

a plant. Hence, a chart of the nature shown in his paper was of great help in determining the value of the going plant.

Referring to Mr. Gantt's chart, W. S. Rogers thought if it were real it would show the unbalanced condition of the plant. That was just as important as anything. The divisions could be carried out further, and show plainly and clearly inefficiency, and the chart would point to and almost name the man, up in the higher office, who was killing himself at his desk, absolutely unable to go out and get a meal, almost, and the biggest leak in the plant, knowing the least about it.

AN INSTANCE OF THE EFFECTIVENESS OF CHARTS

Carl G. Barth said that he wanted to bring up the question of the human element. He did not think there was a better way to treat a man than to give him a good machine to work with, and that was the reason he started in first with the machine. He was not so enthusiastic over making time studies on all routine operations, and had been with four companies without taking a single time study on the Taylor system.

Charts like the one shown had been made under cover, but they had not been presented before the Society heretofore, and he was thankful to Mr. Gantt for having done it. A similar chart was now being carried out with a great deal of detail at the Winchester Arms Company, and it showed the various items by lines instead of percentages, which in his opinion was far more effective. He had been with a certain company and they had increased the production 2.5 per cent. He had then sent in a report to the president that they were then using, with the increased percentage, a little over one-half of the equipment of the company. Mr. Taylor had done the same thing.

In regard to machine idleness, William W. Crosby stated that it was known among textile mills that parts of looms for a whole year at a time were in the storehouse. They had tackle and slings, and looms were put into operation at certain times because certain grades of cloths were demanded, but at other times they were not required. With a sufficiently world-wide market we could keep our mills running at somewhere near the capacity for which they were designed, but you could not run mills fully and economically unless you had the orders to run them on.

HOW PROFITS SHOULD BE FIGURED

H. B. Cheney[1] was of the opinion that every mill had some factor which, running on a particular product, was the controlling factor. For instance, in Mr. Gantt's cotton mill it was probably the looms. You could not make any more goods in that mill than the looms could turn out. Consequently, when it came to making a chart, such as Mr. Gantt had, the idleness portion of the chart should show, as he had arranged it, upon the 100 per cent method; but when you came to the factors or rates upon which you were making your calculations of cost, that policy should not be longer continued. You should take the controlling factor of your mill, your looms, your spindles, whatever it was that controlled the product of the day, and say that all the other departments which were necessary to supply those looms were supply departments, and if your looms ran 100 per cent, that 100 per cent of all the expense of having that department supplied should be consumed in your cost; but if your looms, which were the controlling factor, only ran 85 per cent, then only 85 per cent of all the rest of the overhead should be consumed. All the departments having a chart on a 100 per cent method would show you just the things Mr. Rogers had referred to. It did unquestionably bring out with the greatest clearness every point that was out of balance for that time. But it might be an entirely different matter six months later.

Heretofore it had been the custom to figure profits upon a percentage made upon the article sold. He did not believe it was the right basis to proceed on. What was the most profit that could be made out of a given plant? It was not necessarily that made by manufacturing the article which showed the largest percentage of profit upon its cost, but that which showed the largest profit for the machines run. Therefore, profits, instead of being figured on the article made, should be figured upon the running of the machines. In other words, one article might earn $1.00 a day profit on a loom, and another one $5.00 a day, and the article which earned $1.00 a day might make 50 per cent profit and the one which earned $5.00 a day but 10 per cent profit.

As to the human element, there was one factor in connection with that which he wished to bring out, which was that heretofore men had usually been hired without any particular reference to the efficiency of the individual for the work which they were intended to do. You could not take a man without any regard to his adaptability to it, and force him into a certain mold from the beginning to the end, training him without finding out, when he came to that point, whether he was the best man that could be trained for that particular purpose, and expect to get satisfactory results. He believed it was possible, and would be possible, to apply gages and tests for the purpose of determining the efficiency of the unit before putting it in use.

As to Mr. Gantt's chart, Frederic G. Coburn thought that one of its chief points was that it would show how much it was costing one for idle time. Granting that seasonal requirements and styles would affect the textile mill, at the same time it was known that goods that had twisted yarns in them cost more than those that did not. If you applied the overhead on the loom-hour basis you would lose sight of that—you would not know how much more one fabric cost than another.

In his line a big boring mill would be idle three weeks out of a month. This chart would tell how much that idleness was costing, and it would give some guidance in going after a line of business that would keep the equipment going, and while his concern did not have to combat styles and seasonal variations and conditions that would bring business for a 16-ft. boring mill, at the same time they would have an eye on the chart and would do better and know how much they failed of accomplishing the desired end.

H. M. Wilcox told of results secured at the Winchester Arms Company from a set of charts similar to Mr. Gantt's, only carried out in a great deal further detail. They had studied the idle machine time in the cartridge-manufacturing department for a year or more, and determined how much time they were losing from the possible productive time of the machines due to tools, to machines, to labor, and to excess equipment. They had carried on that analysis so that they knew how much time they were losing due to keys, due to indexing devices, due to setting up of machinery, and changing over of calibers. This had directed their energy toward the point where they were weakest, in eliminating the idle machine time by giving their foremen information in regard to where time was being lost. They had loosened up a great mass of energy which they really did not know they had theretofore. They had made the jobs interesting to the men without any

[1] South Manchester, Conn.

effort other than pointing out where they were losing time, and had gained vastly in production from the activities of the shop men themselves. They had added to the cost of the idle time the cost of scrap, and called it their cost of lost effort. That had nothing to do with the salable cost of the goods. They gave a report of all lost effort to the foremen weekly, and the foremen had responded in attempting to reduce this waste, which was absolutely all waste, as far as operating interests were concerned. He wanted to mention that, to show that they were all working along the same lines.

SUGGESTED MODIFICATION OF MR. GANTT'S CHART

William Kent thought that in a textile mill it might be possible, if the mill were large and made but one style of goods, so to balance the machinery that none of it would be idle more than, say, 10 per cent of the time; but if many different styles were made, the demand for which varied with the season and with the fashion, the weaving machines might be running full time and not be able to take the whole capacity of the spinning machines, some of which would therefore have to be idle part of the time, or to utilize the full capacity of the finishing, inspecting, and shipping departments.

The "expense actually needed" for the production of a variety of articles might thus include a part of the idle time of machines necessary to have on hand to care for a varying demand, but which could not be kept continuously employed; and in such a case it was right to charge some of the cost of idleness into the "normal burden" which was distributed in the machine-hour rate to the cost of the goods. This rate should be determined annually for each machine, after studying statistics of preceding years, and it should include an allowance for the average or normal time that the machine might be expected to be idle during the coming year. A modification of Mr. Gantt's chart was thus suggested to show how much of the idleness of a machine or department was normal and necessary to the conduct of the business, and how much was abnormal and excessive. This might be done by drawing vertical lines on the percentage portion of the chart indicating the normal percentage of full capacity which each machine or department was expected to run during a month of good business. He also thought the expression "value of the property" used in the paper was ambiguous and that its meaning should be defined.

Referring to Mr. Gantt's chart, John E. Mullaney stated that after his company had used it for about a year, he thought it might be worth while to know that if during the time they had been actually charging expenses to the operation, they had been getting out their product at the fullest efficiency. In order to show that they had tried the idea of drawing a red line adjacent to the black line, the idea being to see if the black and red line agreed. If they did, the production in question had been made at 100 per cent efficiency, that efficiency being based on the standards they had set for their production. The first operation of the chart shown had happened to agree very well. In the next operation the red line fell considerably below the black line, and throughout the rest of them, with four exceptions, were very equally all below the black line. The red ones which extended above were interesting to him, at least, because they showed that they were at this time getting a little better productive efficiency out of these particular operations than they had previously planned.

This particular type of chart of working ideas could be applied to an industry in general, where each factory produced an article, and giving a report to some central head, showing it was efficient, and how much of its capacity it was using and at what rate it was using that capacity; and with a given market and a certain definite product to be manufactured at a given time, it might be possible to so distribute the work that the most efficient man would get the work, and those who were not as efficient in that particular operation would have to swing over to some other operation they could be trained to do more efficiently.

W. C. Brinton thought that the slides which had been shown proved very nicely that in most executive work the problems involved practically every department that existed in most of the large corporations. He believed that, in the case of companies doing a business of $10,000,000 or more a year gross, or companies having a very complex problem of distribution, it was essential for the man who ran a chart department of that kind for the corporation to report to the man who was really running the corporation, no matter what his title was. In many cases the general manager ran the company, or the chairman of the board of directors, but the man who ran the chart department should be able to turn in unbiased reports and tell the actual truth, and bring it out so that the man in charge of the business could see it in all its details, and for that reason the man who ran the chart department should be protected by reporting to headquarters. He believed that money spent in running such a department would give a higher percentage of return than that of any other expenditure which the corporation could make.

According to H. V. R. Scheel, there had been presented for their consideration a principle which was a more fundamental thing than a discussion of ways and means. That principle was that we now had a definite measure of the efficiency of the management. We had broadened our consideration of where responsibility lay, consideration of the efficiency of the individual workman on a machine to a consideration of the efficiency of the whole, for which the management, particularly, had to accept responsibility. In other words, Mr. Gantt's paper showed a criticism of the management, but it was a constructive criticism, inasmuch as it presented itself in a way which enabled the management to correct errors, modify its plans, and lay out a course of procedure which would be more intelligent than any routine way of handling facts heretofore employed.

Written discussions of the two papers, from Messrs. Keppele Hall, Harrington Emerson, E. W. Bemis,[1] Stuart W. Webb,[2] and Henry P. Kendall, were read by the Secretary at this point of the session.

Mr. Hall thought it somewhat refreshing, in these days when so much was heard about the efficiency of labor, to have emphasis laid on the efficiency of management. He believed that most management engineers would agree with him in the opinion that the vast majority of failures to succeed in business were due to the lack of what Mr. Gantt characterized as the "ability to do things" on the part of those really responsible, rather than to any other causes. One could well go a step further and state that in many instances a lack of real knowledge of the vital elements of operation precluded the exercise of this ability by those who really possessed it.

Industrial property, wrote Mr. Emerson, had, according to the point of view, three values; namely, the cost of its reproduction, the amount it would bring under the hammer, and its going value—the real value. This latter was difficult to determine, not because it was not possible on the basis of present

[1] City Hall Square Building, Chicago, Ill.
[2] Vice-President, Old Colony Trust Company, Boston, Mass.

[illegible] and with due allowance for a definite amor-[illegible] to convert net income into capitalized value, but be-[illegible] no one could see into the future far enough to set either [illegible] valid amortization or to determine what next year's profits would justify as increased value.

In industrial concerns Mr. Emerson recommended constant reappraisals based on long average earnings. The valuation from month to month as well as the 10 year average, computed for each month, enabled him to estimate the tendency, thus varying the amortization or obsolescence provision.

If of two plants one was able to operate materials, labor and capital valuation at standard, and each combination of materials, men and capital was yielding the largest margin between cost and sales price, while in the other plant operation was below standard and without reference to difference between cost and sales price, the first plant might very easily have many times the value of the second plant, although inventories were identical.

Mr. Bemis thought that Mr. Gantt's paper did not have a large bearing on the work of the appraisal engineer in rate cases, for in these the attempt was to determine a fair value, which might be quite different from the value based on present rates and earnings. The productive efficiency should have some weight in rate cases; not, however, in determining the value of the property, but in leading commissions to allow a higher rate of return to a company of large productive efficiency, attributable to the excellence of the management, as compared with a business not so well managed.

In the opinion of Mr. Webb, from the operating point of view Mr. Gantt's suggestions regarding idleness expense were highly important. It did not seem to him, however, that this item, which he had usually heard referred to as "load factor," reflected very accurately the value of the plant, due to the fact that so many different things might cause a low load factor. While most of them would probably be due to poor management, there would be other factors, such as, for instance, a distinct change in style (over which the management would have absolutely no control), which might throw a plant that had been operating efficiently entirely out of balance. It seemed to him, therefore, essential to add to the elements of which Mr. Gantt spoke at the end of his paper, "demand for the product and relations to the market (good-will)."

Mr. Kendall wrote that at the Plimpton Press that part of the burden which was not earned through the continuous operating of all or any of the machines, was called unearned burden. If the plant ran its full equipment full time, it had a credit; otherwise there was a certain amount of unearned burden, which was deducted from the profit and loss for each department at the end of each four weeks. He thought that if the net book value of a plant were based on the actual net investment and actual earnings after allowing a proper return on net investment, and costs were determined on a basis of direct expense with only the pro rata per cent of burden applied regardless of whether the entire plant was operated or not, we would then have a common and standard way of determining these three points, which at the present time did not exist.

Oral discussion being then resumed, Robert B. Wolf said that he would like to call the attention of the members to the fact that Mr. Gantt had primarily made a strong plea for organization sanity. The records exhibited formed a method of keeping track of the economic forces in the industry primarily for the purpose of enabling the management to have some record of their progress, and, as he had just quoted from Mr. Polakov's paper, the results produced in the plant depended on how these material forces were used; but unless these records of plant progress were furnished to the management, they could not possibly use these forces intelligently.

We heard a great deal about the efficiency of the workmen, and we were doing a great deal to make them more efficient, but were we giving to the management the necessary information to enable those in charge to become efficient? They were human as well as the workmen, but if we were going to humanize our industries and build men, we had not only to build men at the bottom, but men at the top. He thought that was primarily the keynote sounded in this plea by Mr. Gantt for a greater knowledge of the whole progress of the plant.

H. M. Wilcox stated that he desired to broaden one question, and that was in respect to the granting of industrial credits. They had been shown a way by which the efficiency of the management of an industrial plant could be measured periodically, and he could see very good reasons why the measure of the efficiency of an industrial plant, taken periodically, should be used as a basis for the extension of credit to that organization.

A PLAN FOR THE DISTRIBUTION OF PROFITS

William Kent thought that the whole question of the investment of capital and the returns which should be made upon it, the distribution of profits, had got to come up and be solved in the future, and he wished to offer an idea as to a probable solution. Suppose the Government should pass a law, which should be approved by the community at large, that in shipbuilding or in armor plate or in railroads, or in certain other things, public utilities, or industrial pursuits that had connection with the public—what might be called quasi-public utilities, there should be \$1,000 issued in bonds for each \$1,000 of capital stock, the latter being entitled to a six per cent dividend if earned, the former to 3 per cent interest. A company then should be allowed to earn, without any further investment, 5 per cent, to go into the treasury of the company, so that the company might be able to withstand extraordinary charges due to accidents or floods, etc., or due to having to compete with concerns employing superior machinery, necessitating the company to put in better machinery after awhile or go to pieces. Any excess earnings should be divided, one-half going to the stockholders and one-half to three different parties, the Government, the consumers (by lowering the price or rates), and the workmen who helped make the money.

After calling upon Vice-President James E. Sague to preside temporarily, Chairman Hess took the floor and stated that he did not quite agree that Mr. Gantt's paper was as broad as it apparently purported to be. It really was only a question of detail. It did not make any difference how costs were kept, whether one kept tab on the management, or on the day laborer. Essentially, the thing was to know the costs, no matter what the routine was, or who gave the costs, and after all was said and done the methods of determining these costs were probably as various as the people who were trying to find them out, and probably as various as the industries for which the costs were being kept.

F. J. Cole called attention to the fact that, while keeping all the machines going all the time was of course the economical way, a surplus of machines was sometimes required to take care of variations in product, where the character of the machine work varied considerably with different articles of the same general class which were being manufactured.

W. S. Rogers drew attention to two statements in Mr. Polakov's paper, and recited certain personal experiences by way of emphasizing their importance. The final test of good-will came to a concern when it had to borrow money. He had found that bankers, in investigating the right of a company to ask for loans, had not only desired facts regarding the work done, but also proof that the methods used were the best. They were asking what was the value of the methods, and Mr. Gantt had laid the foundation in detail to lead up to that.

Arthur C. Jackson hoped that some time Mr. Gantt would bring before and show the Society the necessity of charts for a whole industry, and select and define and portray on these charts the definite essentials for the economic operation of that industry, so that each member, each corporation within that industry, would have set up before it the beacons without which they were very apt to run upon the rocks. It seemed to him that this responsibility should lie on the engineering profession, and not, as had been the case in the past, on the lawyers or on the political economists.

The Secretary spoke of visiting recently the Birmingham plant of the U. S. Steel Corporation, and of how profoundly impressed he had been by the attention which the management gave to matters affecting the welfare of the workmen. He spoke also of the interest taken by workmen in production charts that he had witnessed not long ago in a large paper mill, and said that these two observations showed to him a way of tying in the excellent points which had been brought out in the papers: first, the human interest of the managers in the personal needs and health of the workmen, even to their housing conditions, and then, second, making the workmen co-partners in the management of the plant.

In closing the discussion of his paper, Mr. Polakov said that he desired to make but one statement. Admitting that the method of use of the investments and tools of production was the revenue-producing factor, the economic soundness of industry must be a broad criterion as to whether the production was carried out in such a way as to make the men idle and the commodity cheap. If we failed to accomplish either one of these things, we would ruin the country by producing things that could not be consumed, or would limit the production on account of the low purchasing capacity of the consumers.

Mr. Gantt, in closing, said that it was not pretended that his paper contained a complete solution of all our valuation or accounting problems, but it did point the way to detect many of the sources of waste and inefficiency which had heretofore been disregarded, and which could not be detected until we got a proper appreciation of values.

Among the discussions which were particularly significant he might single out that of Mr. William Kent, who seemed to be troubled about the difficulty of fixing a valuation for taxation purposes, if this method of valuation were accepted. This was particularly pleasing to him because, if the methods which were proposed did harmonize with the present system of taxation, he would feel very much discouraged, for there was nothing which was so detrimental to our industries and to prosperity in general as our system of taxation, by which the energy, initiative and business success of the individual were taxed for the benefit of the community, and the wealth created automatically by the community was allowed to go, without any return, to individuals who, as a rule, were contributing nothing to that community. If the wealth created automatically by the community should be claimed by the community, it was highly probable that it would be unnecessary to tax any of the industrial activities of individuals, and Mr. Kent's troubles would absolutely vanish. If the proposed system of accounting had a tendency to make that factor clear, it would do much to lift a burden from our industries and enhance the prosperity of the workers.

If we would meet the competition with which some of us thought we would be so direly threatened after the war, we must encourage industry and discourage idleness, for the warring nations, having found what an enormous increase in strength such a procedure had given them, would hardly return, when the war was ended, to the other method which we seemed to cherish so highly.

Arbitrary laws based on opinions inherited from a bygone age were not suited to an age like this, when the struggle for existence, which was so keen in Europe, threatened, perhaps in another form, to involve us; for the same causes that were active there were active here.

Ninety years ago Thomas Carlyle had said, "The tools to the hands that can wield them."

It was a reversal of this policy which more than all other causes combined had brought Europe to such dire extremity. The control of the implements of production had fallen into the hands of investors, who saw more profit in the control of markets than in productive efficiency, which they did not understand.

Competition for the control of markets was at bottom the primary cause of the great war, and the fact that Germany had had a somewhat clearer comprehension of the importance of productive efficiency and the necessity for the control of tools by the hands that could wield them, was the explanation of her tremendous industrial and military power.

During the last eighteen months England had revised her policy, and through her Minister of Munitions had taken industrial control from stock and bond holders and placed it in the hands of those who could "deliver the goods." The development she had made since this change was so phenomenal as to be almost unbelievable. In her attempt to save her life she had learned that strength lay in productive efficiency. The other European nations had undoubtedly learned the same fact.

In the face of these examples were we still going to pin our faith to market control, until aroused by a catastrophe, or could we learn from the fate of others and begin at once to develop productive efficiency? We had been talking efficiency in this country for over ten years, but so far the results had been lamentably small. This was not the fault of the workmen, for wherever we had had efficiency at the top we had had but little difficulty in training workmen to be efficient.

For years, with inefficiency at the top staring him in the face and hampering him at every turn, he had labored to find a means of measuring that efficiency, as it was perfectly evident that without efficient direction, efficient workmen were ineffective, even if it were possible to get them, which it usually was not.

If we could measure and evaluate the productive efficiency of the manager as we now measure that of the workman, we might hope for better results.

The only men organized for the promotion of productive efficiency were the engineers, and it was on their shoulders that must fall the burden of showing what could be done.

He offered as a part of this work the chart shown in his paper as an attempt to measure the efficiency of the executives, and to indicate in a general way their value, which we knew was an integral part of the value of any successful industrial property. This was only a first attempt, and he noted that already one engineer had taken a step beyond what he offered.

GAS POWER SESSION, THURSDAY AFTERNOON

THE Gas Power Session met on Thursday afternoon for the consideration of a program of papers arranged by the Sub-Committee on Gas Power, of which H. J. Freyn is chairman. Mr. Freyn was unable to be present and Prof. William T. Magruder conducted an exceedingly well-ordered meeting. The attendance was upwards of 150, and the papers were of such interest that the session continued until 5:30. Mr. Freyn sent the following telegram to the acting chairman:

"Regretting deeply inability to be present, am sending my best wishes for a successful session, with many thanks to yourself and greetings to all."

O. C. Berry[1] presented the first paper, on A Gas Producer for Bituminous Fuel, pointing out the essential features of a producer designed and experimented upon by himself. The paper was the subject of considerable oral discussion.

Because of its tar content, the author contended that bituminous coal could not be used in a standard updraft producer like anthracite. As even more satisfactory than either a down-draft or double-zone producer, he described a recirculating producer, discharging its gas near the middle of its height and returning the products of distillation above this point to the combustion zone at the bottom. The steam which must be supplied for the gasification process was introduced through a steam-jet blower and provided the means of circulating the gases.

A second line of investigation was to determine the proper temperature for the recirculated gases to precipitate the least tar, and between 300 and 450 deg. cent. (550 to 900 deg. fahr.) was found to be the preferred range.

The remainder of the paper described the recirculating producer designed by the author, an account of which appeared in The Journal for December.

DISCUSSION OF MR. BERRY'S PAPER ON A GAS PRODUCER FOR BITUMINOUS FUEL

In a written communication, Godfrey M. S. Tait said that the methods for the determination of the tar content were all highly practical as applied to the experimental apparatus used, but would have to be modified in connection with the test of a plant in regular service.

He said that the theory as to the volume of the recirculated gas was not original, having been tried with more or less success in Europe. The main difficulty was with the power consumed by the blower and the excessive quantity of steam thus introduced, unless some arrangement were provided whereby the governor of the engine might control the supply of steam.

The findings as to clinkers were apt to be misleading, due to the very small size of the producer. Any arrangement to get away from the balanced draft condition greatly increased the tendency to clinker in all kinds of fuels. The clinker was first formed by a fissure in the fuel bed through which there was a concentration of draft. A large fuel bed and grates that insured an equal distribution of the draft current to all parts of the fuel was the only way to prevent clinkers.

In practice, it would be found that the resultant increase in efficiency due to the fixation of the tarry vapors of the gas rather than to wash them out and waste them, was much less than would be expected.

Personally, he leaned to the construction of bituminous producers along the line of the simple single-zone up-draft type with attached tar washers as being better adapted to the hard usage of practice.

As to the reduction of CO_2 to $2CO$, Mr. Tait's experience indicated that a perfect reduction occurred at 1800 deg. fahr. provided that the draft velocity was sufficiently low to allow the time necessary for the reaction.

He thought Mr. Berry should continue the investigation under conditions entailing more commercial conditions, variable load without special attention, and noting the possibility of keeping the gas tar-free during such variations without attention, the effect of large areas of the grate, etc.

In an oral discussion, Edward Rathbun said that while Mr. Berry's investigation appeared to be an excellent laboratory development, the actual gain in practical knowledge, as an aid to present commercial operation of producers, was somewhat limited. He called attention to Mr. Berry's statement that the gas was "nearly as clean as anthracite gas," and said that in order to develop the producer-gas engine, the gas must be clean, and that gas nearly as clean as anthracite was not clean enough.

Mr. Rathbun pointed out that in breaking up the methanes, the heating value of the resulting gas was low and that the capacity of the engine of a given bore and stroke was thus reduced and the flexibility of operation desired was not obtained.

Without question, said Harry F. Smith in discussing Mr. Berry's paper, the complete oxidation of the hydrocarbon content of the coal, the water vapor and the carbon dioxide, and the subsequent dissociation of these fixed gases and the carbon, constitutes an absolutely effective way of eliminating tar.

He pointed out that unless a coal contained a high percentage of fixed carbon there was not enough fixed carbon in the coal to carry on a recirculating process continuously in a producer. If the producer was running for several hours with sufficient stand-by periods, enough coke would be formed during these periods to cover the deficiency in carbon. One way to overcome the difficulty was to permit part of the products of combustion to pass out of the producer undecomposed, with a consequent loss in efficiency.

The objection to low heating value, mentioned by Mr. Rathbun, was of even more importance if the gas was used for industrial operations, such as brazing and forging. Since there were several methods available for cleaning producer gas, the removal of the tar was so easy and effective and the apparatus so simple that the justification of a more complex producer with the uncertainties of the process was questionable.

A uniform gas from soft coal was difficult to obtain, W. B. Chapman said in discussing the Berry paper. In his experience covering a period of twelve years Mr. Chapman had met with all the difficulties mentioned by Mr. Berry and more, and was not sure, in his own mind, that the problem of obtaining a gas from soft coal, suitable for gas engines, could be solved along the lines outlined in Mr. Berry's paper. The fuel bed of the Berry producer was too deep for easy poking, a disadvantage in practical operation. Unless there was some means of controlling the circulation of gas when the engine was under a light load, the fire would grow cold because of the returning gases.

In his oral closure, Mr. Berry referred Mr. Tait to the determinations of the United States Geological Survey in the

[1] Purdue University, Lafayette, Ind.

matter of the temperature necessary in practice for the decomposition of carbon dioxide. He explained that in testing the gas for tar, the gas was made to impinge upon a card, any tar in it showing a dark mark upon the surface of the card.

The gas was probably not all burned in the bottom of the producer, but it must be evenly distributed over the area at the bottom in order not to form cold paths between the grate and gas outlet. The gases could be cracked very effectively by passing through an incandescent zone, and, under a light engine load, the gases were simply cracked and the carbon monoxide passed through without being turned into carbon dioxide and then into carbon monoxide again.

The plant as operated ran ten hours a day under full load, was not operating at night, and was started the next morning after twenty-five to thirty minutes' blowing. It was never run for ten hours consecutively for more than a week.

MR. SWAIN DISCUSSES THE COMMERCIAL SAMPLING OF PRODUCER GAS

Philip W. Swain read an abstract of his paper on The Commercial Sampling of Producer Gas. He said that, as a rule, the sample of producer gas to be analyzed should be drawn from a pipe in which there was a continuous flow of fresh gas from the main. For a correct continuous sample, a number of conditions must be observed: namely,

a There must be no variation in pressure in the gas entering the sampling bottle

b The sampling pipe must draw from the main a sample representing the average gas over the entire cross-section of the main

c The sample should be drawn at a rate proportional to the flow of gas in the main. If the variations are not great, a sample drawn at a constant rate will approximate closely the correct sample.

Although a very good snap sample could be drawn using the ordinary two-bottle method of sampling, this method could not be used very well for proportional sampling, and was not reliable even for uniform sampling. The author described and illustrated a device which he had designed and used, and which permitted the accurate measurement and control of the flow of water from the sampling bottle.

There were several portable instruments on the market, modifications of the Orsat apparatus, which had means of determining not only the carbon dioxide, oxygen and carbon monoxide, but also the hydrogen, methane, and sometimes illuminants as well. In such instruments, the hydrogen and methane were usually determined by explosion with air. To avoid the various difficulties of determining carbon monoxide by absorption, the carbon monoxide might be determined by explosion with the hydrogen and methane. This involved a little more computation, but the labor might be minimized by standardizing the method and making use of a diagram which the writer had prepared.

Lack of interest in gas analysis, said W. E. Renling[1] in a written discussion, doubtless came from two causes: first, failure fully to appreciate the fact that a gas analysis, when properly interpreted, furnished a splendid check on the efficiency of the plant for the conditions under which it was being worked; and, second, from a rather inherent feeling that the subject of gas analysis was rather too technical, or savored too much of the chemical laboratory, to be really a friend and working tool for the practical engineer, owner or operator. It would be only through broader education and discussion that fuller appreciation would be given this subject.

It was the opinion of H. F. Smith that everything the author had said meant something to the fellow who had been up against the practical side of this work. However, he wanted to caution against the general statement that a good idea of the quality of the gas might usually be obtained from the carbon dioxide alone, to emphasize which he read from a number of analyses made by the same chemist, in the same plant, by the same method, and on gas from the same coal. The extreme variation in the carbon dioxide content, percentage of combustible and heating value gave evidence to show "that it is not always possible to depend on the carbon dioxide indication alone."

In his oral closure, Mr. Swain pointed out that there was considerable difference of opinion among men with wide practical experience as regards carbon dioxide as an index of gas quality, some being so certain that it was an indication of gas quality that only carbon-dioxide determinations were made by them.

In answer to a question by S. A. Moss, Mr. Swain said that it was quite important to have the velocity of the gas in the sampling tube the same as that in the main pipe if the dust or suspended matter in the gas was to be determined; but as the analysis was of a fixed gas which had passed through a scrubber and presumably was well mixed, there seemed to be no necessity for sampling at the exact velocity of the gas in the main. The idea was to take a sample continuously, and to take it at all times in proportion to the rate of flow of gas through the main, so that the final sample would be the same as though all the gas had been drawn off and then a sample obtained from it.

PROFESSOR EARHART TREATS OF CERTAIN NATURAL GAS PROBLEMS

The next paper in order was on The Ratio of the Specific Heats and the Coefficient of Viscosity of Natural Gas from Typical Gas Fields, by Robert F. Earhart. An abstract of this paper appeared in the November, 1916, Journal, to which the reader is referred.

In a written communication upon this paper, Harold B. Bernard said that, due to the many features encountered in piping natural gas, such as condition of pipe, type of joints, bends, temperature changes, etc., it was doubtful whether Professor Earhart's determinations were of value outside the laboratory. For practical conditions, the formulae derived by T. R. Weymouth[1] from numerous observations were unquestionably of sufficient accuracy for problems involving the flow of natural gas.

A recomputation of densities of the author's Table 1 was also given. The new densities were computed from the fact that the densities were as the squares of the relative coefficients of viscosity, the coefficients of viscosity being in the ratio of the times of efflux. It is expected to give later publication to this table.

P. F. Walker, in a written discussion, said that paper was an interesting illustration of the application of scientific methods of analysis to technical problems. It was a variation from the methods which were commonly employed in the discussion of engineering problems, and it was a significant thing that work upon which the engineer was now engaged was being treated in many lines with a degree of accuracy

[1] M. E. Dept., Michigan Agri. College, Lansing, Mich.

[1] Trans. Am.Soc.M.E., vol. 34, p. 1091.

[illegible] Germany, the employment of the [illegible] on the [illegible].

[illegible] the words "ratio of specific heats," [illegible] discussion showed that he was [illegible] the value of the adiabatic exponent [illegible]. It was here that the trouble would begin. It seemed [illegible] necessary to go through the steps of the mathematical proof of the principle that for a perfect gas the adiabatic exponent was the ratio of the specific heats. It had been his observation on several occasions, however, that it was necessary to remind engineers of the fact that the statement applied only to perfect gases. It seemed to be ingrained in the minds of technical and scientific men that the adiabatic exponent must be the ratio of the specific heats. The point brought out in the previous paper by the author, and in substance fully attested to by all who took part in the discussion, was that this gas in its behavior did vary materially from the laws of perfect gases, and hence it must follow that the value of the exponent found for an adiabatic cannot be taken as the ratio of specific heats.

W. D. Ennis opened the oral discussion by stating that while the value of n for the adiabatic curve might be determined from compressor indicator diagrams, no engineer believed that this was the ratio of specific heats. He also pointed out that there must be some error in the author's determination of n, as in some cases it is less than the value of n for any of the constituents of the gas.

As to the author's method of procedure, there seemed to be nothing wrong, except that the determination of n for the gas as a function of that for air by comparing the wave lengths would have seemed more conclusive if the apparatus had been tried out on some other gas, such as carbon dioxide, for which the value of n was known.

Sanford A. Moss showed that the value of n could be computed from the gas analysis from the expression

$$n = \frac{X_1 C_{p_1} + X_2 C_{p_2} + \text{etc.}}{X_1 C_{v_1} + X_2 C_{v_2} + \text{etc.}}$$

Commenting upon the written discussion offered by H. B. Bernard that the densities are proportional to the squares of the times of efflux, Edgar Buckingham said that the statement is at the bottom of Bunsen's method of determining the relative densities of gases by means of efflux through small orifices. The statement was not theoretically correct nor did it give correct values in practice. Bunsen's method is an approximate, not an accurate one, and his own determinations are correct only within five or ten per cent.

As the author was not present, it will be necessary to defer the publication of his closure.

POTTER AND BUCK'S TESTS OF GAS AND OIL ENGINES USED ON TRACTION ENGINES

Also, the authors of the next paper, A. A. Potter and W. A. Buck,[2] were unable to be present. This paper was upon An Investigation of the Internal-Combustion Engine as Applied Traction Engines, which was instituted to determine fuel economy and thermal efficiency of different types of motors used in traction engines. The following conclusions were [illegible]:

[illegible] motors were better adapted to belt work; single-[illegible] and two-cylinder motors operated better than [illegible] motors with fuels heavier than gasoline.

Piston speeds should be lower than in automobile motors, speeds of from 700 to 900 ft. per min. giving satisfaction.

The valve-in the head type of motor had the more efficient combustion space and was to be preferred to the T head or L head types.

The jump-spark system of ignition was to be preferred on account of its mechanical simplicity.

The fuel-economy range was from about 1.3 lb. per b.hp. per hour at one-fourth load to about 0.7 lb. per hour at full load. The fuel consumption in pounds per hour per brake horsepower was very nearly the same for both gasoline and kerosene.

The thermal efficiencies at full load varied from 14.88 to 19.41 per cent for gasoline fuel, and from 13.7 to 15.97 per cent for kerosene.

Carburetors now used are satisfactory for gasoline, but a carburetor jacketed with heat from exhaust gases should be employed when operating with kerosene or with heavier fuels.

The results of the tests show the advantages of kerosene as a fuel. For a group of motors developing 26 b.hp. and under, at full load, with kerosene at 10 cents per gal. and gasoline at 20 cents, the cost of operating with gasoline was 1.99 times that when kerosene was used. Similarly, for a group developing 51 b.hp. and over, at full load, the cost with gasoline was 1.62 times that with kerosene. The advantages of the kerosene-burning motor were somewhat offset, however, by the added trouble in handling and by the shorter life of the motor when operating on such fuel.

W. D. Ennis said that he was particularly interested in the reported economy of the engines tested, which averaged not far from 0.8 lb. This was a strikingly favorable figure as compared with the hot-cap engines of the semi-Diesel type in which liquid fuel was injected as a liquid into the cylinders. These hot-cap engines, at about 50 lb. compression, used about 0.9 lb. of kerosene per b.hp-hr., and just about the same amount of fuel oil of the usual Eastern grade. It was an interesting question whether the extraordinary economy of the carburetor type of engine as presented in the paper, was due to a higher compression than 50 lb. or to better combustion. He said that he did not believe it would be generally admitted that with equal compression and the same fuels the hot-cap engine was inferior in economy to the engine of the carburetor type.

The program concluded with an Illustrated Review of the Development of the Werkspoor Marine Diesel Engine, by Thomas O. Lisle. This has not yet been published in The Journal, but it is planned to give later a comprehensive account of the lecture, with illustrations selected from those used for the lantern slides.

In answer to a question by A. J. Wood, about the relative weights of two- and four-cycle marine Diesel engines, Mr. Lisle said: "It has been found in marine work that the four-cycle engine is rather lighter, owing to the extra parts necessary for the two-cycle, particularly the scavenging pump. Theoretically, the two-cycle should be much lighter, but of all that have been put into service, the two-cycle have been heavier than the four-cycle."

Julius Kuttner[1] asked about the strength of the reversible propeller used on some Werkspoor boats, and was answered that the strength was a matter of design.

[2] Asst. [illegible] Steam and Gas Engrg., Kan. State Agri. College.

[1] 567 West 113th St., New York City.

MISCELLANEOUS SESSION, FRIDAY MORNING

At the general session on Friday morning an address of absorbing interest was delivered by Wm. L. Cathcart[1] on the Development of Our Fleet and Naval Stations. This was illustrated with lantern slides showing vividly the needs of our navy, particularly with respect to naval stations and naval bases, and was supplemented by a general discussion to which valuable contributions were made by Rear-Admirals John R. Edwards and Bradley A. Fiske; and by President D. S. Jacobus and President-Elect Ira N. Hollis. It is expected that the address and discussion will constitute a leading feature of the February issue of The Journal.

MR. CATHCART SOUNDS NATIONAL NOTE ON COUNTRY'S NAVAL NEEDS

Mr. Cathcart said that the elements of naval strength are its ships and men and its shore stations; he showed by means of diagrams how important are naval bases for the protection of our vulnerable coast; and how the location of such bases and naval stations on our own coast with respect to our possible battle grounds of the future are of primary importance. For the maintenance of our navy we needed a large number of navy yards with channels of approach dredged to full depth and with modern equipment for building both hulls and machinery. Reliance must be placed both on mines and submarines for the protection of our harbors, which in turn must be protected by shore batteries or the guns of a fleet.

Mr. Cathcart discussed certain features of interest alike to artillery officers and engineers, such as modern battle ranges, with comparison between the effectiveness of 14-in. and 16-in. guns; fire-control methods, the foundation of which was the successful application of the telescopic sight to naval guns; the possibilities of modern guns and powders, and the degree of excellence of marksmanship in our navy.

He contended that the navy should not be for aggression but to keep peace and to exert what Mahan called the "silent force of sea power," for which a large navy would be needed.

The address made a deep impression upon those present and there was a general feeling of approval and a very evident responsiveness to the convincing presentation by Mr. Cathcart of the nation's needs.

Rear-Admiral John R. Edwards[2] stated that the author's paper was one of the strongest he had heard in the last decade. In view of the fact that he had served as General Inspector of Machinery for the United States for all machinery built on the North Atlantic Coast, he was familiar with every shipyard and with the various shore stations on this coast. He therefore dwelt on the needs of these stations and gave constructive suggestions for their further equipment, of which they are so much in need.

He said that if were were to construct ships we must have facilities for repairing them. There must be docks large enough to take modern men-of-war, cranes heavy enough to lift the immense guns or the turrets off from a ship; deep piers at least 100 ft. wide; dry docks 1000 ft. long; and other equipment in proportion, not forgetting the need for hospitals and dispensaries.

Taking Charleston's harbor as an illustration, the thought was preëminent in his mind that we could allot without reservation the value of either one battleship, battle cruiser, two scouts, or ten destroyers, if necessary, in order to build a modern station at that point. The other countries of the world would measure our strength not alone in battleships but in our facilities to build battleships and to repair and equip them.

The history of Gallipoli and Salonica showed that there must be miles of water front in order to move a modern army, as a result of which the naval engineers of France and England were building large naval piers sufficient to accommodate 50 transports at one time. The need for such piers applies to both distant bases and to those at home, including the base at the Canal Zone.

He reviewed what England had done through the past five years in upbuilding its naval stations, beginning at the Firth of Forth, and what Germany had done at Wilhelmshaven and Heligoland; work of vast extent and of tremendous scope which had many times proved its worth since the beginning of hostilities. These developments certainly constituted a striking object lesson to American naval officers and engineers.

Rear-Admiral Bradley A. Fiske said it was unfortunate that the people of our country did not realize the danger to which they will be subjected when the nations at war agree on terms of peace and arrange what they will do in order to overcome the financial disaster which is threatening them. The people in our country at large believed there was no danger, and were ignorant as to what might be required to insure the safety of the country. It was the duty of every member of the Society to use his power and influence among his associates and acquaintances to show them, by the aid of the accurate thought and language to which engineers are accustomed, what the actual danger was and what the requirements were for national defence.

Dr. D. S. Jacobus emphasized the duty of the engineer to enter into public affairs. He should take more interest and do more in performing his civic and governmental duties. The attitude of the Society has been that it should not undertake anything except strictly engineering work, but times are changing, and we should consider whether the Society should go further than this. Possibly it would be better for engineers from different societies to combine for the purpose of dealing with important public matters and show what engineers can do through coöperation, something after the order of the work done in connection with the industrial census. He felt that the day is not far distant when either through the action of the existing societies or through some other organization engineers will take their true place in the management of affairs.

Prof. M. E. Cooley, speaking from the standpoint of an educator, said that the impression existed that the Naval Academy was the only institution which fitted a young man for naval service, and West Point the only institution [illegible] service. He had recently had occasion to compare the curriculum of the Engineering College [illegible] with that at Annapolis and also at West Point [illegible] the highly specialized training [illegible] in both of these institutions [illegible] very essential. He found that [illegible] engineering school paralleled about 85 per cent, [illegible] possibly more, of what was given at Annapolis and West Point. In other words, by adding about one-half year more of work or by substituting one-half year's work in place of other subjects, young men could be turned out from our engineering colleges with the same general training with which they were now trained at either Annapolis or West Point.

[1] 636 Westview Ave., Germantown, Philadelphia.

[2] Bristol, R. I.

Dr. Ira N. Hollis referred to the participation of the Society in public affairs and said that he not only approved of it but thought that the continuation of the organization as a useful function of society was absolutely in that direction.

There had been a great deal of interest in the United States in preparation for war, or military preparedness; but he looked upon preparedness as a very much larger matter. He would strengthen the conception of service by leaving out the word "military" and extend the work of preparedness to all public and private affairs that are in any way related to the larger success of the nation.

A friend in command of one of the large naval stations had written suggesting that civilians ought to serve for a short time every year as understudies in the conduct of naval manufacture and repairs, so that men would be trained during peace to take charge of the work in time of war, thus relieving officers who were prepared in the more technical details. That illustrated the direction in which we should work and suggested the organization of an Engineers' Reserve composed of members of our Society for all purposes behind the fleets in making the supplies for the Navy and in training for war service.

Was it not a duty of every young man to give, freely, one, two or three years of service to his country, no matter whether that service took the shape of learning how to fire a gun or going into public service for the purpose of building ways of communication between the different parts of the country?

Any young man should feel proud to serve on a Lincoln Highway after enough experience at Plattsburg to teach him obedience and the democracy of the barracks. Two years' digging for his country, as a free contribution towards means of communication, would be as important for peace as for war. The pick and shovel could be made as effective in promoting love of country as the rifle, and every youth ought to have a taste of them.

Brief remarks upon Mr. Cathcart's paper were made also by Carl G. Barth, M. A. Stone and F. G. Coburn.

MR. COBURN DESCRIBES NAVY METHODS OF HEAT-TREATING WROUGHT-IRON CHAIN CABLE

Following the presentation and discussion of the paper on naval preparedness, a brief abstract was presented by Fredk. G. Coburn,[1] of an important paper on Heat Treatment of Wrought-Iron Chain Cables, prepared jointly by Messrs. Coburn, W. W. Webster and E. L. Patch.

All the chain cable for the U. S. Navy is made in the smith shop of the U. S. Navy Yard at Boston under the direction of Naval Constructor Coburn. This chain was formerly hand-forged, but it was finally decided to adopt power forging, after which considerable difficulty was experienced through the frequent failure of the chain links. It was evident that some form of heat treatment was necessary, and as there was practically no information available on the heat treatment of wrought iron, which was used in the manufacture of the chains, an extensive investigation was conducted. It was found that annealing under certain conditions relieved the stiffness which apparently existed in the links and to which their failure was attributed.

Preliminary to the tests upon the links themselves, tests were conducted upon the material used in the manufacture of the chain, in the way of chemical analyses, tensile and impact tests and metallographic examination.

The paper gives the results of these several series of tests, a summary of which will appear in an earlier issue of The Journal.

[1] Boston Navy Yard.

STEAM BOILER SESSION, FRIDAY MORNING

A LONG and highly profitable session was held on Friday morning under the auspices of the Boiler Code Committee. The audience, though small at first, grew in size until at last it taxed the seating capacity of the room. At the request of John A. Stevens, Chairman of the Boiler Code Committee, Professor A. M. Greene, Jr., acted as presiding officer, assisted by Sherwood F. Jeter. In addition to the three scheduled papers, two topical discussions were presented upon the subject of welding.

The first paper, upon An Analysis of Marine Safety Valves, with Suggestions for Repairs and Improvements, by E. F. Maas, considered the various elements of safety valves which had to do with the successful operation of the valve. Seven typical valves were discussed with respect to the following points: Tightness; pop of valve and simmering; lift of valve; closure and chattering; blow-down and its adjustment; discharge capacity; repair and adjustment.

The author believed the flat-seat valve superior to the beveled-seat valve, contending that it was as easy to grind and would more generally remain tight. He showed how certain valves provided with adjustable blow-down might be rebuilt so that when repaired the necessary machining would be small and need not be done to a standard gage. The paper contained many suggestions of practical value for the grinding and repair of safety valves.

Charles W. Barnaby opened the oral discussion of the Maas paper by asking why all manufacturers of safety valves used a square rod for valve springs when it had been discarded for springs for practically all other purposes.

A. A. Cary answered Mr. Barnaby's question by saying that it was possible with the square-rod spring to get more resistance in a given volume. The round spring was theoretically the best. The principal resistance was to torsional movement. The square spring occupied less space, was more rigid, and better adapted for pop valves in every way. It held its shape, and manufacturers who had used round wire and bar springs always came back to the square springs.

MR. TALBOT DESCRIBES HIS MARINE TYPE OF BOILER WITH FORCED CONTRA-FLOW CIRCULATION

Assisted by lantern slides with which to illustrate his paper, Paul A. Talbot[1] gave a descriptive talk upon the boiler which bears his name. This boiler utilizes the principle of forced contra-flow circulation through water tubes at high velocity. Steam drum and water drum are unnecessary, so that danger from explosion is reduced to a minimum. Oil is sprayed by superheated steam into the combustion chamber, which is lined on all sides with heating surface.

The supply of feed water passes through a regulator valve before entering the boiler. This valve is controlled by the expansion of one of the tubes of the boiler so that it opens and closes with varying temperatures of the steam within the tube.

[1] Pres., Talbot Boiler Co., New York City.

The fuel valve is also controlled by the expansion of this same tube so that the fuel supply is cut off if the temperature of the steam becomes greater than is desired. The control of feed and fire thus becomes automatic. A gage is provided for indicating to the operator the relative temperature of the steam.

The high velocity of water and steam over the heating surface prevents the formation of scale. Steam jets are provided for blowing soot from the outside of the tubes.

A high rate of evaporation is obtained, the average, including economizer and superheater surface, being 8 lb. of water per sq. ft. (16 lb. on forced draft).

Because of the contra-flow principle, the effect of increased draft and higher evaporative rates is to increase the economizer surface of the upper tubes and to modify the stack temperature.

In a written discussion, Albert A. Cary commented upon the similarity in construction of the Talbot boiler and the Niclausse boiler, which had the same field tube arrangement. His personal experience had taught him the desirability of having the water storage made a part of the boiler, which provided to a certain extent an immediate source of water supply, when the combustion in the furnace was quickly increased to meet a sudden demand for steam. The tendency of many inventors in producing compact water-tube boilers, especially those of the marine type, had been either to reduce greatly the size of their steam and water drums, or else to do away with them altogether; and it was still an open question as to how far this could be safely and rationally done. In the Talbot boiler, automatic regulating devices did away with water storage.

While the Talbot boiler did not better the Niclausse boiler in exaporative rate, it required considerably less space per unit.

His experience did not lead him to believe that there was solid water within all the tubes of the Talbot boiler when it was in operation. Tests made in England on the Belleville boiler, of somewhat similar tube arrangement and forced water circulation, had shown that 50 per cent of the boiler under normal conditions was filled with steam. Judging from this, it was safe to assume that a considerable lower portion of the Talbot boiler was filled with steam during operation, and such steam-bathed surfaces could hardly be considered good water-contact heating surfaces, i.e., efficient for the production of steam.

He believed in the contraflow principle in operating boilers, providing it could be accomplished by simple means and without too great an expenditure, or inaccessible moving parts.

Extended experience had taught him that the highest results for heat transmission in boilers were secured by removing the steam from the heating surfaces almost as rapidly as it was formed, and thereby permitting the greatest possible area within such heating surface to be bathed and wetted with solid water. In this type of boiler, which prevented the steam formed in the interior of the boiler from escaping from the heating surface, we were certainly not improving the conditions required to facilitate rapid heat transmission through the lower and most valuable area of the heating surface.

The danger of scale in a boiler equipped with field tubes was brought out by Mr. Cary, who said that although there might be a sufficiently high velocity to prevent scaling when the boiler was in operation, there were periods when the boiler would be shut down and when the scale might accumulate so persistently that the circulation of the water, upon resumption of operation, would not be sufficient to remove it.

Capt. C. A. Carr, U.S.N., said that the first tests of the Talbot boiler for the navy showed particularly good results in the reduction of the quantity of oil burned and the increase in speed of the boat. It was believed that in this case the economy was caused directly by furnishing dry or superheated steam to an engine which previously had been very wasteful through the use of wet steam. The use of the Talbot boiler appeared to furnish a ready, reliable, convenient and inexpensive means of supplying steam of any desired degree of superheat for small power installations in which oil was used as fuel.

Perfect control of the feed system for this type of boiler was essential. On account of the small reserve capacity of steam and the friction of steam and water in the boiler, the feed pumps usually furnished with small marine plants would be found unsatisfactory. The automatic control valves were intended for use when the engines were running steadily. When working to bell signal, the oil supply and feed valves were necessarily regulated by hand.

Captain Carr considered the oil-burning system furnished with the Talbot boiler unsuitable for large boilers and wasteful of both oil and steam with small ones.

Prof. R. C. Carpenter said that a study of the White boiler plant in connection with the Talbot boiler should prove of interest. He made reference to a paper which he presented in December, 1906, and which appears in Vol. 28 of the Society's Transactions, dealing with his tests of the White automobile boiler.

John W. Parker spoke of the difficulties he had experienced with his early investigations of boilers of the general type of the Talbot boiler, particularly with the scale formed by the insolubles in the boiler water. He showed how Belleville, who attempted for a long time to build a water-tube boiler without any drum, finally installed the drum, later introducing a gravity circulation independent of the pump, and at last succeded through perfected automatic control devices. If the Talbot boiler succeeds, he believed it would depend on the efficiency of the automatic devices for its success.

In his oral closure, Paul A. Talbot pointed out that the particular advantage of the field-tube construction was the relieving of the strains due to the expansion of tubes between tube sheets. He showed that in the tubes in his boilers, the expansion under a temperature of 800 deg. fahr. was as great as one-half an inch. The high velocity of circulation under extreme firing conditions, he said, keeps the boiler cool.

Speaking of the deposits in the boiler tubes, Mr. Talbot stated that even with the water of Puget Sound in the boilers there was no accumulation of scale in the tubes. After standing all night, there was a small amount of silt in the tubes, but this was swept away as soon as circulation was set up. The high velocities would damage by erosion, rather than corrosion. There was never any formation of sediment noted when the tubes were examined after the boiler had been shut down.

In answer to a question put by D. K. Warner[1] about limiting the draft to two inches, Mr. Talbot said that two inches was not a limit. Lack of time and money have prevented experiments with forced draft.

The tube referred to in the original paper which was removed in 61 sec. was chosen at random by the officers in charge of the test as the one they wished changed. All of the tubes were accessible, but it was not possible always to change a tube in as short a space of time as this.

[1] Sheffield Scientific School, New Haven, Conn. Graduate Student

[illegible] later was answered that the change in the con[illegible] header was made because it simplified the construction and for no reason which affects the operation of the boiler. (This change in construction was illustrated in one of Mr. Talbot's slides and did not appear in the illustrations accompanying the original paper. It referred to the cored passages of the header.)

MR. PARKER OUTLINES THE DEVELOPMENT OF HIS DOWNFLOW TYPE OF STEAM BOILER

The downflow type of steam boiler was discussed at length by John Clinton Parker in a paper bearing that title. With the aid of lantern slides, Mr. Parker presented an interesting lecture.

This paper describes the early experiments which demonstrated the possibility of circulating the water in boilers apparently contrary to the natural way, that is, downward rather than upward. From these there was developed the downflow boiler which was designed and had been built by the author for a number of years.

Among the advantages of the downflow principle was the fact that the course of the water and steam were opposite to those of the flame and hot gases, consequently the hottest particles of each were in communication with the hottest particles of the other and there was a minimum difference of temperature between the adjacent particles of the two.

The tubes are formed, by connecting their ends together through junction boxes, into a number of vertical coils, and one of the special problems of the manufacture of this boiler was the design of these junction boxes. The paper described these boxes, which were constructed of malleable iron.

A. A. Cary opened the oral discussion by making objection to the location of the superheater in the Parker boiler, which was placed in the combustion chamber near the bridge wall. The superheater, he said, was a secondary apparatus, and after the boiler had absorbed all the heat possible, the waste gases were led away to superheat the steam. In this way, one did not deprive the boiler of any of its functions. He also pointed out that the efficiencies obtained with the Western coals in the St. Louis tests, quoted by Mr. Parker, were not as high as would be obtained with Eastern coals.

In his closure, Mr. Parker cited Rankine as his authority for placing the superheater. He deprecated efforts of manufacturers to establish exceptional boiler performance under conditions not readily obtained in practice, and stated that he had made it a rule to compare his boiler with others under ordinary working conditions.

MR. WILDT DESCRIBES THE PENCIL ELECTRODE METHOD OF WELDING

E. A. Wildt[1] gave an illustrated talk dealing with The Pencil Electrode Method of Welding. The manuscript was received too late to appear on the program, but was presented at the request of the Boiler Code Committee in order that this important subject might receive a general discussion.

The object of the paper was to educate engineers on the matter of welding, by a description of the pencil electrode method which was used for boiler joints. The author wished the Society to consider whether it was more feasible to weld the joints of a boiler drum than to rivet them with a butt strap joint.

[1] Lackawanna Boiler & Grate Co., Scranton, Pa.

The success of any weld depended upon bringing the pieces of metal to the proper heat. Electricity was used only to supply the heat, and in the pencil method only just enough heat was obtained to accomplish the joining of the two metals. Regardless of whether the voltage or the amperage were uniform, a metal wire used as part of the circuit always formed one terminal and provided the welding metal.

The temperatures obtained in gaseous and electric-carbon welding wherein fluidity of both metals was a condition, were 2800 to 3000 deg. fahr., while in the electric-pencil method the temperature did not rise much more than 1500 deg. fahr., which was only enough to produce a plastic condition.

The forge welding, approved by the A.S.M.E. Boiler Code, caused heavy expansion strains, so that when the forge-welded seam had cooled off, the adjacent expanded metal produced tensile strains tending to pull the welded portions apart. The pencil electrode and the forge method were alike in the fact that in neither was the metal heated beyond a point necessary to produce a weld. That which prevented the high temperature in the weld was the fact that as fast as the metal to be added to the weld became plastic, the pencil must be advanced toward the work to close up the spark gap, the current otherwise being interrupted. Failure on the part of the attendant to keep this gap the proper size at all times resulted in the frequent extinguishing of the arc. The heat being confined to the smallest area, the expansion and contraction strains were small.

Welds made by this method were feasible for pressures of 500 lb. per sq. in. with half-inch plates, as had been demonstrated by experiment.

The metal of the weld could be controlled by the kind of metal that was added. The weld was made thicker than the original plate to be sure of strength.

There was at the present time a small water-tube boiler of the vertical two-drum type in service. All the tubes were bent and there was not a rivet in the drums.

A written discussion of Mr. Wildt's paper was presented by P. A. E. Armstrong,[1] and illustrated with lantern slides. The superiority of electric welding over gas or fire welding, Mr. Armstrong said, was due to the extremely localized character of the heat generated by the electric arc, thereby resulting in a smaller area of thermal disturbance.

While the electric carbon arc had a tendency to heat the metal almost as much as the gas process, the bare-wire electric process restricted the thermal disturbance in a large measure. The deposited metal, however, was usually oxidized and distinctly cold-short, therefore having almost a complete absence of ductility. The problem was to surround the bare wire with a substance such as the slag which formed when steel was made in order to protect the metal of the weld from the evils of oxidation. Such a means was employed in an electrode recently developed in Great Britain.

The special electrode was composed of an iron or steel core. Running parallel to its axis was a very thin aluminum wire, its purpose being to purify the melt, and covering its entire length was a braided slag. The current passed through the core. The slagged end of the electrode was brought in contact with the job to be welded and an arc formed which had the effect of fusing the core and the covering slag. The atmospheric arc was extinguished and a quasi arc of vaporous slag took place. The molten metal flowed out at the end of the electrode upon the work and was at all times covered with a large body of protecting slag, which had the effect of localiz-

[1] 61 Broadway, New York City.

ing the heat and insuring the complete fusion of all metal within its vicinity. There was no tendency for the slag to become entangled with the weld, as it was much lighter than metal and had no affinity for it.

Most conclusions about the elongation of welded specimens were erroneous, as the elongation did not occur within the weld.

Corrosion was electrolytic in character and depended upon the difference in potential of contiguous areas. Commercial iron or steel contained areas which in the presence of an electrolyte, such as moisture, were capable of forming voltaic circuits, the necessary conditions being afforded by the presence of small particles of impurities or by local conditions of strain in the metal itself.

In a welded joint, if the metal at the weld were less pure than the surrounding metal, the weld would be first attacked, and if the added metal were not homogeneous, local differences of potential in the weld itself would cause corrosion at the weld. The metal deposited by the slagged electrode was of remarkable purity and hence not so readily subject to corrosion.

John C. McCabe asked Mr. Wildt about the welding temperature of 1500 deg. fahr. which he mentioned, and how the stresses set up in the weld were eliminated. He had found the welding material varied, the per cent of elongation running from a fraction of one per cent up to the highest point, 11 per cent, and in view of the bendings or flexures that occurred in the best-formed cylinders, he failed to see how an autogenous-welded vessel, as the problem was understood, could be considered a safe one.

Was not the great difficulty with all autogeneous welding for boiler plates in general the fact that so much of the plate adjacent to the weld was heated, the elastic limit of the plate reduced and its elongation increased? asked Christopher H. Bierbaum. It was known that autogenous welds could be made that were as strong or stronger than the original metal, especially if the weld were left a little thicker than the metal itself. Under such circumstances there was no question as to the strength of the weld that could be made, but did not the internal strains and the heating of the plate induce conditions which should be very carefully determined before any theoretical conclusions could be drawn?

In his oral closure, Mr. Wildt said that the temperature of 1500 deg. fahr. was more or less estimated. He also called attention to the fact the same disturbance was set up when the process of welding approved by the Boiler Code was used as when the pencil electrode method was used. When one considered the strains due to contraction and expansion, they were very much less in the pencil method than in the approved form of welding. This was because the heat was localized and confined to a small area. In the pencil method, the weld was heated, while with the approved forged-weld process there was quite a considerable area heated along the entire length of the seam.

RAILROAD SESSION, FRIDAY MORNING

Before a representative audience, the Railroad Session of the Annual Meeting was called to order by E. B. Katte, Chairman of the Sub-Committee on Railroads, who introduced Mr. T. L. Burton. Mr. Burton presented a paper on Clasp Brakes for Heavy-Passenger-Equipment Cars. The author first discussed the braking required for present-day heavy-steel-passenger-car equipment, and then gave results of several series of brake tests made by different railroads since 1902. As the author stated in his presentation, he did not attempt to describe any particular brake, but confined his remarks to what might be expected of a clasp brake properly designed and constructed.

The discussion was opened by H. H. Vaughan, who commended the author for calling attention again to the desirability of this type of brake, which has been so clearly established by experiment and experience. He said the only reason the brake was not adopted on the Canadian Pacific Railway was that they had a type of truck to which it was difficult to apply it, and that with the low speeds there was apparently no advantage in the clasp brake over the ordinary brake with a large area of brake shoe.

S. G. Thompson also agreed with the author as to the superiority of this class of brake. He said it is perfectly reasonable to think that better results will come from applying the braking force on the two sides of the wheel.

His road had the advantage of having Mr. Burton design some of their equipment in the early days of the clasp brake, and it was under his supervision that a great deal of the preliminary detail work was done.

C. D. Young also heartily indorsed everything in Mr. Burton's paper. He said the Pennsylvania Railroad had and still has quite a large number of steel cars with four-wheel trucks with the single-shoe brake, and they had come to the conclusion that the saving of brake-shoe material would justify the reconstruction, so that as far as this road is concerned there will be nothing but clasp brakes on their steel equipment in time. The same thing applied to the six-wheel-truck cars, for which it is still more difficult to get a successful design.

He emphasized Mr. Burton's contention that for the successful and economical operation of the clasp brake the design must be correct. If you do not have a correct design you will not get the results, and he knew of installations today which were incorrect and which should be modified to get the advantages to be expected from two shoes per wheel.

He thought that some day we will see the clasp brake adapted more generally to tenders, engine trucks, where the wheels are heavily loaded, and freight cars.

A written discussion was contributed by O. C. Cromwell, who outlined the experiences of the Baltimore & Ohio Railroad with clasp brakes. This road now considers this brake the standard brake equipment for heavy-passenger-equipment cars. Mr. Cromwell's discussion will be published in full later.

In closing the discussion the author pointed out that one of the most important advantages of the clasp brake is with low-speed trains, where it reduces, if not eliminates, slack action. If there is anything second in importance to stopping trains in a desired distance it is in stopping them smoothly from low speed.

What Mr. Young said on the importance of properly fitting a brake design is another explanation for the absence of illustrations in the paper of the design. He had occasion to supervise if not to make a great many clasp-brake designs, and it is the rarest thing in the world to find one design suitable for two similar but different designs of cars. With respect to the application of the brake for heavy-equipment freight cars, he said he had just completed designs for some coal cars to carry 240,000 lb. of coal, weighing about 350,000 lb. when loaded.

MR. MUHLFELD DISCUSSES COMPREHENSIVELY THE SUBJECT OF THE USE OF PULVERIZED FUEL IN LOCOMOTIVES

In the second paper of the session, John E. Muhlfeld gave the principal facts and conclusions resulting from a number of years of investigation and research and of development work in connection with the important subject of the use of pulverized fuel in steam railway operation. Mr. Muhlfeld's paper was a comprehensive treatise covering the entire field of the subject—preparation of the fuel, storage, handling, burning, and locomotive performance. It concluded with a summary of the advantages of the use of pulverized fuel in regular road passenger and freight service and was supplemented with a number of illustrations setting forth the principal reductions to practice and results obtaining at this time.

The oral discussion of the paper was opened by W. L. Robinson, who expressed his opinion that the paper covered practically everything, although a number of points could be elaborated upon.

Mr. Robinson said that the application of powdered fuel would be a practical advantage on his own road at the present time on account of the irregularity of supply of coal and the car shortage. Using pulverized coal would do away with this entirely.

He thought the biggest thing that would appeal to the conducting-transportation side was the delays at terminals. On one of the larger roads, which uses about 6,000,000 tons of coal a year, the average mechanical delays at some of the heaviest maintaining stations are between 10 and 11 hours, and the lowest delay at dispatching stations is from $3\frac{1}{2}$ to 5 hours, or an average of 6 hr. 7 min. There is no question but what if you could eliminate the ashpit delays you could cut the delays nearly in half.

One statement of the author that impressed him was that with pulverized coal more skilled manual control of combustion and assistance to the engineer in the operation of the locomotive and observation of track and signals were secured. He thought that would help a great deal toward safety.

The chairman expressed a difference of opinion with one paragraph in the paper, that the extraordinary expenditure required for first cost and fixed charge, as well for combined maintenance and operation, together with the necessity for reliability and flexibility, preclude the general use of electricity as a motive power. He thought it would not be difficult to show that the electric locomotive, and the complete electrical installation behind it, can be maintained cheaper than the equivalent steam unit. As to reliability, he believed the electric installation has been shown to be more reliable under all conditions than the steam; and as to flexibility, in some cases two electric will replace three steam locomotives, and the electric locomotive does not have to be turned round, nor go to the ashpit, nor receive coal. He admitted that at the present time the first cost precluded the use of electricity except under special conditions.

George L. Fowler took up a point not touched on in the paper or discussion,—the action of fireboxes in service. The application of powdered fuel appealed to him very strongly from the fact that apparently with it a more constant firebox temperature could be obtained. It is very difficult to appreciate how sensitive a firebox is to slight variations in temperature.

C. D. Young gave his experiences, extending over four years, in attempting to burn powdered fuel in a stationary locomotive firebox. In his own words:

"The result of that work up to this time indicates very definite limitations in the use of pulverized fuel. The first limitation we have found is that, when we attempted to burn the quantity of fuel per hour that would justify the expense of putting the device in the locomotive, we melted up most everything that we had in the firebox. Our combustion chamber gave us trouble and annoyance that would make it impracticable for us to apply the device to road operation. This can be controlled, at least we have controlled it, but as soon as we attempt to control it we offset the efficiency of combustion; in other words, we reduce the temperature of the firebox by excess oxygen, so as to protect the fire-brick in the box, then we have excess fuel for that burning rate.

He thought it very desirable, however, that everyone who has the problem that powdered fuel presents should work upon it.

Mr. Young then took up various points in the paper and discussed them in the light of his own experience, summarizing in conclusion with the statement that the powdered-fuel stoker, operating as it does with reduced stand-by losses, gives that margin of economy to pay for the stoker.

L. S. Randolph thought that in designing the apparatus for storing and handling powdered fuel, the matter of dust explosions should be watched very closely. While the author seemed to have passed over this question with very slight reference, it should be elaborated on and handled very carefully.

To G. M. Basford, who next discussed the paper, two statements stood out above all the other good ones in this paper. The first was: "The future steam locomotive, on account of its track and bridge weight and tunnel and overhead clearance limitations, will be required to produce the maximum hauling capacity per unit of total weight." We have not yet gotten fairly started on that principle, and to have that question raised in connection with the subject of improved combustion, or pulverized fuel, really was, it seemed to him, a very important thing to come before the engineers and the railroad people at this time.

The other statement of equal importance was the comparison of the work of an Atlantic type locomotive, burning pulverized fuel, with that of a Pacific type locomotive. There are so many Atlantic type locomotives in this country to-day, and the Atlantic type of locomotive really represents in this case a large number of small engines in every part of the country. This statement becomes so important because the Atlantic type, with improved combustion, can be made to do in one case the work of a Pacific type engine, and the next thought naturally is: How many Atlantic types may be made to do the work of Pacific types today? By applying this pulverized-fuel principle to new designs, it will have the effect of prolonging the life and putting back into service a good many outclassed engines on the one hand, and introduce the possibility of using it from the ground up in new design where you start with a clean sheet of paper. That has never yet been done, with the exception of the consolidated locomotive on the Delaware & Hudson.

Charles Whiting Baker was impressed with that part of the paper wherein it was stated that the pulverized-coal equipment would permit the use of low-grade fuels. In some of the special locations where such fuels are obtainable for successful development of powdered fuel, a large reduction in operating expenses may ultimately be brought about, even when the cost of fuel is taken into account.

He thought that the possibility of using this development for switching locomotives in yard service was of immediate interest. If with powdered coal you get a locomotive free

from smoke, you have taken a big step toward putting an end to the agitation against the switching locomotive with its smoke.

It would be very desirable if the author, in his closure, would state if it were possible to regulate the burners so that the amount of fuel burned could be made to correspond with the demand for steam—whether it were possible, for example, to operate a switching locomotive and not have it blow off and waste heat while standing.

Angus Sinclair considered that the progress made lately with the combustion of pulverized fuel has been greater than any made in railway operation for many years.

A lengthy written discussion of Mr. Muhlfeld's paper was contributed by E. H. Stroud, who predicted that still better results will be had than those cited in the paper.

C. W. Corning enlarged, in a written discussion, upon some of the good qualifications of powdered-fuel burning stated in the paper.

J. H. Manning wrote that the paper ably covered the ground, and confirmed the author's statements with experiences with Engine No. 1200 on the Delaware and Hudson.

S. S. Riegel lent further assurances of eventual successful operation of powdered-fuel equipment for locomotive service by referring to important successful users of powdered fuel in industrial works. He stated that the final and best results had not yet been obtained.

In his closure, Mr. Muhlfeld discussed the question of the steam *vs.* the electric locomotive, stating as his opinion that the self-contained motive-power unit will be the one upon which we will have to depend for handling heavy freight trains over long distances. Of course, in a terminal proposition we have other conditions, and electrification is bound to be installed.

He replied to Mr. Baker's question of the applicability of powdered fuel to switching service, that one thing which has caused a great deal of trouble is the absolute control of the fuel bed. This has only been attained recently, with the development of a special feed-governing device which gives almost any range and is very effective.

THE MECHANICAL DESIGN OF ELECTRIC LOCOMOTIVES DISCUSSED BY MR. BATCHELDER

The paper by A. F. Batchelder on the Mechanical Design of Electric Locomotives dealt with features of safety of operation, general requirements of design, adaptability to service conditions in regard to nature of traffic and track, convenience of arrangement of operating devices and location of operator as affecting safety and efficiency, power efficiency as affected by mechanical design, service-time factor, cost of maintenance of permanent way and of locomotives, and first cost of a locomotive. The paper was presented by the author, who felt that too much importance could not be given to developing to the utmost the mechanical part of the electric locomotive that is the simplest in design and highest in efficiency.

C. H. Quereau presented a written discussion, which will be published in more extended form later, in which he gave statistics which would permit a personal conclusion as to the reliability in service of the electric locomotives used on the New York Central Railroad. He thought that these statistics would probably be more satisfactory than any general statement or expression of opinion, no matter how authoritative.

Experience had shown him that the cost of maintenance of engines in switching service was about twice that of those used exclusively in road service. During the period 1912-1915 the cost of maintaining the road locomotives had been about 2.5 cents per mile and that of the switch engines about 4.8 cents per mile. For the first ten months of 1916 these figures had been approximately 2 cents and 4 cents, respectively, but he doubted whether they could be kept permanently at this level. It was only fair to state in this connection, however, that the locomotives had not been designed for switching service, and with that in view they had given remarkable results.

George Gibbs, who also contributed a comprehensive written discussion which it is impossible to abstract satisfactorily, and which will therefore be published in full later, gave some opinions of his own regarding electric-locomotive design. He stated at the outset that a complete presentation of this subject has yet to be made. All we can really do at present is to chronicle experience with various types and classes of electric locomotives in various services. Unfortunately, the total number actually in service is quite limited, and the period over which our experience runs is also, in many cases, short.

He would say, generally, however, that the elimination of reciprocating parts from the locomotive—a result accomplished in electric but impossible in steam locomotives—did not warrant us in abandoning some of the very important principles well demonstrated in steam practice; namely, that for safe and successful operation under average track conditions, high center of gravity, low dead weight below spring supports and unsymmetrical wheel and weight distribution give best results. All this applied especially to high-speed operation; for low speed similar arrangements were also desirable but not so essential.

C. E. Eveleth also contributed a written discussion, in which he endorsed the paper as bringing out all the essential elements which should be taken into consideration and properly balanced before judgment is passed in favor or criticism of the mechanical features of a particular locomotive.

With the author's suggestion of the use of a truck center pin located in a well-elevated position, all of the advantages of high center of gravity, so far as effect on rail displacement was concerned, could be obtained. On the other hand, with ordinary leading-truck designs, it appeared that the high-center-of-gravity designs would give a low-center-of-gravity effect by the action of the rear truck on the track unless the high-center-pin arrangement suggested by the author was adopted on the trucks. Apparently, if high center pins were used on the trucks, the location of the center of gravity was of little importance. He referred, of course, to symmetrically designed locomotives intended to run in both directions.

He stated the incontrovertible facts upon which, from a mechanical standpoint, Mr. Batchelder's claim for superiority of the bipolar gearless design for high-speed service is found. Features which do not seem to have had general recognition place this design distinctly in a class by itself, and it is therefore to be expected that where the system of electrification will lend itself to the use of this type of engine, its application will become very general.

The chairman, opening the oral discussion, thought that it is perfectly obvious that the only difficulty in getting the electric locomotive to ride as well as the steam locomotive is the added requirement of operating in both directions, and of course this arises from the fact that the machine must necessarily be symmetrically designed about a center, or by means of cross-equalizing an effect of dissimilar ends must be created. He thought the addition of hub springs had done more towards the easy riding of a symmetrical locomotive than perhaps any other thing. The effect is, that immediately there

is an irregularity in the track, one wheel tends to rise, to leave the track, and because of the turning effect, the tendency is to skew that axle. Because of the very sensitive springs on the top of the wheel, the wheel is almost immediately forced back to the track, and the tendency to oscillate has been broken up.

This was very noticeable on one of the late types of New York Central engines. Before the springs were added, it was possible, when running 60 or 65 miles an hour, to see the equalizers work, but after the application of hub springs, the equalizers acted so quickly that the eye could not follow them. He had always believed that it was the application of these hub springs that created the particularly easy riding of the late type of New York Central locomotives.

L. S. Randolph took up the question of the guiding action of trucks, which he thought would repay study, especially in connection with the electric locomotive.

The safety of operation was next discussed, and George L. Fowler questioned the author's statements. This discussor gave results of his investigations in regard to the lateral thrust of engines and cars upon the track. He gave diagrams on the blackboard to show why he disagreed with the author's statement that the rear driver puts an excess pressure on the rail on the outside above the other wheels. He also demonstrated by diagrams what thrust is put on the track on a curve by the wheels of various types of engines.

As to the effect of height of the center of gravity, Mr. Fowler gave his reasons for thinking that the thrust is quite as dependent upon the character of the wheel and that of the vehicle as it is upon the center of gravity. In making some investigations in which he had occasion to measure the thrust on trains running from 50 to 60 m.p.h. over an 8-deg. curve, track elevated for a speed of 24 m.p.h., he found that the locomotive did not begin to put the thrust on the rail that a sleeping car at the back end of the train did, and yet the height of the center of gravity of the locomotive and that of the sleeping car only varied about three or four inches.

Mr. Batchelder, in his closure, pointed out that one question he wanted to bring out was the desirability of having more weight on the rail at the place of the thrust. That place, by actual test, is at the rear truck. That is not from guesswork, or from theory, or from calculation, but is actual fact, tested and observed for 50,000 miles of running, for the particular purpose of finding out where the double-end locomotive took its thrust. He had witnessed rails displaced ¾ in. when the front end of the locomotive was on the track.

Mr. Fowler asked Mr. Batchelder if that were not on tangent track, and he replied that it was.

Mr. Batchelder continued that in striking a curve, running on a tangent track, you are oscillating. All the locomotives he had seen run did; if it is a tangent track they are working from side to side, providing you haven't got a "cock-eyed" truck. When the forward truck gets to one rail or the other, it hits the rail, and there is only one place to hit it, and that is at the rear end.

On a curve he had never seen any trouble with double ends, except where a large resistance was put against the curve, the trucks, in other words, putting on too much resistance. A double-end engine, according to his experience, is absolutely smooth and good running on a properly elevated curve.

In regard to Mr. Quereau's remarks as to the pivot point of the leading truck, he had to say that he knew no way of observing it, but in his opinion the outer rail would be the point of pivoting. The same discussor had spoken about the resistance tending to prevent the guiding trucks from oscillating, and he believed that this was true. With the engines the discussor had in mind there was a frictional resistance, and when once the truck had taken a position, something had to be struck before it came back into another position, and it might therefore run cock-eyed on the track and cause flange wear, and in that particular case flange wear was much preferable to oscillation.

Mr. Katte had spoken of coil springs on the box, and he would add that his experience with them had been gratifying.

Mr. Young had understood him to say that a locomotive would not run backward safely. He would rather modify that statement and say that it was not desirable to run it backwards. For that matter, he did not know of any operation of locomotives at 80 m.p.h. backwards, especially of the American type. However, in making tests of two American-type locomotives back to back, with leading trucks, it had been his experience that those locomotives, when run at as high a speed as 80 miles, did affect the track and sometimes very seriously. The defects were not immediately apparent, but they developed sooner or later.

WORK OF THE BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in The Journal, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee as approved by the Council on December 7, 1916, in Cases Nos. 87, 113-123 inclusive. In this report, as previously, the names of inquirers have been omitted.

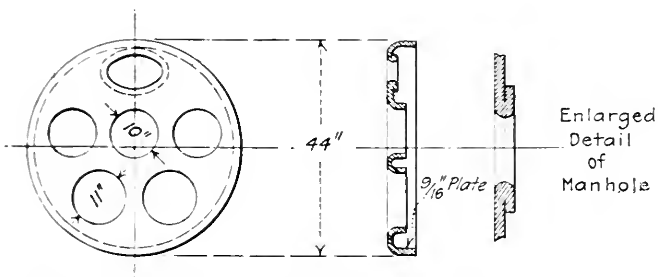


Fig. 6 Special Construction of Manhole Opening

Case No. 87

Inquiry: Is there any restriction in the Boiler Code against the purchase of steel plate by weight per square foot instead of by gage, provided there is a factor of safety of five throughout?

Reply: The Boiler Code does not specify how the plate shall be bought, but material must comply with the Code specifications.

Case No. 113

Inquiry: *a* Are the furnace sheets in all water-leg boilers, such as vertical fire-tube boilers, to receive staying as flat plates; that is, when it is necessary to use staybolts on a circular furnace sheet, is no value to be given according to the Code, to the furnace sheet due to its curvature?

b When the circumferential and longitudinal pitches are not equal, can their product be used in place of p^2, in Par. 199? Also, can it be used and made equal to the square of the values given in Table 3?

c Is it the purpose of Par. 207 to provide a greater spacing than shown in Table 3 for flat plates?

d Is Par. 257 intended to do away with the bevel shear for finishing the calking edges of plates, and does it mean that the plate edges may only be planed, milled, or chipped?

Reply: *a* An internal cylindrical furnace which requires staying, shall be stayed as a flat surface, and no value will be given the furnace sheet due to its curvature, in accord with Par. 212. (See also the Reply in Case No. 57.)

b No, *p* must be measured as specified in Par. 199.

c Par. 207 was not intended to cover the spacing of staybolts on flat plates, but was intended for staybolted surfaces where some form of reinforcement is applied.

d According to Par. 257 of the Code, in order to eliminate the incipient cracks left by shearing, the edges of the plates must be finished by planing, milling, or chipping, whether they are sheared straight or beveled.

Case No. 114

Inquiry: Is it allowable under Par. 333 of the Code to stamp a locomotive type boiler over the fire door, when the latter is located in the side of the furnace section of the boiler?

Reply: Such a boiler may be considered a special type, and according to Par. 333j, the stamp shall be placed in a conspicuous location. It is therefore correct to place the stamp near the fire door.

Case No. 115

Inquiry: Is it permissible under the Boiler Code to use manhole openings in the heads of boilers constructed as shown in Fig. 6?

Reply: Yes, when the head is flat and stayed with tubes as shown in the sketch, or otherwise stayed.

Case No. 116
(In the hands of the Committee)

Case No. 117
(Annulled)

Case No. 118

Inquiry: Is it permissible under Par. 185 of the Boiler Code, to build a horizontal return tubular boiler of 19/32-in. plate (1/32 in. heavier than the limit placed by Par. 185) without planing down the circumferential joints?

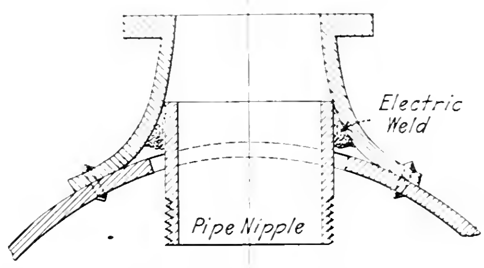


Fig. 7 Welded Connection for Internal Pipe to Nozzle

Reply: The shell plates in horizontal return tubular boilers, where the plate thickness exceeds 9/16 in., must be planed down at that portion of the circumferential joint exposed to the fire or products of combustion, as required under Par. 185 of the Boiler Code.

Case No. 119

Inquiry: *a* Is it permissible under Par. 274 of the Boiler Code, for a pop safety valve with a higher lift than the maximum given in Table 8 of the Code, to use the manufacturers' rated capacity of discharge?

b Under Par. 421 of the Code, is it permissible to rate discharge capacities of safety valves proportional to the lifts, when the lifts exceed the maximum given in Table 8 of the Code?

c If for a boiler equipped with a superheater, one 3-in. or smaller safety valve provides sufficient relieving capacity, is it necessary to place a safety valve on the superheater outlet in addition to that on the boiler, or will one safety valve on the superheater outlet be sufficient for both superheater and boiler?

Reply: a According to Par. 274 of the Code, if the marked relieving capacity of the valve exceeds that given in Table 8 of the Code, the maximum relieving capacity given in Table 8 governs in determining the minimum capacity of safety valve or valves to be placed on a boiler. It will be noted that the capacities given in the Table are for bevel-seated valves; for flat-seat valves, increase these values by 40 per cent.

b In determining the minimum capacity of safety valve or valves to be placed on a boiler, the Table should be used in accordance with Par. 274.

c According to Pars. 269 and 288 of the Boiler Code, one safety valve will be sufficient for both superheater and boiler, provided one 3-in. size or smaller safety valve will meet the requirements for the minimum capacity of safety valve or valves to be provided. For greater relieving capacities than this the Code calls for two or more safety valves.

In view of the resistance to the flow of steam through certain forms of superheaters, recommendation has been made to the Committee that the Code be revised after the Public Hearing on December 8-9, to specify the use of both superheated and saturated valves, without exception, in all superheater boilers.

Case No. 120

Inquiry: Is it to be understood, under Par. 18 of the Boiler Code, that in order to obtain the required thickness of the shell and dome plate after flanging, that sufficiently heavier plate must be used to give the required thickness at the edges after the flanging process?

Reply: According to Par. 18 of the Code, the minimum thickness of shell plates and dome plates after flanging, must be 5/16 in. for diameters of shell from 36 in. up to and including 54 in. in diameter.

Case No. 121

Inquiry: Is it permissible under the rules of the Boiler Code to make a joint by welding a coupling or nipple by the autogenous process to the underside of a steel flanged feed connection?

Reply: If the coupling or nipple connection is securely fastened to the inner side of the steel flange feed connection by the welding process, the requirements of Par. 315 will be complied with.

Case No. 122

Inquiry: Is it permissible under the rules of the Boiler Code to weld to the inner side of a wrought steel steam nozzle a coupling or nipple connection for a dry pipe within the boiler, as shown in Fig. 7?

Reply: There is nothing in the Code to prevent the use of autogenous welding for this joint where no strain is brought on the joint through the action of the steam pressure.

Case No. 123

Inquiry: If a boiler is so designed that a manhole applied as required by Par. 264 cannot be used for cleaning and inspecting the boiler, would the requirements of this paragraph be met?

Reply: In requiring manholes for boilers, as specified under Par. 264 of the Code, it was the intention that the boiler should be so designed that the manhole would be serviceable for entering the boilers for cleaning and inspection, and all such boilers as referred to in that paragraph should be designed so as to accomplish this purpose.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

ELSEWHERE in this number will be found the account of the Annual Meeting. Those who were obliged to miss this convention lost an event. In order for one to progress in his work it is essential to keep in touch with the outside world and these occasions where members of the profession from every section of the country get together are an inspiration to all.

The spirit of mutual helpfulness and coöperation was especially prominent. The keynote was sounded by our Dr. Hollis in his remarks on accepting the presidency for 1917.

Dr. Hollis's speech presages a remarkable year for this Society, and it is fair to assume that other societies are similarly imbued with the sense of their obligation and opportunity.

I took breakfast on two occasions in the week of December 11 with His Excellency, Nicholas P. Melnikoff, the engineer member of the Cabinet of the Czar of Russia.

His Excellency is just completing a tour of the United States to learn American methods and to obtain information generally for the development of Russia, including such a variety of subjects as: methods of gold dredging, lumbering, brazing, smelting, lighting of cities and district steam heating.

He informed me of opportunities of the most fascinating character, for instance, there is one million water horse-power capacity of development within seventy-five miles of Petrograd. Should American enterprise see fit to at once request concessions they would be favorably granted, whereas after the war no one nation could be thus favored.

In addition to this opportunity of the Society to serve the official representative of a nation in securing information of the widest scope for its future development, I was impressed with the fact that there is an engineer in the Cabinet of the Czar. There is no such cabinet officer in the United States. We have no officer representing industry, in distinction from one representing labor and commerce.

This is the greatest industrial nation on the globe and the relation of the engineer to industry is so intimate that perhaps it is not an extravagant hope that during the progress of our country there may be a department of engineering sometime created in the Cabinet of the President of the United States.

The office of Engineer of the Imperial Cabinet, in Russia, while it did not always have this name, is an extremely old one. As early as the fifteenth century John the Terrible attached to his household engineers whom he brought over from Greece to build the Cathedral of St. Basil. Peter the Great at the beginning of the eighteenth century similarly established engineers with official titles as his personal advisers, and moreover made them his personal friends in much the same way that the President of the United States does his physician.

The Engineer of the Russian Imperial Cabinet has a great range of duties. He is the adviser of the Emperor in not only the technical matters pertaining to his palaces but to the cities known as palace cities, that is, the towns in which the imperial palaces are located, and the entire administration, including the police, is in the hands of the palace authorities.

By virtue of the fact that the imperial domains embrace vast territories, larger even than France, not only in the vicinity of Petrograd but in Turkestan and Central Asia, the Engineer is responsible for the development in forestry, lumber, irrigation, agriculture, mining, etc., and it is for these vast sections having untold wealth and resources that His Excellency invites the interest of American enterprise and capital. He told me that he would personally assist any desiring to investigate these opportunities.

With the extraordinary development of the chemical industry in this country and the happy bringing together of the American Chemical Society in intimate coöperation with the Engineering Societies by the recent invitation of the President of the United States, it has occurred to the Secretary to suggest to the members that they observe the remarkable opportunity of the mechanical engineer in chemical industry. Such work as we might undertake is peculiarly ours as distinct from other branches and obviously distinct from chemical work as such, namely, the transfer of a perfected laboratory process to a manufacturing process including plant layout, the handling of materials to secure the most efficient routing, the designing of machinery to get the best results, etc.

With the experience of the nations now at war who are working in mass production for the first time in their history, these nations will henceforth be able to supply to still better advantage all of the materials which they have been accustomed to supply.

In Canada, so I am informed, apropos of competition in manufacture, any individual in the Dominion may go into any factory making munitions and observe the processes and go out and compete. No secrecy is permitted, as this would defeat the object of defense of the Dominion.

What has been made a necessity in Canada by virtue of the war, in its fundamentals will hold as sound business policy in times of peace.

In general there is throughout the country the greatest freedom of visitation in our industries. In ten years, with quite general extension of courtesies to foreign visitors with letters of introduction through our various manufacturing establishments, only one in the whole United States has refused admittance to such a visitor when duly accredited by this Society.

What we need is the actual getting together in conference of the various heads of competing industries for the purpose of comparing costs, developing the most up to date methods for execution in the several plants on much the same basis that a consultation of management of several companies under one administration would naturally effect, so that we obtain all the benefits of wholesome rivalry in manufacture, reducing costs without loss of independence. Then the different industrial organizations should again get together in a coöperative work of selling the American product.

The part of the engineer in all of this is that he should participate in all such conferences. The more an engineer takes a national and even a world view point the more service is he to his profession. CALVIN W. RICE, *Secretary.*

ANNUAL BUSINESS MEETING

THE annual business meeting of the Society was held in the Auditorium of the Engineering Societies Building on Wednesday, December 6th, 1916, at 10 a. m., in connection with the 37th Annual Meeting. Dr. D. S. Jacobus presided.

The Secretary presented the Annual Report of the Council for the year 1916, to which was appended the Reports of the Standing and Special Committees. This report will be published in full in Volume 38 of the Transactions of the Society, and is here given in abstract only. The Reports of Standing Committees were published in The Journal December 1916.

Abstract of Council Report

The Council has held eight monthly meetings and two special meetings, and the Executive Committee of the Council has met five times between meetings of the Council.

The Council registers with deep regret the deaths of E. D. Leavitt, and John E. Sweet, both Honorary Members and Past-Presidents of the Society. Special commemorative resolutions were passed by the Council.

Dr. Ambrose Swasey was this year elected an Honorary Member.

While this year in the affairs of the Society has been one of increased internal activities proportionate to the growth in membership and standing of the organization, and increased inter-society coöperation in matters affecting the Engineering Profession as such, the most significant development of the year has been the Society's participation in movements for the national service. In common with the other national engineering societies, our Society has been called upon by the Government to perform work for the public welfare, and, in turn, we as engineers have received recognition in legislation directly and permanently establishing our profession as an arm of the Government.

Before reviewing the conspicuous and important phases of the activities during 1916 of the membership, committees, sections and student branches, and enumerating the actions taken in joint society matters, this report first refers to the relations the Society has maintained in its service to the nation.

INDUSTRIAL CENSUS

Last year national recognition was accorded the Engineering Profession in the invitation extended to the engineering societies by the Secretary of the Navy of the United States to nominate the members of a Naval Consulting Board. This Society's representatives on the Board are Spencer Miller, Member of the Council, and W. L. R. Emmet.

To conduct the work of compiling this inventory, a Committee on Industrial Preparedness, a sub-committee of the Naval Consulting Board, was constituted with Howard E. Coffin, Mem.Am.Soc.M.E., as Chairman.

To assist this committee in its work, State Directors were appointed, one in each State for each of the national societies mentioned in President Wilson's letter, and they in turn have been generously assisted by "field aides" composed of other members of the Societies who in many cases personally visited the different plants in order to secure the required information.

The Council records its appreciation of the work of the Society's representatives in this splendid movement, which has now been carried through with complete success.

ENGINEER CORPS AND NATIONAL COUNCIL OF SAFETY

In response to an invitation from General Wood, Commander of the Department of the East, a joint committee was chosen by five national engineering societies to facilitate the carrying out of the organization of a Civilian Engineer Reserve Corps as a part of the military forces of the United States. This committee organized with an executive committee of: Wm. Barclay Parsons, *chairman;* H. S. Drinker, Wm. H. Wiley, B. J. Arnold, Ralph D. Mershon. The committee made its first report in December 1915, and in July 1916, Chief of Engineers, Lieut.-Col. E. Eveleth Winslow of the Army Engineer Corps, in writing to all the engineer officers throughout the country said, "Congress has now provided a means by which the civilian engineers can more than fully prepare themselves for that highest duty of citizens—the defense of our country." The bill became effective on July 1, 1916, thus directly and permanently establishing the Engineering Profession as an arm of the Government. Public recognition of the engineer is now as accomplished fact.

As a sequel to the work of the Naval Consulting Board, a bill has been passed by Congress providing for a National Council of Safety, consisting of five Cabinet officers and not more than seven civilians. The latter will be chosen, one each, to represent labor, industry, finance, transportation, physics, chemistry and commerce.

STANDING, ANNUAL AND SPECIAL COMMITTEES
STANDING COMMITTEES

Finance Committee. Last year, when a serious business depression in this country seemed imminent, precautionary measures were taken to conserve the interests of the members of the Society in every proper way. This conservation was carried out a little more than later proved necessary, although not more than seemed wise at the beginning of the year, with the result that we saved $24,000 to go into the surplus. This is made available to increase our working capital, a necessity by virtue of the Society's rapid growth.

All the gifts of money to the Society are intact and invested, and initiation fees have been used during the last few years to retire the certificates of indebtedness issued to pay off our share in the land of the Engineering Societies Building. Our sister societies were each able to pay off, by subscription, their individual share—$180,000—of the purchase price of this land, but with our subscriptions amounting to only about two-thirds of the gifts received by these societies, we have been able to finance the problem on another basis; yet we were the first to pay off the mortgage on the land, by means of certificates issued to the membership. Our certificates were retired on July 1, 1916.

Meetings Committee. The culmination of the work of this committee is represented in the Thirty-sixth Annual Meeting held in New York in December, 1915, and the spring meeting held in New Orleans in April, 1916. Too much praise cannot be accorded to the members of the committee for the great amount of time and work they have given to reviewing manuscripts of the papers presented and arranging the programs of these meetings.

The committee has received valuable assistance in its work from its sub-committees on Air Machinery, Cement Manufacture, Fire Protection, Gas Power, Hoisting and Conveying,

Industrial Buildings, Machine Shop Practice, Protection of Industrial Workers, Railroads and Textiles.

THE ANNUAL MEETING

The Thirty-sixth Annual Meeting was held in New York City, December 7-10, 1915, inclusive. Enthusiasm was manifested in various ways: there was a series of conferences of representatives of the Sections, at which "Extend the Local Sections" was distinctly emphasized; at the Council meetings the sentiment expressed was equally enthusiastic; the spirit of democratization was dominant, and the membership was encouraged to participate in the affairs of the Society to a greater extent.

Unusually valuable contributions to the professional program were made by several of the sub-committees of the Committee on Meetings, and by local committees. At this particular meeting, seven papers were contributed by Sections and thirteen, including reports, by sub-committees.

The papers presented were representative of the mechanical engineering work of the country as a whole, having been selected through intimate acquaintance with the subjects to be discussed and on the mature judgment of the expert engineers who constitute the different sub-committees.

THE SPRING MEETING

The Spring Meeting was held in New Orleans, April 1 to 14, 1916. The local membership of the Society, the association of local members of the American Society of Civil Engineers and the Louisiana Engineering Society, acted jointly as hosts.

Special cars were run from New York and Chicago, stopping for a day at Birmingham, where the visitors were lavishly entertained by the newly-formed section of the Society in that city.

The papers presented were all of a high order, there was a large amount of discussion, and the keynote session of the meeting, on the subject of Industrial Preparedness, aroused a great deal of interest and called forth contributions from engineers from every section of the country.

Publication Committee. The publications of the year have been The Journal, which has been issued monthly, the annual volume of Transactions, the Year Book, the sixth annual volume of Condensed Catalogues, and the Power Test Code (reprinted from vol. 36 of Transactions).

Plans are under way for the further development of The Journal to include such features as will, it is hoped, make this publication a professional necessity to every mechanical engineer.

Volume 36 of Transactions, issued during the summer, was the largest ever published by the Society and contained nearly 1600 pages.

Membership Committee. There were 1879 candidates for membership, 1143 of whom were recommended for acceptance.

Library Committee. The principal matter of interest to the Board this year has been the consideration of the plans for receiving the library of the American Society of Civil Engineers. With this library added to that of the original Founder Societies, the largest and most complete engineering library in the world will be at the service of every engineer in whatever branch of the profession.

House Committee. The House Committee has considered the alterations required in the rooms of the Society to take care of the supporting columns passing up through the rooms to carry the load of the three stories being added to the building for additional library accommodations and headquarters for the American Society of Civil Engineers. They have also advantageously placed the insurance of the property of the Society after exhaustive investigation; have most painstakingly looked after all other interests of the Society's rooms and property, and arranged the details of the President's reception at the annual meetings.

Research Committee. The work of the Research Committee has consisted in lining up definite duties and plans for sub-committee work. The committee has now several sub-committees, including Bearing Metals, Clinkering of Coal, Flow Meters, Fuel Oils, Lubrication, Cutting Action of Machine Tools, Materials of Electrical Engineering, Safety Valves, and Worm Gearing.

Public Relations Committee. The Council has under careful consideration the entire field of the Society's activities in their relation to the public, so that no active work has been taken by the Committee this year.

Constitution and By-Laws. The Committee on Constitution and By-Laws acts in an advisory relation to the Council in consideration of suggested and necessary amendments to the Constitution, By-Laws and Rules.

Standardization Committee. This committee became a standing committee of the Society by amendment to the Constitution in the spring of 1915. The action was the result of a report prepared by Mr. Henry Hess, and approved by the Council in December, 1913. The purport of the report is that the Committee shall standardize the method of making and arriving at standards rather than create standards themselves.

NOMINATING COMMITTEE

The Nominating Committee this year was appointed by the President in a way to secure the greatest possible democracy in selecting nominees for executive offices. The Sections of the Society were divided into five geographical groups and one member of the committee was chosen from each group.

The President appointed as Tellers of Elections for 1916: Robert H. Kirk, *Chairman;* Erwin S. Cooley, Harry A. Hey.

Here follows a detailed account of the work of the various special committees for the year, and of the Society's numerous activities in coöperating with other organizations, both by joint committee work and by Society representation.

Filter Report

The Report of the Committee on Recommended Practice for Standardization of Filters was presented by George W. Fuller, Chairman of the Committee. The report outlined in a comprehensive manner the present practice in the field of mechanical filtration and emphasized the need and value of a pronouncement upon the subject of the rating of mechanical filters. It concluded with recommendations on form of expressing capacity, care as to maximum demand, depth of filter bed, normal filtering material, special filtering material, rate of filtration, etc. The report will be published in full later.

Awards of Prizes

The next business was the awarding of the Junior and Student prizes for papers presented by Junior and Student members respectively. On the recommendation of the Prize

Committees, the Junior Prize for 1916 was awarded to L. B. McMillan, for his paper entitled The Heat Insulating Properties of Commercial Steam-Pipe Coverings. Honorable mention was awarded to Victor J. Azbe for his paper on Power Plant Efficiency, and Herbert B. Reynolds for his paper on the Flow of Air and Steam through Orifices.

Student Prizes for 1916 were awarded to: Boynton M. Green, Leland Stanford University, for his paper on Bearing Lubrication; Howard E. Stevens, Rensselaer Polytechnic Institute, for his paper on An Investigation of the Dynamic Pressure on Submerged Flat Plates, and M. Adam, Louisiana State University, for his paper on The Adaptability of the Internal Combustion Engine to Sugar Factories and Estates.

Honorable Mention was awarded to: M. Boyd Gordon, University of Cincinnati, for his paper on A New Type of Unaflow Engine; S. C. Williams, Stevens Institute of Technology, for his paper on Photostatic Reproduction, and Charles P. Miller, Pennsylvania State College, for his paper on Investigation of Properties of Low and Medium Carbon Steels.

IRA NELSON HOLLIS

Ira Nelson Hollis, President of the Society for 1917, was born in Mooresville, Indiana, March 7, 1856. In 1872 he was graduated from the Louisville, Kentucky, High School, and went as apprentice in a machine shop for building and repairing all kinds of engines, particularly those for the Ohio River steamboats. His health was not equal to the work, however, and he secured an office position with a railroad company, and later with a cotton commission house in Memphis, Tennessee.

In 1874 he entered the Naval Academy as a cadet-engineer, having taken a competitive examination along with about one hundred and twenty-five others, twenty-five of whom were appointed.

Hollis stood first on the list of those who entered, and retained this position throughout the course. When it is mentioned that in the class were included such brilliant men as the late Professor Spangler, Dr. Cooley, and Admiral Griffin, the present Engineer-in-Chief of the Navy, it will be seen that this record means a great deal. There had been a separate class for engineers, of a tentative character, for some years before, but the class which entered in 1874 was the first one to follow a four years' course and pursue studies of a general character as well as those relating particularly to engineering.

It is worth noting that when this class of young engineers went through Annapolis it was before the days of thoroughly organized technical schools and first-class textbooks, with the result that the instructors in professional subjects had little to guide them in the way of successful practice in technical education elsewhere, and had to shape the course largely in accordance with their own ideas of what was necessary, supplementing such textbooks as were available with lectures based on their own experience. Several members of the Society were among these early instructors, including Captain Charles H. Manning and the late Chief Engineers, John C. Kafer and David P. Jones, all of whom have always held an extremely high place in the affection of the young men who were fortunate enough to be students under them.

At that time the unfortunate contention between the Line and Staff of the navy was still quite strong, and its influence was felt even among the cadets. The engineers were made to feel in many ways that their status, actual and prospective, was distinctly inferior to that of their confreres of the Line. The four years' association as fellow students, and in the same classes, with the exception of strictly professional work, did much toward breaking down the ill-feeling. This had so far died out that the Personnel Board in 1897, composed of Line officers and engineers, was able to agree on a union of the Engineer Corps with the Line, and their recommendations to this effect became a law in 1899.

As a rule, it is best not to stir up old troubles, but we could not fully appreciate the stuff that was in these young engineers if we did not realize that these beginners of a new régime were in a difficult position, and that they acquitted themselves most creditably. In justice to the instructors, who were almost entirely Line officers, it ought to be said that very few of them showed any partiality; that their feeling toward the engineers was in the mass, and that individuals usually received the consideration and credit which was due them.

After graduation from Annapolis in 1878, Dr. Hollis spent three years in the Mediterranean and North Sea and on the coast of Africa in the Cruiser Quinnebaug. During his time in the navy he served also on the United States Steamships Alert, Hartford, Richmond, and the Flagship Charleston.

At the conclusion of the cruise on the Quinnebaug, and after promotion to the grade of Assistant Engineer, he was detailed as Professor of Marine Engineering at Union College, Schenectady, New York, in accordance with the provisions of an Act of Congress permitting such details in order to promote technical education. This experience at Union College was excellent preparation for what afterward proved to be his life work.

In 1884 he served with the Advisory Board that built the four ships of the White Squadron, and spent some months in the inspection of machinery at Chester, New York, and Nashua, New Hampshire. On the west coast he spent three years at the Union Iron Works, where some of the early ships for the new navy were then building, among them the Charleston, San Francisco, Monterey, and Olympia. This was a splendid opportunity for a brilliant young engineer like Hollis, as giving a thorough familiarity with the very latest types of machinery, and also for contact with some exceedingly able engineers, among whom were Mr. George W. Dickie, of our Society, who was then Chief Engineer of the Union Iron Works. Everybody was full of enthusiasm, and the daily lunch table offered a forum for the thorough discussion of the many new and interesting problems which were being solved. Dr. Hollis has often spoken of the pleasure and profit of these discussions.

His responsibility was chiefly for the machinery of the Charleston, and when that vessel was completed he went to sea in her. At the Union Iron Works he had supervised the design and construction of the machinery, and now had the opportunity of seeing how it worked in practice, and to note opportunities for improvement. While on the Charleston he was detailed at Iquiqui to the Filibuster Itata after the capture for the purpose of getting her ready for a return to the United States. He went North in her in the spring of 1891, and then went to China in the Charleston. In January, 1892, he went to Newport on the Staff of the Apprentice School on Coasters Island.

Shortly before his three years of service on the Charleston would have expired, Admiral Melville, who was the Engineer-in-Chief of the Navy, was asked to designate an officer to lecture on naval engineering at the Naval War College. As it was the first time the invitation had been extended, the Admiral felt it necessary to choose a man specially fitted for this work. After a survey of the available officers, he selected Hollis, who was ordered to the Navy Department shortly before the time for the lectures so that he might prepare them. He was peculiarly fitted for this duty by his ability as an engineer, his recent experience in the building and operation of the most modern machinery, his experience as a teacher at Union College, and his felicity as a writer and speaker. The opportunity was a fine one, because no lectures of this sort had been given at the War College previously, so that he had the whole field to draw upon. The result was exactly what his friends had anticipated, and proved the wisdom of Admiral Melville's selection. The lectures were a great success in every way, and not only aroused the admiration of the officers to whom they were delivered, but were published and served for some time as a sort of textbook on modern marine machinery.

When Hollis was ordered to the Bureau of Steam Engineering, it was not alone to prepare the lectures, but Admiral Melville had selected him to be the successor of Chief Engineer (now Admiral) Frank H. Bailey as chief designer. He was Mr. Bailey's assistant, and it is safe to say that two abler designers of marine machinery could not have been found. During this service, which lasted only about a year, Hollis suggested a number of excellent features which were incorporated in the machinery designs of that period. His last work in the navy was the preparation of specifications for the machinery of the gun-boat Nashville and the design of machinery for some of the torpedo boats.

In 1893 Harvard University was looking for a professor of engineering and wished to consider, among others, a naval engineer. The high standing of Dr. Hollis at the Naval Academy, his splendid practical record, and his famous lectures at the War College, all marked him as the man to be considered. At the suggestion of the Secretary of the Navy, on the recommendation of Rear-Admiral Sampson and Rear-Admiral Melville, he was invited to accept the Chair of Engineering, and resigned from the Navy in September, 1893, to enter on his duties at Harvard University.

At that time engineering in Harvard was at a low ebb, but as a result of the endowment for engineering by the McKay fund, it was desired completely to reorganize the engineering department and form new classes in civil, electrical, and mechanical engineering. This not only called for executive ability of the highest order, but from the fact that Mr. McKay made his money in mechanical engineering, or things connected with mechanical engineering, it was desired to select a mechanical engineer to carry out the plans for development.

At the end of two years at Harvard, Dr. Hollis was made a member of the Athletic Committee and soon after became chairman. The outdoor athletics were transferred from the old home field to what is now known as Soldiers' Field, which at that time was largely a swamp. It was recovered by dredging gravel out of the Charles River and pumping it onto the swamp. While he was chairman of the Athletic Committee, Soldiers' Field was thus made into a playground, a metropolitan driveway was put along the river, a fence was built around the field and the necessary buildings connected with athletics erected, including the Harvard stadium and boathouse.

The necessity for replacing the old wooden seats on Soldiers' Field was emphasized by a fire which burned down one of the stands during a baseball game. Fortunately the excellent management, through the students, prevented injuries, but the University then took up seriously the replacement of the wooden stands by something less inflammable. Concrete, the use of which was then novel for large structures, was adopted as the most rapid form of construction, and the stadium was built in four months, to seat about 30,000 people. The thought in connection with the size of the stadium was to limit the number of spectators to that which would include only the students and graduates and their friends, as there was no thought of making a public spectacle out of athletics. The stadium was paid for in part by money saved from the gate receipts and in part by the graduates of the Class of 1879.

Under the direction of the engineering department Pierce Hall was built for the different branches of engineering. The civil, electrical and mechanical engineering departments were transferred to the building about 14 years ago, and the instruction and courses were once more reorganized.

Up to that time Dr. Hollis was Chairman of the Committee that raised the money for the Harvard Union, and it was under his supervision that its building was constructed. In this, as well as in the designing of the stadium and in other ways, he was for years intimately associated with Charles McKim of McKim, Mead & White. In every way he entered into the University life at Harvard, apart from the engineering side, and it has been reported on good authority that President Eliot said a few years after Dr. Hollis became a member of the Harvard faculty that he was the "greatest find" in 25 years.

In the discussions relative to an understanding between Harvard University and the Massachusetts Institute of Technology, Dr. Hollis advocated effective coöperation between the two, and has always believed that it would have been wrong to erect engineering laboratories in both places.

In the summer of 1913 Dr. Hollis resigned to take the presidency of the Worcester Polytechnic Institute, where there are splendid opportunities for continuing his forceful work for the advancement of engineering education.

Dr. Hollis has always retained his keen interest in the Navy, and was a very active factor in causing the Personnel Board to be organized. He was a friend of Colonel Roosevelt, who was then Assistant Secretary of the Navy, and had discussed the project of the amalgamation of the Line and the Engineering Corps with him very effectively.

The late Francis H. Wilson, then a Congressman from Brooklyn, had also discussed this same subject with Mr. Roosevelt. The result was that Mr. Roosevelt was convinced of the importance of a careful investigation of the subject, which led him to recommend the organization of the Personnel Board; and when the project for amalgamation came up it found him already posted on the subject.

Recently, Dr. Hollis had served in connection with the work in Industrial Preparedness, and just before that with the Chamber of Commerce in Washington. He was also a member of the Commission on National Defence, and its recommendations were submitted to the various chambers of commerce in the United States looking to a better Navy, a better Army and a legalized Council on National Defence. The chambers of commerce approved almost without division, and the report of the Committee and its findings have since practically been adopted by Congress.

W. M. McF.

COUNCIL NOTES

DECEMBER 5, 1916

At the meeting of the Council on December 5, 1916, the following members were present, President D. S. Jacobus presiding: John H. Barr, R. M. Dixon, *Chairman Finance Committee*, Arthur M. Greene, Jr., James Hartness, F. R. Hutton, W. B. Jackson, Spencer Miller, H. de B. Parsons, James E. Sague, Jesse M. Smith, S. T. Wellman, E. H. Whitlock; by invitation, Dr. Ira N. Hollis, C. H. Benjamin, officers-elect, W. L. Saunders, Past-President of the American Institute of Mining Engineers; and Calvin W. Rice, *Secretary*.

Sections. W. G. Starkweather was appointed on the Boston Local Committee.

W. H. Insley, Chairman, L. M. Wainwright, Vice-Chairman, W. A. Hanley, Secretary, B. G. Mering, Treasurer, L. W. Wallace and F. C. Wagner were appointed as the executive committee of the newly-constituted Indianapolis Section.

A. L. Black and A. M. Lockett were appointed on the New Orleans Committee in place of Professors Kerr and Rugan.

C. A. Paulsmeier and E. A. Rogers were appointed on the San Francisco Local Committee.

M. E. Cooley, Chairman, E. C. Fisher, T. H. Hinchman, G. W. Bissell and J. W. Parker, Secretary, were appointed an Executive Committee of the Detroit Section.

A Section at Baltimore, Md., to include all the members of the Society within thirty miles of the City Hall, was approved.

A Section at Erie, Pa., to include all members of the Society within a radius of thirty miles of the Erie City Hall, was also approved. This Section was granted the privilege of coöperating with the Engineers Society of Northwestern Pennsylvania. J. E. Wadsworth, Chairman, C. S. Hopper, Vice-Chairman, M. E. Smith, Secretary, R. Conrader, Treasurer, and N. A. Newton were appointed an Executive Committee of the new Section.

The report of the Committee on Sections, covering the work of this committee for 1916, was received and referred to the Publication Committee for publication in The Journal; it appears elsewhere in this issue.

The Council expressed its regret that the term of office of Mr. E. H. Whitlock, both as a member of the Council and as Chairman of the Committee on Sections, would expire with this meeting, Mr. Whitlock having carried the responsibilities of the organization of sections to such a splendid success. A vote of sincere thanks was accorded Mr. Whitlock and the members of his committee.

DECEMBER 8, 1916

At the meeting of the Council on December 8, the new officers were formerly introduced. The following were present: C. H. Benjamin, Robert H. Fernald, Arthur M. Greene, Jr., Wm. B. Gregory, Ira N. Hollis, *President*, Charles T. Plunkett, new members; John H. Barr, R. M. Dixon, *Chairman Finance Committee*, James Hartness, D. S. Jacobus, W. B. Jackson, Spencer Miller, John A. Stevens, and Wm. H. Wiley, *Treasurer*, F. R. Hutton, Hon. Secretary, and Past-Presidents Jesse M. Smith and Worcester R. Warner; Henry Hess, I. E. Moultrop, Chairman of the Publication Committee, and Calvin W. Rice, *Secretary*.

Condensed Catalogues. The report of the referendum on Condensed Catalogues was received. This report indicated a vote to date of the meeting of 2373 for the continuance of this publication and of 334 against it. Thereupon the Council voted to continue the publication.

United Engineering Society. E. G. Spilsbury was elected a Trustee of the United Engineering Society.

Engineering Foundation. W. F. M. Goss was nominated to the Board of Engineering Foundation to represent this Society.

John Fritz Medal Board. John R. Freeman was elected a Trustee of the John Fritz Medal Board to represent this Society.

Executive Committee. President Ira N. Hollis, D. S. Jacobus, John H. Barr, Arthur M. Greene, Jr., C. T. Main and Spencer Miller were appointed as the Executive Committee of the Council for 1916-17.

Major Wm. H. Wiley, F. H. Clark, and C. C. Thomas were appointed Honorary Vice-Presidents to represent the Society at the Congress of Constructive Patriotism of the National Security League to be held in Washington, Jan. 25, 26 and 27.

Regular meetings of the Council are to be held on the third Friday of each month.

The following minute was passed by the Council and directed to be entered as a part of the record of the meeting of December 8:

Voted: That the Council here assembled record upon the minutes of the Society its sincere appreciation of the untiring, unselfish and earnest service rendered the Society during the past year by its President, Dr. D. S. Jacobus.

Calvin W. Rice,
Secretary.

PUBLIC HEARINGS BY THE BOILER CODE COMMITTEE

As announced in The Journal several months in advance, a Public Hearing on the Boiler Code was held on Friday and Saturday, December 8 and 9, 1916, in the Engineering Societies Building, New York, for the purpose of receiving suggestions relative to changes in the A.S.M.E. Boiler Code. This Hearing was in pursuance of the following recommendation of the Boiler Code Committee to the Council:

"Your Committee recommends that you appoint a permanent Committee to make revisions as may be found desirable in these Rules, and to modify them as the state of the art advances, and that such Committee should hold meetings at least once in two years at which all interested parties may be heard."

The Hearings began at 2 p.m. on Friday under the direction of Mr. John A. Stevens, Chairman of the Committee, assisted by fourteen members of the Committee. Discussion of the Boiler Code was entertained, beginning with the opening page of the Code and continuing through paragraph by paragraph to the Appendix. Everyone interested was given full opportunity to speak on each paragraph and all discussers were invited to submit their recommendations in writing after the Hearings. It was the purpose of the Committee to secure from those in attendance as much information as possible concerning the details of every rule in the Code, with a view to determining the desirability of making changes in them.

No replies or comments were given by the Committee mem-

bers on the Code requirements during the Hearings. The Committee has arranged to meet in January to consider the recommendations offered at the Hearings in greater detail.

The attendance at the Hearings was representative of all branches of the industry, including a large number of organizations interested in the steam boiler field, from the railroads, from the boiler manufacturers, from the makers of materials used in boiler construction, and from users of boilers. Some 1500 invitations had been sent out to all those on record as interested in steam-boiler construction, and a representative delegation was present. There was an unusual delegation from the various states and municipalities interested in the enforcement of steam-boiler regulations, which was largely due to the announcement made at the American Uniform Boiler Code Congress in Washington on December 4 and 5 (see reference to the Congress elsewhere in this issue), that every state and municipality that adopts the A.S.M.E. Boiler Code shall be entitled to have a representative present at all meetings of the Boiler Code Committee. Representatives were present from five states and from the Province of Ontario, Canada.

The very limited amount of discussion offered on the Code rules was a remarkable tribute to the comprehensiveness of the Committee's original work in 1914. Very little was offered in connection with the material specifications, the principal discussion being confined to the details of boiler construction and the fittings and appliances used therewith. The detail which entailed the longest discussion was the question of the extension of Par. 186 to permit of the welding of boiler joints by other than the forging process; the advocates of the several forms of autogenous welding presented an interesting array of data in this connection. But slight changes were suggested by the heating boiler interests and also relative to the rules for existing installations. Many helpful suggestions were offered by the representatives of the various states. All of these are at present under consideration by the Committee and will be given detailed study at the meeting in January.

Symposium and Annual Reunion

On Thursday of the Annual Meeting there was held a Symposium on Aviation. Charles M. Manly, Mem.Am.Soc. M.E., consulting engineer of the Curtiss Aeroplane & Motor Co., of Buffalo, N. Y., introduced the topic with an address on the early history of aviation, covering the development from the earliest efforts recorded to present-day practice. A particularly interesting part of his talk was that which dealt with the work of Professor Langley, of the Smithsonian Institution, with which the speaker had been associated, having been the designer of the motor and operator of the machine in its trial flights.

Mr. Manly followed his paper with the presentation of a number of lantern slides illustrative of the history of aviation, and finally a motion picture of the original Langley machine as it appeared in some recent flights when it was equipped with pontoons so that it could start from the water, and had installed a new motor and propeller, and was flown over Lake Keuka.

The second speaker was Glenn L. Martin, formerly of The Martin Co. and now vice-president of the consolidation of this company with the Wright Co., known as the Wright-Martin Co. Mr. Martin has been concerned with the building of aeroplanes for the Government, especially in California, and has a record of no serious accident with any machine of his type. His talk took the form of a description of the sensations which are experienced in an aeroplane, particularly the first time one goes up, and his account of the ride which he gave Dr. Brashear over the San Jacquin was greatly appreciated by the many friends of "Uncle John" who were in attendance.

The man who is believed to be the only past-president of The American Society of Mechanical Engineers who ever piloted an aeroplane was the next speaker—James Hartness, who gave a very interesting resumé of his experience at the aviation school in Garden City last summer. At the end of his talk Mr. Hartness was surprised perhaps as much as his audience by having a view of himself in an aeroplane flashed on the screen.

The last speaker was R. B. Lea, secretary of the Sperry Gyroscope Co., Brooklyn, N. Y., who showed first by a model of a gyroscope and later by lantern views and motion pictures how the principle of the gyroscope is utilized in keeping an aeroplane on an even keel, or stabilized. Motion pictures taken from the aeroplane when it was flown around the Statue of Liberty and below and above the East River bridges showed these familiar objects of the metropolis from new and unusual viewpoints.

Following the symposium those interested in dancing were invited to go to the fifth floor of the Engineering Societies Building, and others who preferred visiting with one another were accommodated on the eleventh floor of the Society's headquarters, where Dr. and Mrs. Hollis, with Mrs. Torrey and a number of the members of the Ladies Committee acted as host and hostesses, and supper was served.

Dr. and Mrs. Jacobus were host and hostess on the fifth floor. At about 11:30 p.m. a recess was taken and supper served on this floor and also on the sixth floor, after which dancing was resumed until about two o'clock.

Smoker at Annual Meeting

Following the precedent established a year ago, a smoker was held in connection with the Annual Meeting on Wednesday evening, December 6, 1916, this time on the fifth floor instead of in the Society's rooms on the eleventh floor. As members and guests entered they were handed a blue box with the Society's name and emblem in gold on the cover, containing cigars, cigarettes and matches, which not only saved the bother and confusion of passing each smoker his needs during the evening, but also provided those attending with a souvenir of the occasion.

Frank B. Gilbreth, Mem.Am.Soc.M.E., opened the entertainment program with a short talk on his experience on a trip to Europe during the war, and in his inimitable way of making even sober things funny, he described the search of the ship in which he crossed and numerous incidents connected with its convoyance to port. His talk was illustrated with lantern views which were especially interesting when it was known under what circumstances they were taken, as from portholes or behind barriers, for under the conditions the camera could not be used in the open.

Edwin J. Prindle, chairman of the Entertainment Committee of the New York Section, presided at the smoker, and following Mr. Gilbreth's talk told some good stories himself and then introduced the performers in the vaudeville program provided, including a ventriloquist, tenor soloist, two monologists, musical comedy specialist, magician and pianist.

Refreshments were served during and after the program. About seven hundred were in attendance.

College Reunions

As in previous years, Friday night of the Annual Meeting was "College Reunion Night," and reunions were held by the Engineering Alumni of the following institutions in New York and vicinity:

Brown University Alumni gave a banquet at Brown University Club.

Cornell University Alumni gave an informal dinner at the Cornell Club.

Lehigh University Alumni held an informal dinner and smoker at the Machinery Club.

Massachusetts Institute of Technology Alumni gave an informal dinner at their Club.

Pennsylvania State College Alumni held an informal "get-together" reunion dinner and smoker at Hotel Navarre.

Polytechnic Institute of Brooklyn Alumni held its reunion at the Engineering Societies Building, at which Frank Gilbreth delivered a lecture on Motion Study.

The Purdue Club of New York gave an informal dinner at the Phi Gamma Delta Club, in honor of Dean C. H. Benjamin of Purdue University, newly elected a Vice-President of the Am.Soc.M.E.

Stevens Institute of Technology Alumni gave their annual theater party, followed by a dinner at Hotel Astor.

University of Illinois Alumni gave an informal dinner at Stewart's Restaurant.

University of Michigan Alumni gave "a regular Michigan smoker" at Keen's Chop House.

Worcester Polytechnic Institute Alumni held an informal dinner in the ballroom of the Hotel McAlpin.

Annual Meeting Excursions

Eight well-attended excursions to points of engineering interest in New York and vicinity were held in connection with the Annual Meeting. The places visited were the Telephone Building, New York City; the Equitable Building, New York City; the Otis Elevator Company, Yonkers, N. Y.; the Essex Station of the Public Service Company of New Jersey; the Stevens Milk Company, Brooklyn; the Loose-Wiles Biscuit Company, Long Island City; the New York Steam Company; New York City, and the New York Navy Yard, Brooklyn.

Plans for the excursions were in the hands of a committee of eleven, of which John N. Norris was chairman, and members of the committee acted as personal guides to introduce participants, review the features of the trip and furnish the necessary information. The accounts of the excursions are perhaps best given in the words of the guides themselves:

EQUITABLE BUILDING

On the second day of the Annual Meeting a party of members and guests of the Society visited the Equitable Building, said to be the largest office building in the world, and were fortunate in having the features of its mechanical equipment explained by the Chief Engineer. This building occupies an entire block, and extends from 55 ft. below the street to 548 ft. above it. It has 40 numbered floors and 3 basements, each of an area of about 50,000 sq. ft. To serve the 15,000 tenants and those who transact business in the building there are 6 bays of 8 latest-type traction elevators. The elevator journey from the street to the fortieth floor takes a little over one minute.

In the lowest basement the building has its own power plant, supplying heat, water, fire protection and refrigeration. The spacious engine room contains three 600-kw., two 300-kw., and one 200-kw. 240-volt direct-current engine-type generators, each driven by a horizontal, side-crank simple steam engine working at about 150 lbs., and about atmospheric exhaust.

The boiler room contains two 550-hp. and five 450-hp. water-tube boilers, arranged for use with mechanical stokers. The fuel usually burned is a mixture of soft coal and No. 3 buckwheat which is stored in three bunkers, of 800, 200 and 1000 tons capacity, respectively. On account of the great height of the building natural draft is more than sufficient for combustion purposes.

The exhaust steam from the engines is used for heating the building and for making ice. Heating is on the vacuum system, and generally an ample supply of heat can be provided without raising the pressure above atmospheric. The exhaust steam passes to an oil separator to which is attached a 30-in. riser that goes straight up to the roof. Steam for heating is taken off at the thirty-sixth floor. There is a separate system of mains for the street floor, and some of the radiators on this floor only have thermostatic control. The absorption ice machines have a capacity of 12 tons of cake ice and 100 tons total refrigeration a day. Refrigerated brine is also furnished to the restaurants in the building. As some of the brine must be pumped to the top floor, the gauge shows pressures exceeding 350 lbs.

In the pump and compressor rooms there are ejector and sump pits, vacuum pumps, compressors for the ejectors, house pumps, fire pumps, a water-filtering plant, etc. The house pumps develop pressures of 280 lbs. and more. The fire pumps have on test developed a pressure of 50 lbs. at each of four 1-in. nozzles on the roof. A duplicate system of steam mains and water connections is provided for the pumps so that no emergency is likely to disable the whole plant. There is no central exhauster for vacuum cleaning, but each floor is equipped with portable motor-driven cleaners.

Selby Haar.

STEVENS MILK COMPANY

The excursion to the gas-power plant of the R. F. Stevens Milk Company, Brooklyn, New York, was of especial interest. This plant is a new installation and consists of producer-gas engines for operating refrigerating machines and for generating electric current for both power and lighting purposes. The plant consists of three 300-hp. suction-type anthracite producers using pea coal; three 250-hp. four-cylinder four-cycle vertical-type gas engines, and one three-cylinder four-cycle gas engine of 150-hp. Two of the four-cycle engines are belted to refrigerating machines and are used for cold storage and ice making. The third four-cylinder engine is direct-connected to a 150 kw. direct-current generator, and the 150-hp. three-cylinder engine is direct-connected to a 100 kw. generator, furnishing current at 250 volts for general power purposes round the plant.

J. H. Norris.

ESSEX STATION, P. S. CO. OF N. J.

The Essex Station is situated on the Passaic River, about two miles below and east of Newark, N. J. The location gives exceptional facilities for condensing water, coal supply and storage, ash disposal, etc., and furnishes a proper electrical distribution center.

The present buildings will house approximately one-half of what is considered the ultimate capacity, although since the plant is built on the unit principle it is capable of indefinite expansion.

The boilers are placed at right angles to the generator room, and a separate building houses the electric switches, feeders, bakery, etc.

The main generating units consist of two 25,000 kva. turbines with direct-connected exciters. These turbines are supported from the basement floor line on steel framing, leaving maximum room for access to condensing apparatus.

For each turbine there are installed four 1373 hp. water-tube boilers with superheaters and underfeed stokers. The furnace gases pass through economizers and induced draft fans to self-supporting steel brick-lined stacks 250 feet high above the grates.

Much care was taken in the equipping of the station to obtain apparatus that would facilitate economical operation and also

promote the safety and convenience of the operating force.

Many thanks are due to the company for their trouble in seeing that every one who participated in the excursion had an opportunity for a thorough examination of the station.

A. T. Nickerson.

NEW YORK STEAM COMPANY STATION "A"

The New York Steam Company has several central stations delivering high-pressure steam through pipes in the streets for both power and heating purposes in New York City. Station "B" serving the downtown district for the past 35 years has an installation of 58 boilers with a normal capacity of 16,000 hp., while the new station "A" has but 12 boilers with a capacity of 24,000 hp. This is in keeping with the progress in the matter of installation of steam mains, etc., of today as against the methods first used.

The station building is 107 ft. x 116 ft., and while in reality there are only four floors, the building is equivalent in height to ten stories. The tops of the stacks are 300 ft. from the ground. The ground floor is given up to the station auxiliaries—boiler-feed pumps, city-water service pumps, blowers, etc. All station auxiliaries will require about 1500 Boiler hp. when the station is operating at maximum capacity.

The first floor has six boilers in units of 1000 hp. normal rating each, but to be operated at 200 per cent capacity. They are automatically stoked and equipped with traveling grates for burning the smallest screenings of anthracite coal.

For steam purposes Croton water is used but is softened before entering the boilers. The service pump suctions are connected direct to the City mains with water meters between pumps and mains.

The second floor is laid out the same as the first making the total of 12 boilers. Above the second floor is the coal bunker of 3000 tons capacity. At the south end of the building are the storage bunkers—capacity 5000 tons coal storage and also the ash bunkers above referred to.

Sufficient scientific apparatus is installed to give complete detail for checking the efficiency of the individual boiler or the entire plant. The operation of the plant under maximum conditions will require thirty men, which is a saving of 75 per cent over the methods in the old station.

The steam is delivered from the plant to the street mains, whence it is distributed to the consumers both for power and heating purposes. Among the larger power consumers are several of the biggest office buildings, and it is not generally known that such large buildings as these have their own plants for the generation of electrical current for both power and light and secure their steam from the street service to drive their engines. This has been proved both practical and economical and high-speed engines have run for years without any bad effects.

Claude Hartford.

BROOKLYN NAVY YARD

The annual excursion to the Brooklyn Navy Yard was held on December 8 and was well attended as on previous occasions. The party was received by the officers assigned by Admiral Usher and Captain Burd, and through their courtesy the members were allowed to inspect practically every part of the principal navy yard in the country.

A sight of great interest was the part of the yard where the superdreadnought *New Mexico* is now being built. This enormous ship will have a displacement of 32,000 tons and will be one of the largest in the navy.

The battleship *Arkansas* being in the dry dock for overhauling was available for inspection and some of the members went over the ship from bow to stern.

Although the large ships attracted most of the attention, nevertheless the torpedo boats, destroyers and submarines were not neglected.

The trip through the large machine shops proved that the Navy Yard is not an assemblying plant, as here were visible huge machines for turning out engines, turbines, turrets and various other apparatus necessary for complete ships. The large Diesel engines which were placed on two of the Navy colliers during the last year were built complete in this yard and one of these ships was in the harbor on the day of the excursion.

The plate shop, power plant and boat-building shop were also visited. In the last mentioned shop an exhibition was given of the method which is now used for dropping the life boats into the water quickly. Tenders and life boats were also shown in the various stages of construction.

John H. Lawrence

LOOSE-WILES BISCUIT COMPANY

The varied uses to which machinery can be put in an establishment, such as is maintained by the Loose-Wiles Biscuit Company, will ever be of absorbing interest to mechanical engineers. The applications of machinery at the plant held the sustained interest of the party during the entire trip.

The company generously provided guides who, starting from the roof, conducted the party down floor by floor, to the basement, showing the methods of sifting and distributing the flour to the dough mixers, the batch wagons in which the various doughs or batters are allowed to raise; then the biscuit-cutting machines and the ovens for baking, and finally the assembling and packing departments.

Of especial interest was the machinery for baking and cutting the sweet sugar-lined wafers, and the methods of making the many fancy biscuits. At the conclusion, each of the party was presented with a box of fancy crackers.

The power plant was also visited. This consists of water-tube boilers, steam turbine and a-c. generators. The engine room was a particularly interesting place.

J. H. Norris.

THE TELEPHONE BUILDING

An excursion to the Walker Street Telephone Building of the American Telephone & Telegraph Company was made December 6. Messrs. G. W. Peck, H. G. Spohr and A. C. Vinal of the Telephone Company accompanying the party.

On arrival at the telephone building guides were assigned and the party was taken to the third floor where the incoming cables are received and separated on to the incoming cable racks. Here is also located a large rack upon which are mounted relays and other instruments, a large fuse board with indicating lamps, and indicating fuses. Closely adjacent are located the testing boards and testing apparatus, by means of which the cables are tested at frequent intervals. In one part of the room is a switchboard and motor generator sets used for charging storage batteries, and in an adjoining room a storage battery installation is arranged. On the third floor are also located the arrangements for handling various telegraph lines and connections, most of which are leases.

The guides explained thoroughly the entire scheme of installation, opening man-holes, uncovering switchboard connections, and in other ways showing plainly and clearly just how the vast number of various pairs of wires are handled. On the fourth floor the switchboards handling long-distance calls for the metropolitan district are located. The guides demonstrated the working of all the instruments and traced out the route of calls originating in this district for cities at a distance. The operation of the recording board, directory board, distributing table, and various connected departments on this floor were thoroughly explained and demonstrated. On this and the floor above are located all of the active switchboards with their allied departments handling incoming and outgoing long distance telephone calls for New York City and surrounding territory. The operation of the board handling incoming calls from a distance, as well as the operation of the department which continually checks the efficiency of the individual operators, was shown. It was shown that in handling a long-distance call between a point in New York City and a point in Pittsburgh from seven to nine different operators were involved, as well as many thousand dollars worth of equipment.

In this building is maintained a school for instruction of candidates for positions as switchboard operators, and this school being in session an excellent opportunity was afforded the party to follow every step of the course. Particularly impressive was the great care paid to ventilation, lighting and other particulars which have a bearing upon the health and efficiency of the operator. Another impressive feature was the number of supervisors employed: about one to every five operators. In general this excursion was exceedingly pleasant and interesting.

E. S. Cooley.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER FEBRUARY 10, 1917

THE American Society of Mechanical Engineers is an organization for mutual service of over 7500 engineers and associates cooperating with engineers. The membership of the Society comprises Honorary Members, Members, Associates, Associate-Members and Juniors, all elected by ballot of the Council. Application for membership is made on a regular form furnished by the Secretary which provides for a statement of the standing and professional experience of the applicant and requires references from voting members personally acquainted with the applicant. The requirements for admission to the various grades will be furnished upon request.

Below is the list of candidates who have filed applications for membership since the date of the last issue of The Journal. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate-Member or Junior, and those in the third under Junior grade only. Applications for change of grading are also posted.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by February 10, 1917, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about March 15, 1917.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE MEMBER

California

EDMONDSON, WILLIAM G., Mechanical Engineer, Interstate Commerce Commission, San Francisco

Connecticut

PECK, CARLOS C., Foreman Rolling Mill, Bridgeport

WEST, ERNEST H., Assistant Superintendent, Bridgeport Wks., Remington Typewriter Co., Bridgeport

Florida

BAKER, C. T., Chief Engineer, Southern Utilities Co., Jacksonville

Iowa

RANSOM, WILLARD G., Salesman and Engineer, The Bettendorf Co., Bettendorf

Massachusetts

ALLEN, CHARLES L., Treasurer and General Manager, Norton Co., Worcester

DOUGLAS, ROBERT C., New York State Representative, Norton Co., Worcester

DUNBAR, HOWARD W., Assistant Chief Engineer, Norton Grinding Co., Worcester

LOVEJOY, FRANK O., Assistant Manager, The Fiberloid Co., Indian Orchard

OWEN, OSCAR L., Patent Attorney, Whitin Machine Works, Whitinsville

SMITH, EDWARD F., President and General Manager, Greenfield Machine Co., Greenfield

Michigan

DRUMMOND, R. S., General Manager and Vice- President, Detroit Steel Products Co., Detroit

Minnesota

AUSTIN, CLEM C., Salesman, American Hoist & Derrick Co., St. Paul

COMSTOCK, ELTING H., Professor of Mine Plant and Mechanics, School of Mines, University of Minnesota, Minneapolis

Missouri

COX, CHARLES G., District Manager, McIntosh & Seymour Corp., St. Louis

New Jersey

RIEWERTS, MAX, Assistant Chief Engineer, Botany Worsted Mills, Passaic

New York

BARTLETT, PAUL, Mechanical Engineer, American Technical Advice Co., Woodhaven

BARRY, RALPH E., Marine Engineer, Tebo Basin, Brooklyn

LAWRENCE, WILLIS, Chief Mechanical Engineer, Lexington Building, Interboro Rapid Transit Co., New York

ROBINSON, JOHN R., Power Plant Specialties, New York

RUE, ERNEST F., Superintendent, Engineer, Steam Ship Dept., Vacuum Oil Co., New York

Pennsylvania

GEARHART, J. A., Secretary and Treasurer, Gulick-Henderson Co., Pittsburgh

NUSBAUM, LEE, Member of Firm, Pennsylvania Engineering Co., Philadelphia

SYKES, MATTHEW A., Superintendent, Remington Arms Co., Eddystone

WOOD, JAMES H., Field Engineer, Southwark Foundry & Machine Co., Philadelphia

Tennessee

MITCHELL, WILLIAM L., Department Chief, Tennessee Department of Workshop and Factory Inspection, Nashville

Vermont

BEARDSLEY, WILLIAM H., Assistant Superintendent, Jones & Lamson Machine Co., Springfield

Canada

COOLIDGE, C. E., Formerly Chief Engineer, Howitzer Dept., The Canadian Fairbanks-Morse Co., Toronto

HARRIS, CHESTER G., Assistant to Manager, Dufferin Plant, Russell Motor Car Co., Toronto

TISSINGTON, FRANK, Chief Draftsman, McKinnon, Holmes & Co., Ltd., Sherbrooke

Philippine Islands

DUFFY, OWEN, Superintendent and Chief Engineer Insular Cold Storage and Ice Plant, Manila

Russia

SATKEVICH, ALEXANDER, Professor of Mechanical Engineering, Nicolas Academy of Engineers, Petrograd

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

District of Columbia

BURDICK, HAROLD S., Lieutenant (j. g.), United States Navy, Washington

Illinois

STARK, JULIAN E., Chief Draftsman, Crane Co., Chicago

YOUNG, WILLIAM V., Vice-President, The American Appraisal Co., Chicago

New Jersey

VOIGT, MAX T., Tool Draftsman, Bosh-Magneto Co., Plainfield

New York

BROWN, CLINTON B., Erecting Engineer, Henry Worthington, New York

DE VRIES, REIMER P., Mechanical Draftsman, Robert Sayre Kent, New York

EBEN, LEON A., Mechanical Draftsman, Jabez Burns & Sons, Inc., New York

HARTFORD, LIONEL C., Representative State of New Jersey, Manning, Maxwell & Moore, Inc., New York

KOMPASS, FRANK O., Chief Draftsman, M. T. Davison, Brooklyn

O'NEILL, JAMES H., Manager and Purchasing Agent, Machine Dept., Continental Can Co., Inc., Syracuse

RIPLEY, WILLIAM H., Marine Sales Engineer, Griscom-Russell Co., New York

ZILLGER, ARNO, Mechanical Engineer, Clark Bros. Co., Olean

Ohio

BAIRD, LYMAN S., Mechanical Engineer, Firestone Tire & Rubber Co., Akron

HELPBRINGER, JAMES N., Power Plant Engineer, Firestone Tire & Rubber Co., Akron

KERR, THOMAS H., Gas Engineer,
The Ohio Fuel Supply Co., Columbus
RETTIG, GEORGE P., Mechanical Engineer,
Cincinnati Motor Syndicate, Cincinnati

Pennsylvania
GEBHARDT, LOUIS E., Centrifugal Pump Designer,
C. H. Wheeler Mfg. Co., Philadelphia
LUKENS, WILLIAM L., Engineer in Ordnance Dept.,
Bethlehem Steel Co., So. Bethlehem
PITTS, GUY C., Assistant to Yard Engineer,
Sun Shipbuilding Co., Chester

Rhode Island
KENDRICK, ALFRED F., Mechanical Engineer,
Glenlyon Dye Works, Phillipsdale

South America
HARRIS, SIMEON W., Sub-Superintendent of Distribution,
The San Paulo Gas Co., Ltd., San Paulo, Brazil

Washington
HOBART, FREEMAN A., Superintendent,
Henry McCleary Timber Co., McCleary

Canada
SMALLWOOD, RICHARD L., Engineer and District Manager,
Canadian Buffalo Forge Co., Ltd., Toronto

India
STEPHENS, FREDERICK S., Superintending Engineer,
Seven Tea Factories, Chulsa, Zurantee and Engo Tea Cots,
Jalpaiguri District

FOG CONSIDERATION AS JUNIOR

Illinois
FITZ-GERALD, GERALD, Industrial Engineer,
St. Clair County Gas & Elec. Co., St. Louis
HIMELBLAN, HARRY, Engineer,
American Steam Conveyor Corp., Chicago
MASTERS, HERBERT R.,
with B. F. Sturtevant Co., Chicago
WOOLNER, SEYMOUR A.,
with Woolner Distilling Co., Peoria

Maryland
RANDOLPH, ORLANDO R., Material Inspector,
Test Department, Baltimore & Ohio R. R., Baltimore

Massachusetts
GUETHING, THEODORE H., Assistant to Mr. John A. Stevens,
Cons. Engr., Lowell
MABBOTT, HAROLD C., Charge of Mechanical Engineering Course,
Northeastern College, Boston
NOURSE, RALPH C., Assistant Foreman, Foundry Dept.,
Crompton & Knowles Loom Wks., Worcester

Michigan
TODD, CHARLES R., Superintendent,
Dail Steel Products Co., Lansing

Minnesota
DINSMORE, ARTHUR T., Superintendent,
Western Rug Co., Minneapolis
FRANCE, JOHN E., Industrial Engineer,
Crex Carpet Co., St. Paul

New Jersey
ANDERSON, HARRY T., Assistant in Tool Design Dept.,
Simplex Automobile Co., New Brunswick
BRIZZOLORA, ROBERT T.,
with Worthington Pump & Machinery Corp., Harrison
FRICK, CLIFFORD H., Assistant Boiler Room Engineer,
Public Service Elec. Co.,
HARPER, PHILIP S.,
with Worthington Pump & Machinery Corp., Harrison
LANSING, RAYMOND P., Assistant Engineer,
Bijur Motor Lighting Co., Hoboken

New York
BROWN, IRVING F., Assistant Engineer,
Westinghouse, Church, Kerr & Co., New York
GLUCK, EDWARD V.,
with Soapitor Co., New York
HUNT, HERBERT S., Assistant Mechanical Engineer,
American Sugar Refining Co., Brooklyn
KUTTUER, JULIUS, Mechanical Engineer,
Universal Leather Co., New York
SWEENEY, LOUIS M.,
Graduate Brown University, Poughkeepsie
TAYLOR, CHARLES F., Engineer,
Allied Machinery Co. of America, New York
WILSON, OLIVER W., Engineer,
Cost Engineering Dept., The Barrett Co.,

Ohio
FELDBUSH, HARRY A.,
with Worthington Pump & Machinery Corp., Cincinnati
KLEIN, CHESTER T., Vice-President,
Cookson Steam Specialty Co., Cincinnati
TREAT, MERRITT W., Inspector,
The Travelers Insurance Co., Cleveland

Pennsylvania
GINSBURG, JACOB,
with Westinghouse Electric & Mfg. Co., E. Pittsburgh
HARTMAN, JOSEPH W.,
with Cambria Steel Co., Johnstown
HEPBURN, LOUIS L., Foreman Machine Shop,
Midvale Steel Works, Nicetown
KIEHL, EUGENE, Electrical Engineer,
The Atlantic Refining Co., Philadelphia
MARX, HARRY J., Mechanical Draftsman,
Arthur Brock, Jr., Philadelphia
SCHAEDGEN, JOSEPH F., Designer,
The American Steel & Wire Co., Donora

Rhode Island
MICHELSON, HERMAN H., Designing,
Beaman & Smith Co., Providence

South Carolina
JACKSON, FREDERICK R., Assistant Engineer,
with Mr. J. E. Sirrine, Mill Engineer and Architect, Greenville

Wyoming
HAMILTON, ROBERT W. F., Assistant Superintendent,
Central Station, Wyoming Electric Co., Casper

APPLICANTS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE-MEMBER

New Jersey
LANG, CHARLES W., Ordnance Engineer,
Sloan & Chace Mfg. Co., Ltd., Newark

Washington
WADDELL, ROBERT, General Superintendent,
Washington Iron Works, Seattle

PROMOTION FROM JUNIOR

Connecticut
HANDS, RONALD C., Supervisor of Schedules,
Winchester Repeating Arms Co., New Haven

Illinois
CRESSLER, KERR M., Engineer,
Henry I. Lea, Consulting Gas Engineer, Chicago

Massachusetts
TURNER, CHARLES H., Chief Engineer,
Osgood Bradley Car Co., Worcester

New York
BILLINGS, EDWARD J., Engineer,
Henry L. Doherty & Co., New York
DURYEE, ANDREW B., Mechanical Engineer,
Gerstendorfer Bros., New York
HILL, E. LOGAN, Assistant Engineer,
The Erie Railroad Co., New York
KNOWLTON, FREDERIC K., President,
M. D. Knowlton Co., Rochester
MESSNER, MANFRED, Engineer,
Bing & Bing Construction Co., Inc., New York
NICKERSON, CHARLES W., Superintendent of Transportation,
Westchester Lighting Co., Mount Vernon
ROGERS, ROBERT W., Chief Engineer,
Superno Co., Inc., [illegible]

Ohio
LOTHROP, MARCUS T., Manager,
Tube & Steel Dept., Timken Roller Bearing Co., Canton

Pennsylvvania
DANNER, E. C., General Superintendent,
Ganteer Works, Cambria Steel Co., Johnstown

Summary

New Applicants	91
Applicants for change of grading:	
Promotion from Associate-Member	2
Promotion from Junior	12
Total	105

NECROLOGY

HARRY D. JOHNSON, JR

Harry Dibrow Johnson, Jr., was born in South Bend, Ind., on July 29, 1882, died in that city Noveber 11, 1916.

Mr. Johnson received his early education in the public schools of South Bend, after which he entered Cornell University, graduating in 1904. Immediately he was employed with the General Electric Company at Schenectady, N. Y., and after two years returned to South Bend for responsible work with Studebaker Brothers Manufacturing Company. During the first seven years he progressed from machinist and draftsman and assistant master mechanic, having charge of building, design and construction, power-plant operation, machine design, maintenance, repairs, methods, piece prices, factory layouts, design and construction, to the position of master mechanic and extension work director.

Mr. Johnson's varied interests included public enterprises and general charities, as well as memberships in the University Club of Chicago, the Indiana Club, the South Bend Country Club, and the Chamber of Commerce. In 1912 he became a Junior Member of the Society.

CLIFFORD E. LIPE

Clifford E. Lipe was born December 23, 1887. Securing his earlier education in the public schools of Syracuse, N. Y., he entered Cornell University and graduated from the school of engineering of that university in 1911. On a year's trip abroad he studied the automobile business from an engineering and manufacturing standpoint, and on return was engaged immediately to look after the engineering work of the Brown-Lipe Gear Company. He became chief engineer of that company, having charge of experimental engineering, including developing and testing new transmission devices, testing accessory devices brought to that company by designers and inventors, and designing or developing the company's line of four-speed transmissions. As engineer and designer with the C. E. Lipe Manufacturing Company, he designed a great variety of special devices, tools, jigs and fixtures, including a special automatic machine for drilling and reaming solid steel ball retainers. He became vice-president of the Brown-Lipe Gear Company, being a member of the Board of Directors and very instrumental in dictating the business policy of that company.

He was elected to Associate Membership in the Society in 1914.

ALFRED WATERS PROCTOR

Alfred Waters Proctor was born in Needham, Mass., May 26, 1878. Having from early youth an inclination toward things mechanical, he determined to fit himself for mechanical engineering, and in 1899 entered the Massachusetts Institute of Technology.

On leaving the Institute, Mr. Proctor acquired his first experience by working as designer and draftsman in the plants of Blanchard Machine Company and Burton Electric Smelting Company, and with Carl L. Sponholtz, architect, all in Boston. He was later employed as designer of machine tools with Western Electric Company, and in the manufacture of pyrographic tools with J. G. Tyssowski Company, Chicago, Ill.

Much of his time was devoted to inventions and the design of special machinery, for the manufacture of which he operated shops of his own in Washington, D. C.

From 1907 to 1915 he maintained an office in New York City, during which time he made a number of special investigations, including tests on inventions of pumps, tests with pumping and engine apparatus and tanks to determine the highest efficiency of differently-shaped siphon bowls, tests on speed of type bars for the Royal Typewriter Company, reports on inventions for the Crown Cork and Steel Company, chronograph tests on shoe machines for Reece Button Hole Machine Company, and ball-bearing measurements for the Hess-Bright Manufacturing Company.

Mr. Proctor was for seven years an examiner in the United States Patent Office, and during that time attended and graduated from Columbia University Law School, and was admitted to practice as a lawyer by the Court of Appeals of the District of Columbia and by the Supreme Court of the United States. Because of his peculiar qualifications, which now included a thorough training in the theory and practice of engineering and a wide knowledge of patents and patent laws, his services were sought as an expert in patent litigation. His success in this capacity resulted in his being retained in some of the most important patent cases before the courts in recent years, and his standing with the members of the patent bar, and the confidence and respect with which the judiciary regarded his work were such that in several cases he was invited to sit with the court as a technical adviser. It had been with some reluctance, however, that he relinquished his active work as engineer, having always a preference for actual constructive work, and he continued to act frequently as a consulting engineer.

Mr. Proctor was elected to membership in the Society in 1916, and was also a member of the University Club, the Knickerbocker Field Club, and the Young Men's Republican Club, all of Brooklyn, and of the Technology Club of New York City. His death occurred on September 10, 1916.

HUBERT LEIGH WATSON

Hubert Leigh Watson, who died in New London, Conn., October 11, 1916, was born in Philadelphia, Pa., September, 1888. He was educated in the public schools of Hackensack, N. J., and later entered Cornell University for a course in mechanical engineering, taking his degree in 1910. The following year he pursued advanced work in gas-engine design.

For practical experience, Mr. Watson began with the summer of 1909 to employ his vacation time in apprenticeships, at that time as machinist's helper in the repair shops of the Delaware, Lackawanna & Western Railroad at Kingsland, N. J.; in 1910 he worked with the American Car and Foundry Company at Berwick, Pa., in its steel car department, and in 1912 and 1913 was employed with the De La Vergne Machine Company, New York City, in erecting and testing oil engines, also doing some special tool designing.

From 1911 to 1915 he was instructor in practical mechanics in Purdue University. He was in charge of the course in gas-power-plant design and taught all sections in mechanism.

In July, 1915, he resigned from Purdue University to accept a position with the New London Ship and Engine Company, of Groton, Conn.

He published an article on Accelerating Force of Reciprocating Parts in *Machinery,* August 1916.

Mr. Watson was a member of Purdue Cosmopolitan Club, and in 1913 became a Junior Member of the Society.

AMONG THE SECTIONS

On Tuesday, Wednesday and Thursday of Annual Meeting Week, the official delegates of sixteen of the twenty Sections of the Am.Soc.M.E., and representatives of five centers contemplating the establishment of Sections, met in conference with the Committee on Sections.

A great deal of valuable information as to the special conditions obtaining in various localities was developed and useful suggestions made which should do much to enhance the interest in this most important phase of the Society's activities.

On the first day of the Conference the delegates met at luncheon with the members of the Council and officers-elect. On that occasion the President and President-Elect took advantage of the opportunity to voice their keen interest in the activities of the Sections, and their desire for correlation of their work with that of local engineering interests whenever possible. That the Society is taking a leading part in this spirit of coöperation was evidenced by the fact that there were present by invitation at the first day's session of the Conference, representatives of the other three Founder Societies in the persons of T. J. McMinn, Assistant Secretary of the A.S.C.E., W. H. Hall, Chairman of the Sections Committee of the A.I.E.E., and A. D. Beers of the A.I.M.E.

The Sections represented and their official delegates were:

Atlanta	Earl F. Scott
Birmingham	Paul Wright
Boston	A. L. Williston and W. G. Starkweather
Buffalo	C. H. Bierbaum
Chicago	Joseph Harrington
Cincinnati	A. J. Baker
Detroit	M. E. Cooley
Indianapolis	William H. Insley
Milwaukee	Edward Hutchens
Minnesota	J. V. Martenis
New Haven	J. W. Roe
New Orleans	William B. Gregory
New York	H. R. Cobleigh and John H. Norris
Philadelphia	D. Robert Yarnall
St. Louis	Hans R. Setz
Worcester	Edgar H. Reed

There were also present representatives from the following localities:

Hartford	J. Breslav
Lowell	A. W. Vaughan
Meriden	C. H. Decherd
Providence	W. H. Paine and A. H. Annan
Rochester	Lucien Buck

SCOPE OF THE CONFERENCE

The first day of the Conference was given over to an "Experience Meeting," at which each delegate reported the work of his Section during the past year and plans for the ensuing season. A report was made by the Committee on Sections giving a resumé of what it has accomplished in the second year of its work. This report is appended.

The first section brought out the facts that generally all Sections are closely coöperating with existing engineering societies and clubs in their respective localities and thereby securing greater interest on the part of all engineers, the presentation of a higher class of papers, a better spirit of "get-together" and good fellowship and the establishment of a permanent headquarters for the engineers of the locality. Ways and means for the continuance of this forward movement were discussed, and among others the following were advanced:

1. The desirability for "pre-meeting" suppers at a reasonable price which would encourage general participation and afford opportunity for increasing acquaintanceship.
2. Provision for all attending each meeting to wear a badge, giving their names to assist in acquaintanceship.
3. The desirability of all coöperating to the utmost in this matter of good fellowship and "get-together" movement, and especially on the part of the older members in relation to the newcomers.
4. The wisdom of having short papers, well presented and not too technical in nature, with prearranged intelligent and snappy discussion and adjournment in season to enable the members to mingle for a social hour and partake of a lunch,—"Dutch" or otherwise.
5. Excursions to points of engineering interest and industrial plants, which afford opportunity for getting acquainted while learning something of value.

The subsequent sessions were taken up by a thorough discussion of proposed changes in the By-Laws of the Society with regard to rules covering the administration of the Sections, and when these are finally decided upon they will be published in The Journal.

PUBLICITY

The Conference considered that particular attention should be paid to Sections' publicity. Advance notices of meetings should not only be sent for publication in The Journal, but also to newspapers and technical papers; reporters should be invited, and abstracts of papers furnished them if desired. Publicity for the engineer has long been overlooked, and this is largely responsible for the lack of appreciation on the part of the community of the prominent part taken by engineers in public relations.

Proper methods will do much to broaden the interest of engineers and afford them equal recognition with the legal and medical fraternities, which on account of the human element in their professional work are today exerting such a strong influence in the activities of the community.

Report of the Second Year's Work of the Committee on Sections, 1916

The first year of the activities of the Committee on Sections was devoted largely to formulating a policy which would provide for a uniform administration of the Sections with regard to their relations with the parent Society and without conflicting with conditions peculiar to their respective localities. This was accomplished through the medium of two conferences of Sections' delegates (one at each of the two general meetings held in 1915) supplemented by a large volume of correspondence.

During the past year it has been possible to inaugurate a number of innovations in the Sections' activities and it is believed that the coöperation afforded by the Society has been rewarded not alone by increased interest on the part of members located in the territory covered by the several Sections, but also through stimulating members in several districts to undertake the establishment of new Sections.

At the time of the last Section Conference in December 1915, there were Sections at the following centers: Atlanta, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Los Angeles, Milwaukee,

Minnesota, New Haven, New York, Philadelphia, St. Louis, San Francisco and Worcester. The Birmingham Section was authorized at the meeting of the Council held in December 1915. Since then five Sections have been added to the list: Baltimore, Detroit, Erie, Indianapolis, and New Orleans. Two of them, Baltimore and Erie, have been authorized in December, 1916, so that we now have twenty Sections of the Society.

There are a number of industrial centers where conditions appear to be ripe, or nearly so, for the organization of Sections, or where meetings may be held in conjunction with Sections already existing. Among these places may be mentioned Cleveland, Columbus, Hartford, Kansas City, Lowell, Meriden, Providence, Pittsburgh, Rochester and Toledo. It is suggested that existing Sections coöperate in spreading information as to the value of Sections in promoting the engineering profession and incidently the "Mutual Service" afforded by The American Society of Mechanical Engineers, because it is well that all who enter the Society do so with the understanding that they are getting an opportunity to *give* as well as *receive* service. One way in which Sections could coöperate in the development of new Sections would be to prepare an article giving concisely the value of the Section as they see it. This might be undertaken by a member of the Executive Committee who has had sufficient experience in the work to have a knowledge of what may be termed a composite opinion of the members of the Section with regard to its worth to them. A series of such articles could be used to considerable advantage by the Committee on Sections in formulating a pamphlet for distribution in localities where Sections are proposed.

During the year the President, Secretary, or Chairman of the Committee on Sections has visited practically all of the Sections of the Society excepting those located on the Pacific Coast and they were visited in the fall of 1915. In addition visits were made to Baltimore, Detroit, Erie and Indianapolis on the occasion of the Organization Meetings held at those places.

CONSTRUCTIVE ACTIVITIES

Among others, the following developments have been achieved:

A proposed set of Amendments to the By-Laws of the Society, to govern uniformly the work of the Sections. These were submitted to the Sections' Conference at the Annual Meeting, December, 1916.

Unusual recognition was accorded the Sections by President Jacobus in giving each of five groups of Sections the privilege of electing one member of the Nominating Committee charged with the duty of selecting candidates for the Council on the ballot just closed.

Another illustration of the recognition of the importance of Sections is a Resolution by the Council to present at the 1917 Spring Meeting an amendment to the Constitution to make a Standing Committee of the Committee on Sections.

A "clearing house" for motion picture films on industrial subjects and lectures has been established, and a start has been made to secure written lectures, sometimes with slides, which lectures may be presented by a member of the Section who is willing to become sufficiently familiar with the subject matter to present it.

Sections have been assisted in their desire to encourage the young engineers just out of college through an additional amount added to their appropriations for each graduate Student Member who locates within their territory. In return the Sections are expected to give these graduate Student Members all the privileges of the Section for a period of two years after graduation. Thereafter it is expected that regular application will be made for membership in the Society if one expects to continue to obtain such privileges.

The various Sections have begun in a small way to coöperate with one another through an exchange of literature and notices of meetings. This should be further developed so that whenever a member of one Section expects to visit a city where another Section is established, notification be sent in advance and if possible arrangements be made whereby the Section visited may have opportunity to entertain the visitor and have him make some remarks, or if possible deliver a technical paper.

The Journal now devotes considerable space to a portrayal of the work of Sections, and it is hoped that the Sections will coöperate not only by submitting promptly reports of their activities, but also by keeping the Editor informed regarding all engineering news of their respective districts and especially proposed engineering developments. Every Section is encouraged to nominate one of its younger members to act as a correspondent of The Journal.

Transactions of the Society should be available for the members of Sections, and as fast as Sections secure headquarters where such Transactions may be properly cared for, it is planned to provide them.

UNIFORM DATE FOR CHANGE OF OFFICERS

Another accomplishment of the year has been to secure the consent of all Sections to uniformly elect their officers between March first and the end of May so that such elections may be formally reported and ratified by the Committee on Sections and the Council at their June meetings (held the second Friday of June) and the new officers thereby enabled to uniformly begin their activities on July first.

It is hoped by this procedure it will be possible for the Executive Committees of Sections to map out their programs for the ensuing year and have dates, speakers and places of meeting decided upon, and reports thereof sent to the Society's headquarters by October first of each year.

The most recent and one of the most successful achievements in Sections' activities was a Joint Meeting by the Boston, New Haven, New York and Worcester Sections and the Providence Engineering Society at New London, Conn., on November 11, 1916. Over sixteen hundred persons attended and special trains were run from Boston and Providence and New York and New Haven. In addition to being the first Joint Meeting of Sections ever held it was at the same time the largest gathering ever held under the auspices of the Society.

ELLIOTT H. WHITLOCK, *Chairman.*
W. F. M. GOSS,
L. C. MARBURG,
WALTER RAUTENSTRAUCH,
D. ROBERT YARNALL,
Local Sections Committee.

SECTION MEETINGS

BIRMINGHAM, OCTOBER 25

An enthusiastic meeting of the Birmingham Section was held October 25 at which W. P. Caine, Assoc.Am.Soc.M.E., gave a most interesting talk on The Use of By-Product Coke-Oven Gas as a Fuel and Some of the Problems Presented in its Use at the Ensley Steel Works.

The Tennessee Coal and Iron and Rail Road Company at its Steel Plant at Ensley has between 28 and 33 million cu. ft. of by-product gas to dispose of each day. This is the surpius made at their By-Product Coke Oven Plant at Fairfield and forced through a 24-in. pipe line 8000 ft. long ,and from the Semet-Solvay Ovens located next to the Ensley Plant.

In the talk the causes of the irregularities in the delivery and demand for the gas and the lack of a gas holder were brought out in order to indicate the conditions under which it has to be used and the necessity of being able to supplement or substitute some other fuel upon short notice sufficient to care for the variations.

Descriptions were given of various types of burners used, and their application to special conditions as for heating ladles, drying ovens, mixers, open-hearth furnaces, heating furnaces, soaking pits, etc.

All burners have a chamber in which the gas and air or a part of the air necessary for combustion are mixed before the mixture is ignited in the furnace. In some the air is drawn in by the gas jet or jets, while in others it is a jet of compressed air, air from a fan blower or air blown in with a steam jet.

Experience has shown that the burners will back-fire and burn in the mixing pipe with those in which the air is drawn in and if allowed to burn in this manner, the capacity is noticeably reduced and in some instances the end of the mixing chamber has burned off. This occurs when the gas pressure is lowered or its velocity is reduced by trying to draw in too much air for the proportions of the burner. To avoid this trouble a burner was made on the multiple-jet principle with a very short mixing chamber.

Following this talk, Mr. Gaboury, of the Woodward Iron Co., gave his experience on installations similar to those described by Mr. Caine. This was followed by H. P. Ryding, who called attention to the economies now effected as compared with what might

have been done had the entire installation been built new with a view to using by-product gas.

The chairman outlined the program for the coming season as follows: *December*, Flying Machines by Prof. M. T. Fullan, of Alabama Polytechnic Institute; *January*, Combustion and Combustion Chambers in Locomotive Practice, by A. T. Anthony; *February*, Dr. Ira N. Hollis, President, and Calvin W. Rice, Secretary of the Society; *March*, Illumination, by Prof. A. A. Wittig, of the University of Alabama; *April*, Prof. A. St. C. Dunstan, of Alabama Polytechnic Institute; *May*, annual meeting, Dr. Thornwell Haynes, President of Birmingham College.

Paul Wright,
Section Secretay.

BIRMINGHAM, NOVEMBER 15

The meeting held by the Birmingham Section on November 15 was its first anniversary meeting, and it was the general sense of the meeting that the Section had been successfully organized on a basis to do effective work. Two talks were given, illustrated by photographs and charts thrown on the screen by the new balopticon machine. The use of this machine is more or less original with this Section, and the results were highly satisfactory in every respect.

The first talk was given by Mr. Paul Wright, who showed a number of photgraphs illustrating the manufacture of cast-iron water-pipe. These pictures showed the operation from beginning to end of the American Cast Iron Pipe Company's plant at Acipco, Birmingham. This company manufactures 400 tons of pipe per day, and is the only pipe shop in the country that runs double shift; it also has the distinction of making pipe 16-ft. long, and is the pioneer in the manufacture of this long pipe.

Mr. J. H. Klinck led an interesting discussion of the paper by Samuel Insull presented at a meeting of the New Haven Section on April 5, 1916, The Progress of Economic Power Generation and Distribution. Each picture and chart was well illustrated by the balopticon. Mr. Klinck added several illustrations of his own experiences with different types of turbines.

In the discussion, Frank Cutler called attention to the fact that the consideration of a central power station for the Birmingham district might be the means of conserving considerable power, and at the same time take advantage of the diversity principle as strongly emphasized by Mr. Insull.

Paul Wright,
Section Secretary.

BUFFALO, NOVEMBER 1

At the meeting of the Buffalo Section held on November 1, Frank B. Gilbreth, Mem.Am.Soc.M.E., spoke on Motion Study; his lecture was illustrated with slides showing his well-known cyclograph, in which a light is fastened to the object whose motion is to be recorded, and the camera is opened to record the path of the lighted object. Mr. Gilbreth's lecture opened up many fields of thought and showed what could be done in further advancing the study of the elimination of waste, whether in motion or materials.

John Younger,
Section Chairman.

BUFFALO, NOVEMBER 15

Professor Wm. L. Cathcart, Mem.Am.Soc.M.E., addressed a meeting of the Buffalo Section on November 15 on The Navy; its Fleet and Naval Stations. His talk was illustrated with slides showing various phases of work in the Navy, including some splendid pictures of battleships. The speaker showed how the engineer was responsible for the modern fighting machine and pointed out that an engineer would be required more and more to express his feelings as regards the growth of a navy suitable for the adequate defense of the United States.

John Younger,
Section Chairman.

BUFFALO, NOVEMBER 29

Before the meeting of the Buffalo Section held on November 29, C. H. Bierbaum, Mem.Am.Soc.M.E. and Chairman of the Sub-Committee on Bearing Metals of the Research Committee, read a paper on Graphite, with special reference to its use in lubricating compounds for bearings. The paper described at the outset the experience of the Lumen Bearing Company in producing the most economic and useful bearings for particular purposes. The first field of investigation was that of the metallurgical treatment of bearing metals in the foundry; in addition it was found necessary to investigate and correct improper designs from the point of view of both the strength and proportion of the bearing, as well as the oil grooves. This in turn brought in the oil supply in general and lead to a broad investigation of the entire field of lubricants, and from the beginning of this investigation graphite promised to be a vital subject. The results obtained with this metal were so varied, however, and at times so unsatisfactory that they lead to special studies of the composition and impurities of graphite, finally resulting in the perfection of a process by means of which all objectionable impurities are removed; impurities such as mica, silicon, feldspar, iron oxide, alumina and clay to the amount of 30.7 per cent., have been removed by this process from some of the best lubricants on the market.

L. J. Foley,
Director of Publicity.

BUFFALO, DECEMBER 13

On December 13, Alfred P. Brush, consulting engineer, of Detroit, spoke to the Engineering Society of Buffalo on the Four-Cylinder Automobile Engine, and other engineering topics. Mr. Brush said in part:

"Considered solely from the standpoint of numbers, the four-cylinder engine is, and has been for the last ten years, the standard prime mover for self-propelled road vehicles, and in my judgment will continue to be, so long as the four-cylinder internal-combustion engine holds its place as the most satisfactory prime mover for mobile use.

It is my opinion that the six-, the eight-, and the twelve-cylinder motors have all been developed more nearly to their ultimate possibilities than has the four-cylinder engine, and it is also my opinion that the greatest obstruction to the development of the four-cylinder motor toward its ultimate possibilities has been and is its very popularity. Volume of production makes for efficiency of production and stagnation of development.

There is another very real obstruction to the development of the four-cylinder engine. It has come to be accepted as the engine for the extremely low-priced automobile.

Four of the leading manufacturers of four-cylinder-engined cars claim for their engines maximum horsepower per cubic inch of piston displacement ranging from 0.142 to 0.206, with total piston displacements ranging from 170 cu. in. to 213 cu. in., and maximum total horsepowers ranging from 25 to 35."

Mr. Brush then described a four-cylinder motor which has been produced during the past year and which developed over 0.2 hp. per cu. in. from 400 r.p.m. to 2600 r.p.m.

A general discussion of engines followed Mr. Brush's talk, and Chas. M. Manley of Curtiss Aeroplane Co., Russell Huff, Chief Engineer of the Dodge Company, David Fergusson, Chief Engineer of the Pleasure Car Department of the Pierce-Arrow Corporation, and others took part.

A local Section of the Society of Automobile Engineers was formed at this meeting. David Fergusson was elected chairman. The vice-chairman and secretary are Chas. M. Manley and David W. Sowers.

L. J. Foley,
Section Correspondent.

CHICAGO, NOVEMBER 17

The first meeting of the Chicago Section this season was held on November 17, and was announced as Army and Navy night. The chairman introduced William A. Moffet, Commander of the Great Lakes Naval Training Station, who told how naval cadets were prepared and showed numerous lantern slides of their quarters and features of their training. Beginning with the *Constitution*, the development of the navy was traced up to the last battleships off the ways.

It was the speaker's opinion that if we ever attain naval supremacy we must build ships larger, faster and with greater gun power than ever before; in other words, go the limit in the three features by which a battleship is rated. In this way the

present day dreadnaught or superdreadnaught would be outclassed and soon become obsolete. Physical limits would be reached in a battleship having a displacement of 60,000 tons, 18 in. guns and a speed of 35 knots.

Lucien B. Moody, Major, Ordnance Department, Rock Island Arsenal, spoke on the army ordnance department, showing views of its factories and products and the guns now used by the army. In time of war the five arsenals would supply only a small part of the munitions needed; it would be necessary to depend largely on the output of private enterprises.

Captain Christie, of the new United States Aviation Station at Chicago, outlined the methods of training aviators, the present status of the service and the hopes for the future. A review of the difficulties of the United States aviation corps in Mexico and anecdotes from the personal experience of the speaker were heard with great interest.

Robt. B. Thayer,
Section Secretary.

LOS ANGELES, NOVEMBER 2

A technical session of the Los Angeles Section met on November 2, when E. F. Soderholm, Mem.Am.Soc.M.E., delivered an address on Deep-Mine Hoisting, a subject which his experience qualified him to handle well. A dinner was served and attention was called to the meeting of the Engineers of Los Angeles every Thursday, at which there would be always something of interest to the members of this Section, and an invitation was extended them to attend these meetings.

Ford W. Harris,
Section Secretary.

MILWAUKEE, NOVEMBER 17

At a joint meeting of the Milwaukee Section with the Milwaukee Engineers Society and Milwaukee Section of the American Chemical Society on November 17, Prof. Otto L. Kowalke gave an address on the Characteristics of Base Metal Thermocouples. The address first described an investigation regarding the performance and constancy of base metal couples. For this purpose samples of couples had been purchased in the open market, the couples being calibrated against a carefully standardized platinum couple. First the couples were all calibrated with 4 in. of their lengths immersed in the furnace; second, calibration was made with 15 in. of their lengths immersed. Then the couples were all treated for 20 hours, respectively, at 400 deg. Cent., 600 deg. Cent. and 800 deg. Cent., and after each treatment the couples were separately calibrated.

The results of these treatments and calibrations showed that in many cases there were variations of 150 deg. Cent. between the calibration at 4 in. and 15 in. immersion. This difference was due to a lack of proper annealing before being put into service. Many of the couples gave very satisfactory performance and showed a variation in calibration of from 25 to 40 deg. from the beginning to the end of the test. This is not an excessive variation. Microphotographs of the wires were also made before and after heat treatment for two hours, respectively, at 400 deg. Cent., 600 deg. Cent., 800 deg. Cent. and 1000 deg. Cent.

In all cases where satisfactory calibration was found, it also happened that the metals composing the wires in the couple formed a solid solution. It was found that in each couple where silicon was used to an extent of about 3 per cent. a segregation of the metal took place, which resulted in an excessive change in calibration; the extent of this change being 150 deg. at 1000 deg. Cobalt was also investigated as a chemical element.

Various couples were made up with iron, *Advance*, nichrome and constantan wires. These couples were treated in a manner similar to those described above. It was found that cobalt *vs.* *Advance* or constantan gave satisfactory calibrations. Cobalt does not get brittle so easily as does nickel, nor does it oxidize quite so readily. A combination of cobalt *vs.* nickel-iron alloy gives a most satisfactory performance. There was less than 5 deg. difference between the original and final calibrations.

Fred. H. Dorner,
Section Secretary.

MINNESOTA, NOVEMBER 9

The Minnesota Section held its third meeting of the season in Minneapolis, Minn., on November 9. The speaker was Dr. E. F. Friedman, chief chemist of the McLaughlin, Gormley, King Co., of Minneapolis, Minn., who addressed the meeting on Coke and Its By-Products. The talk proved exceedingly interesting and was followed by a lively discussion, during which the opinion was expressed that the inferiority of the dyes manufactured in this country is due not to lack of knowledge, but to the fact that our manufacturers will not take the time to carry the reduction of the crudes down to the proper base.

D. M. Forfar,
Section Secretary.

NEW HAVEN, NOVEMBER 15

The Fall meeting of the New Haven Section, held on November 15, was held in two sessions as usual. At the afternoon session, papers were read on Methods of Testing Metals, by Prof. W. K. Shepard, and on Applied Metallography by Prof. C. H. Mathewson. These were followed by discussion of the subjects by Mr. Skinner, of the Westinghouse Company, Mr. Staples, Prof. L. P. Breckenridge, Mem.Am.Soc.M.E., and others. The Hammond Laboratory was thrown open to the meeting, and dinner was later served in the Yale Dining Club Hall to visiting engineers.

The evening session was opened by Calvin W. Rice, Secretary of the Society, who gave notice of the 37th Annual Meeting to be held in New York, December 5 to 8. Prof. Breckenridge announced that an exhibition would be given by the Yale Mechanical Engineers Club in the Mason Laboratory, December 8. A paper was read by S. J. Berard, Instructor in Machine Design of Sheffield Scientific School, on Methods of Duplicating Drawings, and Frank B. Gilbreth, Mem.Am.Soc.M.E., spoke on Developments in Time-Study Methods and Devices, both of which brought out considerable discussion on the application of photography to engineering. Mr. Berard gave an illustration of blueprinting by exposing a tracing in the stereopticon and almost immediately showing the blueprint on the screen. Programs were prepared by the blueprint department of the Mason Laboratory as examples of methods of duplicating from negatives.

A full account of this meeting is published elsewhere in this issue.

E. H. Lockwood,
Section Secretary.

NEW ORLEANS, OCTOBER 2

A joint meeting of the Louisiana Society of the members of The American Society of Civil Engineers and the New Orleans Section of our Society was held on October 2. The chairman announced a new policy for the Section, by which full coöperation might be maintained with the Louisiana Engineering Society without any conflicts of work. Under this policy, the preparation of new papers of merit is to be confined largely to the Louisiana Society, and the activities of our Section are to be devoted to the discussion of papers which shall have appeared either in The Journal or Transactions.

The topic of discussion of this meeting was the paper of G. C. Noble, entitled The Design and Test of a Large Reclamation Pumping Plant, published in the May, 1916, issue of The Journal and later selected by the Committee on Meetings for presentation at the Annual Meeting in December, 1916.

Professor Gregory and Messrs. Shaw, Hutson, Okey, Delery, Nelson, Dusenbury, Burwell and Olson participated in the discussion of this paper, bringing out a number of points of interest not previously developed. This discussion will be referred to Mr. Noble for his reply.

H. L. Hutson,
Section Secretary.

PHILADELPHIA, NOVEMBER 28

On November 28, a meeting of the Philadelphia Section was held in the auditorium of the Philadelphia Engineers' Club. Mr. MacCoull of the Westinghouse Machine Co., of Pittsburgh, spoke upon the subject of mechanical development of aviation. He pointed out that from ancient times, it has been man's insatiable ambition to conquer the air, and history from the earliest times is marked by accidents occurring from experiments with various types of flying machines. The most rapid progress in the development of air machines has occurred in the past ten years.

Mr. MacCoull's paper laid particular stress upon the development of aeroplane engines, and gave instances of engines developed to meet the requirements of the very least possible weight per h.p. It is almost unbelievable that successful engines have been constructed which weigh only three or four pounds per h.p. His lecture was illustrated throughout with a number of fine lantern slides showing the development of the aeroplane engine within the past ten years. Valve arrangements and cooling systems were also treated in his paper.

Following Mr. MacCoull's paper, Dr. C. E. Lucke, Mem.Am.Soc.M.E., Dean of the Department of Mechanical Engineering of Columbia University, gave a very graphic description of the problem of aeronautical engine design. Dr. Lucke is Chairman of the Advisory Aeronautical Committee, appointed by the War Department, and showed by his talk that he was intimately familiar with the difficulties involved in successful aeroplane engines. Dr. Lucke was somewhat pessimistic in his view of the situation as to the dependability of modern aeroplane engines. Take any five engines, Dr. Lucke said, and start them and leave them alone, and hardly three can be depended upon to run without attention for over two hours. He felt as if the problem was just beginning to be solved, and as soon as capital became interested in the matter and the manufacture of aero-craft took its place on a plane with other lines of industrial work, then would the development of the engine begin in earnest. It was estimated that it would require from $50,000 to $500,000 to develop a good aeroplane engine and embody all the most recent improvements.

Dr. Lucke talked about carburation, the necessity of lightest possible power plant, fixed cylinders versus rotary cylinders, ignition, engine housing, crank cases; analyzing his talk throughout with the use of curves drawn upon the blackboard. Dr. Lucke thought that not sufficient attention had been paid by designers to stresses involved, and emphasized the necessity for designing to meet the heat carrying conditions. The great problem, therefore, is to get together a sufficient amount of design data to enable engineers to handle the problem in a more scientific and thorough manner.

Although an American was the inventor of the present aeroplane, it is much to our shame that the last two or three years has seen Continental Europe considerably outdistance us in the progress made in aviation.

Discussion on the subject was led by Dr. Jos. A. Steinmetz of the Aero Club.

W. R. Jones,
Section Secretary.

PROVIDENCE, NOVEMBER 22

At the November meeting of the Providence Engineering Society, held in the Engineering Building of Brown University on the 22nd, definite steps were taken for the winter's activities by the formation of four sections, which with the section on fire protection previously organized make five sections to start with. The new sections are: Machine Shop, Efficiency and Scientific Management, Structural Engineering and Designing and Drafting. It is expected that they will immediately take up their work and organize interesting meetings in this department of the Society's activities.

The speaker of the evening was Mr. Nelson B. Lewis, Chief Engineer of the Board of Estimate and Apportionment, Bureau of Public Improvements, New York City. His address was on the subject of City Planning as an Engineering Problem, and was well illustrated by lantern slides. He pointed out the serious situations which have arisen in several of our large cities because this feature of the city's activities was not given proper consideration. For instance, a street system once established continues almost indefinitely, and therefore should be carefully planned; a street layout and a transportation system are the means by which the people pass from their homes to their work, recreation and amusement, and so should be conveniently arranged. Park and recreation facilities and the importance of the location of public buildings, both with regard to their convenience and appearance were discussed.

Albert E. Thornley,
Corresponding Secretary.

ST. LOUIS, DECEMBER 6

The St. Louis Section participated in a joint meeting of the Associated Engineering Societies of St. Louis, held on December 6, under the auspices of the Engineers' Club of St. Louis. Members and guests were agreeably and instructively entertained by photoplays of unusual merit on the subjects of railroad safety and the evolution of transportation from the time of the squaw with her papoose on her back to the present electrification of the Chicago, Milwaukee and St. Paul Railroad. These were supplemented by a paper on Railroad Trespassing, by A. A. Krause, Commissioner of Safety of the Missouri, Kansas & Texas Railway System.

L. A. Day,
Section Secretary.

ST. LOUIS, DECEMBER 13

The Associated Engineering Societies of St. Louis and the Engineers' Club attended a lecture, dance and luncheon given at the club rooms of The United Railways Company, St. Louis, on the evening of December 13. Mr. A. G. Allan, Assistant Engineer, Valuation Department, Missouri Pacific Railway, spoke on Some Experiences of a Civil Engineer. The talk was non-technical, describing, with a personal touch, peculiar features encountered during twenty years of railroad, canal and reservoir building in the West and was illustrated by lantern slides from photographs of the different classes of construction. Mr. Allan's address was the second one enjoyed by the members of these societies in 1916.

L. A. Day,
Section Secretary.

STUDENT BRANCHES

BUCKNELL UNIVERSITY

A meeting of the Student Branch of Bucknell University held November 6 was the occasion of admitting to active membership in the Branch the Junior Mechanical Engineers. The topic discussed at the meeting was The Function of the Sales Engineer and His Relation to Machine Design, and a paper on that subject was read by Raymond E. Sprenkle; comparing the duties of the sales engineer of the present with the same service as it was in the past, he brought out the opportunity of the sales engineer to study the requirements of the users of machines with a view to discovering what modifications of standard types will be needed to effect an increase in production or decrease in cost of installation, and so meet competition and the conditions presented by novel machinery problems.

The subject was further discussed by Professor Burpee, Mem.Am.Soc.M.E., who developed other possibilities for advancement in the work of the sales engineer.

C. M. Kriner,
Branch Secretary.

CASE SCHOOL OF APPLIED SCIENCE

The Student Branch of the Case School of Applied Science held its regular monthly meeting on December 6. Mr. M. Luckiesh, of the N.E.L.A., gave an interesting talk on the subject of Light, Shade and Color. Mr. Luckiesh as head of the research department of the association has made a marked advance in perfecting lighting facilities. A conspicuous work of his department has been the development of artificial daylight. With the aid of diagrams and illustrations he explained the fundamental theories and practical features of his science, including the importance of color as a factor in better lighting, and emphasizing the prominence of light, shade and color in the arts.

A. Treuhaft,
Branch Secretary.

UNIVERSITY OF CINCINNATI

The meeting held by the Student Branch of the University of Cincinnati on October 20 was the initial meeting for the year 1916-17. Branch President Cowell, presiding, outlined the plans for the coming year, reminding the members to prepare for the Spring Meeting of the Society to be held this year in Cincinnati.

The meeting was addressed by A. J. Baker, Mem.Am.Soc.M.E., who is connected with the sales department of the Cincinnati Milling Machine Company, and who gave an instructive and interesting

forecast of the problems which will confront the engineer at the end of the European war.

Short talks were also given by Prof. A. L. Jenkins and C. A. Joerger, of the University faculty.

EARL A. BOTTS,
Branch Secretary.

UNIVERSITY OF COLORADO

At a meeting of the University of Colorado Student Branch, held November 23, plans were completed for a trip of the members of the Branch to the sugar factory at Longmont, Colorado, which is the third largest factory of its kind in the world and offers many points of interest to the mechanical engineer. A blackboard talk on the general outlay of the plant was given at the meeting and on the 24th the plan was consummated by the trip to the plant

R. F. HAMILTON,
Branch Secretary.

CORNELL UNIVERSITY

The first meeting of the Student Branch of Cornell University was held November 13, at which Prof. Rolla C. Carpenter, Mem.Am.Soc.M.E., Chairman of the Branch, outlined the aims of the Society and the advantages to be gained from membership therein, bringing the student into more intimate touch with engineering practice as it is today, by the presence of prominent engineers at meetings of the Student Branches to present important engineering topics. The meeting was addressed by Professor Jacoby of the College of Civil Engineering of Cornell University, an authority on bridge design, who, in a talk on this subject, discussed the fall of the Quebec Bridge, expressing his opinion that the disaster was due not to any negligence on the part of the engineers in charge, but rather to the fact that the science of engineering was not far enough advanced to insure its success; that the construction of this bridge had been the most gigantic task of its kind ever attempted; the engineers had no precedent to follow and at best their success was only a probability. Officers of the Branch were elected for the year, as follows: Chairman, Professor Carpenter; President, W. C. Bliss; Vice-President, R. O. Compton; Secretary, S. M. Barr, and Treasurer, W. W. Robertson.

S. M. BARR,
Branch Secretary.

UNIVERSITY OF ILLINOIS

An interesting talk on Industry in Bulgaria was a feature at the meeting held November 16 by the Student Branch of the University of Illinois, in which P. Gherganoff, a native of Bulgaria, outlining the geographical formation of that country and its consequent effects on the life of the people, told of their economic products, their travel routes, railroads and the wonderful opportunities for water-power development, which are being readily seized by engineers.

At the meeting held by this Branch on December 7, F. M. Van Deventer gave an illustrated lecture on The Use of Blast Furnace Gas for Power Purposes, comparing blast-furnace gas with producer gas and showing that a large conservation of energy might be effected by the use of blast-furnace gas in boilers and internal combustion engines. The apparatus necessary to prepare the gas for use in engines was shown by lantern slides, as were also the different power units throughout the country where this gas-energy is available, while other slides gave views of the details of large modern internal combustion engines.

V. S. DAY,
Branch President.

KANSAS STATE AGRICULTURAL COLLEGE

The Student Branch of Kansas State Agricultural College held its third regular meeting this season on November 2. Several subjects of interest were discussed, Mr. C. A. Frankenhoff giving a talk on the Utah Copper Company, followed by J. I. Brady, who took up the subject of Ore Treatment by the same company. These were supplemented by A. C. Arnold in a talk on the Shell Plant of the Hart-Parr Company, and the discussions were concluded by E. T. Whitcomb with remarks upon the Manufacture of Shells at the Plant of the Hart-Parr Company.

WM. N. CATOY,
Branch Secretary.

PENNSYLVANIA STATE COLLEGE

The November meeting of the Student Branch of Pennsylvania State College was held on the 27th. R. L. Sackett, Mem.Am.Soc. M.E. and Dean of Engineering of Pennsylvania State College, spoke to the meeting on Power Plants, illustrating his talk by lantern slides showing the ground plans of several plants as well as methods in use for the convenient handling of coal with the greatest saving of time and labor.

The meeting called for a member to represent the Branch at the Annual Meeting of the Society in New York, with the result that Mr. Harry Hammond attended for that purpose.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

About 200 new members were voted into the Student Branch of Massachusetts Institute of Technology at its first business meeting on October 13. There were interesting talks by Prof. E. F. Miller, Mem.Am.Soc.M.E., and honorary chairman of this Branch, Prof. A. E. Norton, Mem.Am.Soc.M.E., Mr. H. L. Coburn, Mem.Am.Soc. M.E., and Mr. J. O. DeWolf, Mem.Am.Soc.M.E. Plans were made for a visit by the members of the Branch to the Waltham Watch Company's plant on October 26.

The first Student Night of this Branch was held November 10, the entire program being carried out by student members of the Society, including a talk by A. E. Keating on an investigation of the efficiency of a boiler plant in Bridgeport, Conn., remarks on engineering opportunities in China by H. C. Ling, and a short account of tunnel construction by W. J. Beadle, based on his work in the New York tubes.

The members of the Branch entertained about twenty guests from the Institute on an excursion to New London, November 11.

EDWARD W. ROUNDS,
Branch Secretary.

PURDUE UNIVERSITY

The meeting held on November 28 by the Student Branch of Purdue University was instructively entertained by motion pictures showing the Indianapolis plant of the Ford Motor Company, which brought out the high efficiency attained by modern labor-saving machinery as applied in the manufacture of Ford cars. Views of safety appliances, schools for the instruction of foreigners and the supervision of foodstuffs supplied to employees emphasized the welfare campaign as conducted at the Ford plant.

G. A. RUESS,
Branch Corresponding Secretary.

WASHINGTON UNIVERSITY

A resumé of an inspection trip to the Ford Motor Company's plant at Detroit, Mich., was the subject at the meeting of the Student Branch of Washington University, St. Louis, Mo., on November 23. The discussion embraced the features of axle design, motor assembly, motor block and testing, commutator and distributor, and observations made at the plant of the Detroit Edison Company on boilers, student members Page, Kurtz, Thumser, Keysor and Conzelman participating in the discussion, after which Prof. F. E. Berger, Mem.Am.Soc.M.E., gave his impressions of the practical instruction of seeing these plants in operation.

WALTER KURTZ,
Branch Secretary.

WORCESTER POLYTECHNIC INSTITUTE

The month of November is reported by the Student Branch of Worcester Polytechnic Institute as having been of great interest.

On November 3, Gershom Smith, vice-president and general manager of the Tabulating Machine Company, of New York, addressed a meeting of the Branch on the subject of cost accounting, explaining the several ways in which shop costs are accounted for, the method of apportioning the burden and the modern system of tabulating cost accounts by machine. To illustrate these points Mr. Smith had on the platform a group of tabulating machines de-

vised and patented by Dr. Hermnn Hollerith, of Washington, D. C., Mem.Am.Soc.M.E.. which were the machines used by Dr. Hollerith in tabulating census returns, and were shown to do very wonderful work, being in use among prominent business concerns, especially the large railroads.

On November 11, by invitation from the parent Society, the members of this Branch attended the submarine exhibition at New London, Conn.

On November 14, Dr. D. S. Jacobus, while in Worcester to attend a meeting of the Worcester Section of the Society, addressed the Student Branch, taking as his subject Some Points Relative to Steam Engineering. The opportunity of meeting Dr. Jacobus was enjoyed by the members of the Branch.

The most important feature of the meeting held by this Branch on December 4 was an instructive talk on the Heat Treatment of Steel, by Chester M. Inman, who discussed the subject from experience gained largely through his two years' connection with the United States Steel Company in Canton, O. At this plant the speaker had been to a considerable extent in charge of certain phases of their heat-treatment work. In showing what was to be expected from certain heat treatment, Mr. Inman explained how such results were gained, why certain qualities in steel were desirable, giving the students the meaning of the terms ferrite, pearlite and cementite and the reasons for their presence, as well as their composition. The results of Mr. Inman's experience in the use of the Shore scleroscope and the Brinell hardness tester were given, as well as some insight into the questions of elastic limits and yield points, with their relation to each other.

H. P. Fairfield,
Branch Corresponding Secretary.

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping anyone desiring engineering services. The Society acts only as a clearing house in these matters.

POSITIONS AVAILABLE

In forwarding applications, stamps should be enclosed for transmittal to advertisers; applications from non-members should be accompanied by a letter of reference or introduction from a member, such reference letter to be filed with the Society. Copy for notices must be in hand by the 15th of the month.

TECHNICAL GRADUATE, age 30 to 35, practical experience in manufacture and building of steam and hydraulic machinery. Man preferred with wide shop experience, capable of directing men. Location Ohio. Interview arranged only after examination of statement of qualifications, records and compensation expected. 328

LARGE PUBLIC INSTITUTION of middle Northwest seeks services of strictly high class man who can conduct classes and lectures on automobiles. Must be technical graduate with practical experience and not afraid of work. 421.

DESIGNER. Technical graduate. Experienced in design of small intricate machinery. Location New York. 424

ENGINEER who combines faculty for writing logical interesting technical reports with ability to turn these into reliable newspaper stories. Single, age about 30. Technical education. Experience in building construction and if possible general knowledge of power-plant engineering. Demonstrated ability as writer displayed through editorial and similar work. Name confidential. 594.

INSTRUCTORS for school of mechanical trades in Iowa. Salaries $1,000 to $1,200 per year; promotion dependent to large extent upon commercial work which can be turned out during the year.

(*a*) Energetic young man with some business ability to take charge of automobile department; must know his subject thoroughly as department is doing large repair business, and must be able to build up department educationally and commercially. Competent to teach in automobile lines, including electric cranking, lighting, and ignition course, be able to organize material and work in such way that maximum number of students can be handled with minimum teaching force and expense.

(*b*) Man to handle foundry and machine shop and possibly forge. 676.

PUBLICITY ENGINEER to take charge of firm's publication and write all advertising copy. State age, experience and salary expected. Location Illinois. 687

YOUNG ENGINEERS, experienced in manufacture and analysis of metals. Salaries $65 and $80 per month to start. Location New Jersey. 689

DRAFTSMEN with experience on electric traveling cranes. Permanent employment and good wages to competent men. Location Ohio. Apply by letter. 693

EXPERIENCED DRAFTSMAN on water-tube boiler work as detailer and designer. $1,200 to $1,500. Permanent position and good prospects for right man. Location Pennsylvania. 695

ASSISTANT TO MANUFACTURING EXECUTIVE. Mechanical engineer. Must show successful experience in same line of work, and also speed, energy, endurance, initiative, aggressiveness, courage, accuracy, memory, good judgment, strong sense of propriety. Location Detroit. Name confidential. 696

ESTIMATING ENGINEER. Engineering and estimating experience required as involved in formulating selling prices and calculation of proper size of steam, gas, pumping engines, air and gas compressors and heavy special machinery. Technically trained man desired. Give experience, references and salary desired. All correspondence strictly confidential. Location Ohio. 697

SUPERINTENDENT for large manufacturing plant. Must be familiar with manufacturing methods for producing small interchangeable parts of brass, steel, and iron. State age, education, experience and salary desired. 699.

REPRESENTATIVE for large concern manufacturing one type of machine tool, to work in conjunction with agents. Previous selling experience not necessary. Good mechanical ability most desirable. Should be about 30 and have had mechanical training in conjunction with wide shop experience and should possess knowledge of best practice in machine tool uses. Location Ohio. 706.

YOUNG ENGINEER with some office and shop training for position as confidential man in office. Will have charge of various cost price and engineering records and assist in oversight of engineering salesmen, to eventually work into considerable amount of sales engineering correspondence. Location Detroit, Mich. 712.

LARGE EUROPEAN COMPANY requires machine-tool salesman speaking French, Italian or Russian, with practical experience, to assist in purchasing machine tools in United States. Suitable man would later be required to reside abroad. Apply by letter. 715.

DESIGNER. Engineering graduate, with experience in automatic machinery. Good opportunity to clever man. State education, experience, and salary expected. Location New Jersey. 717.

DRAFTSMAN. Permanent positions for high-grade men. Location Plainfield, N. J. 719.

CHIEF ENGINEER OF STEAM PLANT of 10,000-kw. capacity (turbine plant). Willing to pay for high-grade engineer. Location Pennsylvania. 721.

YOUNG ENGINEERS on power-plant operation and testing. Apply by letter. Location New Jersey. 722.

MACHINERY SALESMAN, salary and commission, with guarantee of $150 per month. Experienced in boiler and power-plant work. Location New York. 723.

MECHANICAL ENGINEER, with several years mechanical experience, for investigating mechanical operations and equipment and developing new apparatus in connection with operations of large industrial concern. High-grade man desired. In first letter state age, experience and training. Location New Jersey. 724.

COMBUSTION ENGINEER experienced in hand and stoker firing of bituminous coal, for studying boiler efficiency and other combustion problems. High grade man desired. Location New Jersey. 725.

DRAFTSMEN. For large rubber concern in Ohio, number of competent draftsmen on machinery layouts, piping and electric wiring. Also two tracers and a checker. Location Ohio. 727.

PRODUCTION AND PLANT EFFICIENCY WORK. Technical graduates. Preferably two or three years' experience. Must be capable, wide-awake and want to make good. Well established company. Location Indiana. Unusual opportunity for several men of ability to work into organization. 728.

MECHANICAL DRAFTSMAN, with about six years experience in detailing machinery. Location New Jersey. 729.

MECHANICAL ENGINEER who would be interested in partnership in established business dealing largely in apparatus pertaining to economical production of steam, as recording instruments, steam meters, water meters, calorimeters for fuels and gases, etc. Headquarters New York. 736.

EDITORIAL ASSISTANT for technical paper. Location New York. Salary $30. 738.

YOUNG ENGINEER as salesman, for mechanical apparatus, forgings, castings, etc. Salary $25-$30. Location New York. 740.

ENGINEER for American plant in Hayti, to take charge of engines, boilers and pumps. Should be familiar with d-c. installation for lighting plant. Salary $150 to $175 per month. Will pay traveling expenses, board allowance, and after six months service entitled to return expenses. 742.

ASSISTANT ENGINEERS, familiar with power-station and factory-construction work. Location Connecticut. 743.

PRACTICAL MANUFACTURING EXECUTIVE, accustomed to supervising quantity production on modern basis, preferably of machine parts and stampings, and with some technical and construction experience; man from 30 to 35 years of age. Willing to join a large organization at salary of about $2000, as utility man and candidate for future position of more importance as opening arises. Location East. 746.

DRAFTSMAN familiar with thresher, gas and steam tractors. Give experience, age and salary desired. Location Ohio. 749.

MEN AVAILABLE

Only members of the Society are listed in the published notices in this section. Copy for notices should be in hand by the 15th of the month, and the form of the notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

MECHANICAL ENGINEER, technically educated, twenty years experience in shop and drawing office, railroad and general contract engineering. Desires to make a change. Location immaterial. At present employed. Salary $2400. A-1

MECHANICAL ENGINEER. Twenty years experience in practical management of power-plant equipment; 15 years as executive. Broad experience with steam, electrical, hydraulic and refrigerating machinery. At present chief engineer and superintendent of maintenance for large industrial plant. Desires to connect with large concern wanting to improve conditions. Minimum salary $2500. A-2

ASSISTANT TO EXECUTIVE or EXPERIMENTAL ENGINEER. Stevens 1911 graduate; married; age 28. Possesses energy, initiative, self-confidence. Last three years in Middle-West in natural-gas transportation and measurement, including successful experimental work. Temporary engagement with U. S. Bureau of Mines about to end. Desires position with large industrial or engineering concern offering permanency and future. Initial salary not primary consideration. A-3

ASSISTANT MECHANICAL ENGINEER. Jun. Am. Soc. M. E., Cornell M.E. graduate; age 28. Has had considerable drafting-room experience, and at present employed with large coal-mining company but desires to make change. For last three years experience chiefly confined to power plants and testing power-plant equipment. Location preferred, New York. A-4

RAILWAY MECHANICAL ENGINEER, age 37, technical education, seventeen years experience, as railway machinist, draftsman, chief draftsman and mechanical engineer. Desires position with railway company, railway-supply house or industrial plant, with greater responsibility and opportunity. Location immaterial. At present employed. Salary $2100. A-5

FUEL TESTING ENGINEER. Graduate; age 34. Seven and a half years experience in scientific testing of coal in industrial plants, for large coal company in Middle West. Desires position as combustion engineer for large user of coal. At present employed. A-6

SALES ENGINEER. Graduate. Experienced in scientific testing and selling of coal. Desires position as sales manager for coal-operating company. At present employed. A-7

CHIEF DRAFTSMAN or ASSISTANT SUPERINTENDENT. Technical graduate; age 36. Thirteen years experience. Familiar with manufacture of water-gas, soaps, leather belting, coal-mining and handling machinery. At present employed. Salary $1800 to $2400. A-8

DRAFTSMAN. Age 25. Three years technical training. Three years shop practice. Two years experience on design of appliances for installation of steam, gas, air, water and oil. Familiar with production work. Desires position with future. A-9

EXECUTIVE ENGINEER. Age 33. Ten years in responsible charge of important work; estimating, designing and constructing systems for the technical handling of all kinds of material in course of manufacture; six years in present position. A-10

ENGINEER OF TOOLS AND METHODS, SUPERVISOR OF PRODUCTION, CHIEF DRAFTSMAN or ASSISTANT SUPERINTENDENT. Member wishes to correspond with well-established concern. Wide experience in several of the largest and best-known concerns in this country and Europe, manufacturing small and medium-size accurate interchangeable parts, such as adding machines, typewriters, cash registers, watches and electrical mechanism. Natural mechanical and executive ability, together with broad experience in developing production of above work. Location, Chicago or vicinity preferred. A-11

WORKS MANAGER, SUPERINTENDENT or PLANT ENGINEER. Graduate mechanical engineer. Good organizer and executive. Extensive experience in the management of mechanical departments of railroad, coal-mining and industrial corporations; design, construction and management of large steam and electric power plants; design, construction, and maintenance of industrial plant buildings; reinforced concrete; design, installation, and maintenance of heavy and light steam, hydraulic and electrically driven machinery; management of shop, yard, office and drafting room forces. A-12

MECHANICAL ENGINEER. Technical graduate; age 26; two years experience operating and maintaining large power plant for industrial company and two years in efficiency, time-study and production end of same concern. Desires position with responsible future. Location New Jersey or Pennsylvania. A-13

MANAGER, WORKS MANAGER, or GENERAL SUPERINTENDENT. Technical education, M.E. Good executive abilities. Over 25 years abroad and varied experience in heavy, medium (electrical and metal working), small and interchangeable work; thorough in modern methods, and practical along all departments, machine shop, smith, foundry, plating, japanning, wood-working, etc. Thoroughly capable in shop organization and supervision of manufacturing; qualified in office, buying, sales, cost, piece, bonus or premium methods. A-14

DESIGNING or CONSTRUCTING ENGINEER desires to change. Wide experience in power- and industrial-plant, pumping-station design and construction. Salary $4200 or salary and fees. A-15

ASSISTANT SUPERINTENDENT. Graduate M.E. Capable machinist. Familiar with scientific shop management and can produce results in handling men. A-16

MACHINE DESIGNER. Technical graduate. Seventeen years experience on centrifugal pumps, steam engines, steam pumps, elevating and conveying machinery, ball-bearing manufacture, roofing paper and paper machinery, factory equipment and maintenance. Now holding position as chief draftsman and engineer. Desires responsible position. Location Boston or vicinity preferred. A-17

MECHANICAL ENGINEER at present in executive position with large construction company, seeks connection with industrial or contracting concern near New York. Proven ability to handle general problems as well as details of technical or business nature. Familiarity with costs and prices qualify for position of responsibility. A-18

MECHANICAL ENGINEER. American; technical graduate 1902. Thoroughly familiar with manufacture and sale of high-grade engineering specialties. Factory experience in pattern, foundry, machine shop and drafting departments. Theoretical and practical experience of 16 years. A-19

HEATING AND VENTILATING ENGINEER. Age 35, married. Graduate M.E. from prominent university. Six years experience in estimating and designing heating and ventilating systems, covering wide range of installations. Desires permanent and responsible position. Available about January 1. A-20

CHIEF DRAFTSMAN, MECHANICAL ENGINEER, COMPETENT EXECUTIVE, systematic and reliable; has originality and initiative; 15 years experience. A-21

MECHANICAL ENGINEER. Jun.Am.Soc.M.E. Cornell graduate; age 28. Six years experience on power plant testing and supervision, and some selling experience. At present employed. Location preferred, New York or vicinity. A-22

TECHNICAL ENGINEERING EXECUTIVE. Age 34, married. Nine years practical experience as production engineer and executive. Good organizer, hustler, keen observer, energetic; has originality and initiative; up-to-date in costs, efficiency engineering, factory management, etc. Desires change with greater opportunities. Location immaterial, if healthy. A-23

MECHANICAL ENGINEER, MAINTENANCE ENGINEER, MASTER MECHANIC. Graduate; age 33; married. Thirteen years experience in Germany, England and United States, steam and electrical plants, heating and ventilating, factory layout and equipment, labor-saving devices, construction and maintenance, systematic. Desires permanent responsible post. A-24

WORKS MANAGER. Twenty years experience in manufacturing typewriters, firearms, automobiles and power-house equipment. A-25

EXPERIENCED ENGINEER on dies, jigs, fixtures and special machines for metal-working purposes is open for position. Chicago district preferred. A-26

MECHANICAL ENGINEER. Graduate from prominent university. Valuable and wide experience in shop, office and field both as subordinate and executive; five years in sales and consulting capacity with present connection. Desires responsible position in executive offices of good, live, progressive concern. A-27

MECHANICAL ENGINEER, ASSISTANT TO WORKS MANAGER or SUPERINTENDENT. Assoc-Mem.Am.Soc.M.E. Graduate Cornell University; age 31. Eight years experience in shop and drafting room. Accustomed to dealing with men. Aggressive, and eager for responsibility. Wishes larger opportunity than present position affords. Best references. Eastern states preferred. A-28

MECHANICAL ENGINEER. Age 33. Specialties: shop- and power-plant construction, including installation of buildings, foundations, machinery and electrical apparatus; also crude-oil burning, valuation engineering and railroad mechanical engineering. A-29

TECHNICAL GRADUATE, eight years experience heat-treating, forging, testing and metallographic study of steel and brass. A-30

WORKS MANAGER or GENERAL SUPERINTENDENT. Age 40. High grade man open for new position. Able executive, good mechanic, with thorough practical knowledge of labor, production methods, planning and conditions necessary for economical factory management. Excellent past record. A-31

SUPERINTENDENT, SALES ENGINEER or ASSISTANT TO EXECUTIVE. Assoc-Mem.Am.Soc.M.E. Age 35. Fifteen years experience in manufacture and sale of electrical machinery. Desires change. Available upon 30 days notice. A-32

MECHANICAL ENGINEER or ASSISTANT SUPERINTENDENT. Assoc.-Mem.Am.Soc.M.E. Technical training, shop experience, 10 years of design and experimental work on gas, oil engines and air compressors. Able to ferret out and correct vexing problems about a shop, and estimate costs. Middle West preferred. A-33

EXECUTIVE, MANAGER IN ORGANIZATION WORK. Fellow A.I.E.E., Member of The Franklin Institute. Broad business experience and technical training; familiar with shop practice, cost, productive systems and sales engineering; operation of power wagons; also design, construction and purchase. A-34

ASSISTANT TO SALES MANAGER. Assoc-Mem.Am.Soc.M.E. Graduate M. E. Age 34, married. Desires position as assistant to executive or sales manager or as advertising manager. Several years advertising and editorial experience in power plant, mining and contracting fields. Very little actual selling experience. Good correspondent. Tactful. Accustomed to responsibility. East preferred. At present employed. A-35

MECHANICAL ENGINEER, graduating from well-known university in February, desires position with future. Any location. References and experience given. A-36

INDUSTRIAL ENGINEER. Technical graduate, Junior Member, age 29. Three years' experience as designing draftsman of industrial plants, transmission machinery and labor-saving devices. Past two years industrial engineer, experienced on time-study work, scheduling, modern cost system, accounting, etc. Ability to increase production and decrease costs, standardize equipment and methods of manufacture. A-37

INDUSTRIAL ENGINEER. Associate-Member. Pulp and paper mills (specialty newsprint). Fourteen years' experience in design, supervising, complete layouts, purchasing, construction, operating and maintenance. Executive capacity. A-38

GAS ENGINE ENGINEER. Technical man. Eight years' experience in design, development, and production of stationary engines and aeronautical motors. Desires position requiring unusual executive ability and judgment. A-39

ENGINEERING EXECUTIVE. Graduate M.E.; age 36; married. Good executive and organizer. General business training as executive in purchasing, selling and manufacturing departments, having filled positions of purchasing agent, branch sales manager, and plant manager, the latter for several years. Thoroughly familiar with modern manufacturing methods, efficiency systems and cost accounting. Prefers position which would ultimately lead to an officer and part owner or partner in the business. A-40

YOUNG ENGINEER, TECHNICAL GRADUATE, with two years' good engineering experience desires position as mechanical engineer or in engineering sales. At present employed. A-41.

MASTER MECHANIC OR CHIEF DRAFTSMAN. Ten years' experience in the manufacture of interchangeable parts. Thoroughly experienced in design of jigs, tools, fixtures and special automatic machinery for manufacturing parts on interchangeable basis to close limits. Location preferred in (or in vicinity of) New York or Newark, N. J. A-42.

ASSISTANT TO EXECUTIVE OR CONSULTING ENGINEER. Associate member, technical graduate, age 28. Ten years' practical experience, embracing machine and plate shops, drafting, inspecting, estimating, production and supervision. At present assistant superintendent of manufacturing plant employing 350. Location in vicinity of New York preferred. Salary $2000. A-43.

WORKS MANAGER, CHIEF ENGINEER OR GENERAL SUPERINTENDENT. American, 44 years of age, with 18 years' practical executive experience in the positions of chief draftsman, general superintendent and works manager on light and medium-heavy interchangeable parts as used on typewriters, moving-picture machines, gasoline and electric auto trucks, water meters, linotype machines, automatic machinery and machine tools, etc. Desires to make a change on or about May or June, 1917. For the past five years and at present successfully engaged as general superintendent with a manufacturing concern making machine tools. Desires to locate within a radius of 100 miles from New York City. A-1 systematizer, organizer and production man, with excellent executive ability, and can produce results. Best of references from past and present employers as to integrity, honesty and ability. Salary, $4000 per annum. A-44.

ENGINEER. Eighteen years' experience, covering shop management, sales and development work, principally in connection with pneumatic appliances. Seeks executive position. A-45.

INDUSTRIAL PLANT EXECUTIVE. General experience as engineer, purchasing agent, and cost accountant in large industrial plant. Available on short notice. Present location New York. A-46

MANAGER. Mechanical Engineer, 35, technical graduate. Eleven years' thorough manufacturing experience in both office and shop, including sales and organizing cost, production, bonus and piece-rate departments, principally on light machinery, small tools and interchangeable parts. Can handle men successfully, lower costs and maintain quality. Salary $5000. A-47.

ENGINEER. Specialist and recognized expert in public-utility and industrial power work offers full or part time services to firm or corporation interested in such properties. Broad experience in the design, construction and operation of power systems and in making investigations, valuations and reports covering going and projected enterprises. A-48.

PRESENTATION OF THE JOHN FRITZ MEDAL

THE John Fritz Medal was presented to Prof. Elihu Thomson, eminent electrical engineer, for "achievements in electrical inventions, in electrical engineering, and in industrial development, and in scientific research," in the Central Hall of the Massachusetts Institute of Technology, on the evening of Friday, December 8, 1916.

The meeting was called to order by Prof. Albert Sauveur, Chairman of the John Fritz Medal Board of Award, and the program of the evening included addresses by John J. Carty, Chairman of the Presentation Committee of the John Fritz Medal Board of Award: E. W. Rice, Jr., President of the General Electric Company, and Dr. Richard C. Maclaurin, President of Massachusetts Institute of Technology. The presentation was made by Dr. Charles Warren Hunt, Past-Chairman of the Board of Award, and the ceremonies concluded with a response by Dr. Thomson.

Mr. Carty reviewed the history of the John Fritz Medal, described the manner of awarding it and enumerated the distinguished men to whom this award has already been made.

Mr. Rice, a life-long friend of Professor Thomson, and with an intimate knowledge of his work, delivered a very interesting and forceful address. As emphasizing the magnitude of Professor Thomson's inventive work, Mr. Rice said:

"It would be impossible in the brief time at our disposal to adequately describe the achievements of our medalist in these various fields as it would involve describing the life work of one of the world's most prolific and industrious inventors and scientists. The impossibility of performing such a task can perhaps best be indicated by the statement that in the field of electrical inventions alone Profressor Thomson has been awarded something over 550 U. S. Patents, and in other fields, notably mechanical work, about 150 patents: that he has made contributions to the world's scientific and technical literature set forth in several hundred articles describing not only his own discoveries and inventions but making remarkably interesting contributions to scientific speculation and thought."

ELIHU THOMSON

The speaker also gave testimony to the profundity of Professor Thomson's scientific knowledge:

"As a close observer of Professor Thomson's activities for over 36 years, I may be able to say something of interest as to his method of work. A skilled workman, he is always able to himself do the work which he asks others to perform. He prefers to make his own drawings, freehand sketches, to which he adds dimensions and a short written description. He selects his own materials, supervises the work, quickly makes such modifications as may be needed during its progress and stands constantly ready to give just the advice necessary to help over difficult places and turn failure into success. His inventions are the result of such profound and accurate knowledge and developed with such skill that they almost invariably work on the first trial in accordance with expectation. One of the most extraordinary things about his experimental work is its low cost. I am sure that if a prize were to be given for the inventor or engineer who could make a dollar go the furthest and produce the greatest results that Professor Thomson would have no worthy competitor in this or any other country. And I say this feelingly because I have had some experience with other inventors. He seems to possess an almost intuitive insight into Nature and her ways, probably because of the quickness and accuracy of his perception combined with the most remarkable depth and range of scientific knowledge, all helped by a marvellously retentive memory. In fact Professor Thomson perhaps more than any other inventor since the days of Henry or Faraday, combines in his person profound and accurate scientific knowledge with extraordinary technical skill."

Dr. Maclaurin characterized Dr. Thomson as an educational force of great potency and a man whose merits should, in the very highest interests of education, be widely appreciated and acclaimed. He gave an interesting conception of the mentality of such a man as Dr. Thomson:

"It has sometimes seemed to me that not the least significant fact in regard to Professor Thomson's work is the fact, known to those who have had the pleasure of seeing him in his home, that his laboratory is built right into the home and is an integral part of it. Probably thoughts on scientific problems are never wholly absent from his mind, although he may be consciously thinking of quite other matters. It can hardly be necessary to say that a man who has achieved what Thomson has done must be more than an unselfish, generous, well-trained, well-rounded, well-balanced man of science. Above all and pervading all must be imagination, not necessarily the imagination of a poet, but something akin to that in quality and in power, and it is of course mainly because Thomson is a man of imagination in the highest sense that he has achieved so much success and earned so much respect, not only in this country but throughout the scientific world. He has been literally showered with honors and it must be almost a unique thing to obtain two great national medals within almost a week, one from the Royal Society of London, and the other the great honor of the Fritz Medal that is now to be awarded. I heartily congratulate the Board of Awards on having found a man worthy to be placed beside the greatest whose names have already given dictinction

to their selection like Graham Bell, Edison and Kelvin. Such a one undoubtedly is Elihu Thomson.

Past-Presidents Visiting China

Dr. John A. Brashear, Mr. Ambrose Swasey and Mr. John R. Freeman, all past-presidents of The American Society of Mechanical Engineers, sailed from Vancouver on December 20 on an extended tour of the Orient to inspect engineering work there and also to enable Dr. Brashear to learn more about the educational system in that part of the world.

The tour is the climax of probably one of the most notable birthdays in the career of Dr. Brashear. On Wednesday, November 22, Pittsburgh friends of the Doctor planned a great public reception to him, and two days later "Brashear Day" was observed in that city and all Pittsburgh was given the opportunity of contributing to a fund for purchasing and endowing the old Brashear home and workshop in Holt Street. Commenting on the tour, the *Pittsburgh Sun* said editorially:

IT IS NEVER TOO LATE

Dr. John A. Brashear—and the name is enough of an introduction—will arrive at the 76th milepost on his journey through life on November 24th. This represents at least 70 years of activity, of dreams, of ambitions, of hopes realized and of disappointments that were unavoidable; of elation at success and depression at failure; of happiness and of sorrow. But through them all the beloved doctor has not allowed the big things to crowd out of his life the little ones, and by so doing he has retained constant interest in the things that have been going on around him. He has remained young in mind and body, and today he is physically and mentally more vigorous than two-thirds of those who claim a corresponding number of years.

But the point of this is that on his birthday Dr. Brashear will leave for a tour of the Orient. He will study the educational problem as it is presented in the Philippines, Japan and China. Accompanying him will be two well-known men, one skilled in Oriental affairs and the other, like the doctor, a maker of astronomical instruments. The tour outlined is a comprehensive one and will give the travelers a broad view of the Orient, and the exceptional opportunities for investigation that will be afforded them will be ample.

The action of Dr. Brashear in undertaking this long journey, principally for pleasure, to be sure, but also for study, affords the average individual food for thought. It is never too late to undertake anything that promises to redound to the benefit of humanity, no matter in how small a degree. Some persons might be inclined to think that after one has passed the Biblical span he is justified in taking a rest. But not so with energetic and youthful Dr. Brashear. He wants to know about the educational system of the Orient. What he sees there might result in an improvement in this country, and so he joins two congenial companions and starts. He will return even a better man than when he left because his mind will have become enriched by what he has seen and by the persons with whom he has talked and Pittsburgh will get the benefit. It is a wonderful thing to be able to carry 76 years as easily as does Dr. Brashear.

Mr. Swasey, in his characteristically painstaking manner, prepared in advance the complete itinerary of this tour, from the time of Dr. Brashear's leaving Pittsburgh on November 24 and his own departure from Cleveland on the same date, to the party's arrival back at San Francisco on April 2, 1917, after their journey to Yokohama, Kobe, Peking, Hankow, Nanking, Shanghai, and Hong Kong, and supplemented this with a map showing the route of the trip.

Mr. Freeman is accompanied by his two sons, John R. Freeman, Jr., a recent graduate in electrochemical engineering, and Hovey T. Freeman, a recent graduate in mechanical engineering from the Massachusetts Institute of Technology.

American Uniform Boiler Code Congress

The work of the Boiler Code Committee received marked impetus from the action of the American Uniform Boiler Code Congress held at Washington, D. C., on Monday and Tuesday, December 4 and 5, 1916. The Congress was a gathering of representatives of various states interested in a uniform boiler code, which was called by the Industrial Commission of the State of Ohio, the body having charge of boiler regulation in that State. Representatives were sent by the Governors of 28 states, which, with the representatives of boiler-making, boiler insurance and other interests, numbered some 70-odd attendants. Hon. J. C. Callery, Chief Deputy, Division of Boiler Inspection, State of Ohio, presided.

The program began with an address by Hon. T. J. Duffy, member of the Industrial Commission of Ohio, who brought out forcibly the obligation of the Government to guard its citizens against the avoidable hazards of industry, pre-eminent of which is the use of magazines of energy like steam boilers, and the desirability of uniformity in the regulations adopted to this end.

He was followed by Dr. F. R. Hutton, Mem.Am.Soc.M.E., professor emeritus at Columbia University and vice-president of the American Museum of Safety, whose topic was Civilization and Government Are Based on Human Life; Protection of Life Is a Government's First Duty. Professor Hutton spoke of the importance to the mechanical engineer of safety considerations, and he showed how the mechanical engineer is best fitted to make provisions for the safety of the public. He alone can pass on the advantages or disadvantages of special constructions and his recommendations may safely be trusted. The mechanical engineer has become a leader whom we cannot afford to disregard, and safety standards proposed by him may be accepted as authentic.

The speaker stood "for the proposition that an industrial accident (and a boiler rupture or failure is such an accident) is an economic loss and an indefensible blunder from which the community has a right to be defended, and by ordinance or legislation." He showed that a boiler accident entails a loss in five different directions and explained that these are all capable of being expressed in dollars, aside from the bereavement in fatalities and the suffering inseparable from such disasters. From this he showed that the safeguarding of human life against boiler accident by legislation and ordinance is in line with progress and development, and he showed that scientific knowledge has advanced to a point where safety can be attained and that there remains only the question of proper legislative channels. Now the legislative and executive arms of the government should take hold with a strong hand to correct and remove the fatal conditions. It has been made clear that the facts and laws of applied science in respect to stresses and safety in pressure resisting vessels have been codified and recorded, and a way pointed out whereby uniformity of standard in the various states of the Union may be secured.

The second session opened with an address from Hon. P. J. McBride, Commissioner of Labor of Kansas, on The Protection of Labor as a Human Necessity and Its Effect on Business Economy. Mr. McBride emphasized the importance

of greater attention to the safety of boilers and their appurtenances as an element in the industrial development of the nation.

Next, Prof. L. P. Breckenridge, Mem.Am.Soc.M.E., of Sheffield Scientific School, Yale University, spoke interestingly on Civil Service in the Department of Boiler Inspection. He pointed out the importance of absolutely divorcing this department from politics, and showed how the civil service could best handle the examinations and appointments of the boiler inspectors. He referred to the A.S.M.E. Boiler Code as a set of boiler-construction rules that should be generally applicable in all states, and he made a plea for uniformity throughout. He produced statistics showing that in 1914 there were in the whole German Empire 8 boiler explosions—the same number that Mr. McBride had just admitted having in the State of Kansas in 10 months. In the United States in the same year there were 575 explosions; in Germany the loss of life was 2, in the United States 30; in Germany the personal injuries 7, in the United States 176.

S. F. Jeter, Mem.Am.Soc.M.E., accredited representative of the State of Connecticut, read a letter from Governor Holcomb expressing his belief in the desirability of uniformity of laws covering similar commodities in different states and advising of his interest in the movement embraced in the Boiler Code Congress.

J. C. McCabe, Mem.Am.Soc.M.E., chief inspector of the City of Detroit, Mich., spoke on Realizations of a Uniform Boiler Code. He first showed clearly the hardship that is now imposed on both builders and purchasers of boilers by the numerous different codes and pointed out how necessary is this movement toward uniformity in construction codes. Mr. McCabe made a strong plea for a single uniform code, urged all states that have different codes to coöperate with the various states that have adopted, or are about to adopt, the A.S.M.E. Code, and announced that the State of Michigan would adopt that code this winter.

Mr. Callery announced that his State, which has in effect been working under two different boiler codes, is about to adopt the A.S.M.E. Boiler Code as its standard.

Hon. Victor T. Noonan, safety director of the Industrial Commission of Ohio, who was slated at the Tuesday morning session for an address on Some Interesting Aspects of Accident Prevention, was unable to be present and the time was occupied in general discussion. Thomas C. Eipper, deputy commissioiner of the Department of Labor of the State of New York and connected with the Bureau of Industrial Code, said that the bureau had the A.S.M.E. Code under favorable consideration. The possibility of Federal supervision of boilers transported from one state to another was suggested.

Henry Hess, chairman of the Standardization Committee of the A.S.M.E. and a member of the governing Council of that society, read a paper telling of the genesis and history of the A.S.M.E. Boiler Code. In Mr. Hess' address, the announcement was made that in the future, every state and municipality that adopts the A.S.M.E. Boiler Code shall be entitled to have a representative present at all meetings of the Boiler Code Committee.

Hon. Edward N. Hurley, chairman of the Federal Trade Commission, read a paper on Standardization as the Foreword of Business Efficiency. John A. Stevens, chairman of the Boiler-Code Committee of the A.S.M.E., told of the manner of production of the A.S.M.E. Code and the care which had been taken to have all interested parties have a voice in its formation.

The following resolution was unanimously adopted, only those having credentials from state or municipal executives being allowed to vote:

Whereas, Industry in every line of endeavor is very closely associated with steam as a motive power and the use of steam boilers; and

Whereas, Obtainable statstics covering a period of years show that in the United States there is annually a loss of from 400 to 500 lives and the disablement of from 1,000 to 3,000 people due to explosions of steam boilers; and

Whereas, The Government has recognized in the effort it has put forth in the safety movement that its first duty is the protection and safety of human life; and

Whereas, The Federal Government where it has the jurisdiction has prescribed rules for the construction of steam boilers; therefore, be it

Resolved, That it is the sense of this congress that all states should exercise supervision over the manufacture and use of steam boilers and all pressure vessels.

Mrs. Helen Adelaide Goldsmith (appointed by Mayor Gearon as delegate from Chicago) read an address commending the work of the A.S.M.E. and urging the yielding of the more sedentary occupations to the women, while the men occupy themselves with the more active work of the world. William F. Keisel, Jr., Mem.Am.Soc.M.E., assistant mechanical engineer, Pennsylvania R. R., said that the railroads had interested themselves in the framing of the Code and were in favor of its adoption. Reports were heard from committees on legislation, boiler codes, interchangeability of inspectors, etc., and resolution of thanks to the Ohio Industrial Commission and to Thomas E. Durban, chairman of the American Uniform Boiler Law Society were adopted.

Sixty-Ninth Meeting of A. A. A. S.

THE American Association for the Advancement of Science and the national scientific societies which have arisen from it and retain affiliation with it, have been important factors in encouraging scientific research and diffusing general interests in its results. The Association is organized in 12 sections covering the field of pure and applied sciences. Section D is the Engineering Section, of which Prof. A. H. Blanchard, of Columbia University, is Secretary. Our Society is affiliated with the Association and is represented on its Council by Dr. D. S. Jacobus and Mr. Wm. B. Jackson.

The Association held its sixty-ninth meeting in New York City from December 26 to 30, 1916. The membership of the Association at present numbers about 11,000, and it is believed that this meeting was the largest and most important gathering of scientific men hitherto held in this country or elsewhere. All the affiliated societies joined with the Association in this convention, and this year there were, including the sections of the Association, more than 50 separate national bodies meeting together.

Section D, Engineering, held a session in the Engineering Societies Building on the invitation of The American Society of Civil Engineers, The American Institute of Electrical Engineers, The American Institute of Mining Engineers and The American Society of Mechanical Engineers. At this meeting Dr. Bion J. Arnold gave the address of the retiring chairman and there were addresses by representatives of the national engineering societies, including President Hollis of our Society, followed by a reception to engineers and their associates.

Section D also held a joint session in the Assembly Hall of the Automobile Club of America with the National Highways Association, The Automobile Club of America, and the National Automobile Chamber of Commerce.

ENGINEERING SURVEY

A Review of Engineering Publications in All Languages. All the leading periodicals of the engineering world, embracing over 1000 different publications, are received at the Library. These are systematically examined for review each month in the Survey.

SUBJECTS OF ABSTRACTS

In this issue. Section Aeronautics. we publish a list given out by Lieut-Col. Geo. O. Squier. Aviation Service. War Department. U. S. A.. embodying some of the problems connected with the development of military aviation and aerostation. This list is well worth attention. both because of its source and the evident carefulness with which it has been thought out.

The publication of this list is the beginning of an effort on the part of The Journal to cover the development of engineering research in the process of evolution. as distinct from abstracts of results previously published in other periodicals.

THIS MONTH'S ARTICLES

H. L. Horning compares truck and tractor engines. and discusses the characteristic curves of such engines, as well as the important but comparatively neglected subjects of water pumps and engine cooling.

Methods of comparing automobile performance are discussed by W. Fishleigh. who. among other things, presents a simple formula for the "automobile performance factor," which. the writer contends. affords a valuable comparison for cars.

In a paper before the Philadelphia Section of the S. A. E.. John Younger. Mem.Am.Soc.M.E.. presents the theory of retardation as applied to motor cars. In the discussion of this paper, the speaker made an important statement. viz., that the time is coming when local authorities will have to submit brakes to a regular system of inspection as a means of insuring the safety of travel on public roads.

In the Section Engineering Materials is reported a paper on testing steel by alternating stresses. the author using a method substantially different from that of Bauschinger. It appears to be possible to find the stress which a given sample of steel is capable of sustaining for an unlimited number of reversals without damage; this can be done by "static" tests of the kind described. which have a further merit of quickness as compared with endurance tests carried to destruction.

In the same section will be found another paper on steel. this time on the annealing of carbon steels as affected by small changes of temperature and by magnetic fluxes acting separately or simultaneously. Among other things. the writer describes an electromagnetic method whereby the critical point of a piece of steel under heat treatment can be determined directly and accurately. This method. especially in the case of low-carbon steel. proved to be of higher sensitiveness than the thermoelectric method.

Modern methods of heat treatment as applied at an American plant are described in an abstract taken from *The Iron Trade Review*.

Data of tests on the tensile strength of asbestos rope when exposed to fire have been obtained experimentally in the mechanical laboratory of the Tomsk Institute of Technology. in Siberia. Russia. They show that on the whole. if used as life lines at fires. asbestos ropes present no material advantage as compared with ordinary hemp rope.

Some minute reactions in the combustion of wood are described by James Scott, whose investigations of similar reactions in the case of rusting of iron and paints on metal have been reported in previous issues.

That ignition of explosive gas mixtures by electric sparks is essentially a phenomenon of ionization. and does not depend exclusively on either temperature or voltage in the spark gap. is the contention of J. B. Morgan.

From *Power* is briefly abstracted the description of a new internal-combustion engine. Its cycle diagram is reproduced and explained.

In the section Mechanics will be found a brief reference to an article by Prof. A. Stodola on the critical speed of shafts. A more complete abstract of the same article will be given in an early issue.

Safety devices for preventing explosions in gas-firing installations on steam boilers are described from data published in a German periodical.

Aeronautics

SCIENTIFIC RESEARCH FOR NATIONAL DEFENSE AS ILLUSTRATED BY THE PROBLEMS OF AERONAUTICS, Lieut-Col. Geo. O. Squier

The following are some of the present problems connected with the development of Military Aviation and Aerostation.

I AERODYNAMICS

a Continue the development of the mathematical theory to explain the phenomena recorded in the aerodynamical laboratories, and to forecast further results.

b Obtain solutions for the speed and direction of flow of air about geometric and aerotechnic forms, and develop experimental means to visualize or map the speed and direction of flow.

c Map the currents of the upper atmosphere which may be of most use in aerial navigation, and evolve simple practical rules for the guidance of pilots.

d Give fuller explanation of the phenomena of soaring, i.e., aeroplaning indefinitely without motive power.

e Develop equations and laws of comparison by which the behavior of large aircraft may be more accurately foretold from tests of models. Apply further the principle of dynamical similarity.

f Investigate more direct and effective methods of securing a lift or thrust in the air from the consumption of fuel.

g Complete theory of the air screw.

II ENGINE PROBLEMS REQUIRING RESEARCH

a Fuel. Possibly the most far-reaching problem is fuel. A fuel that will carry more power into an engine per unit volume will be a direct gain.

Attempts have been made to combine alcohol, gasoline, acetylene, picric acid, ether, and other hydrocarbons with the above object in view. Questionable results have followed. There has been an increase of power, but nothing so far commercially or practically useful.

This question must be studied with the greatest of care and from a truly research standpoint.

b Solid Fuel. Solid fuels that can be converted into liquid in small quantities just prior to use, are desirable for military aviation. In case of accident from shot or shock, leakage of liquid fuel is a danger. Solid fuel could be carried in quantity with less danger.

c Engine Cooling. The problem of radiation is important. If some substance could be found that would circulate through the cooling system, at higher temperatures than water, it is probable that greater engine efficiencies would result. Oils, salt waters and other materials have been tried with indifferent success.

d Liquid-Fuel Pipes. Tubing that will resist vibration (causing rupture) is desired. An oil- and gasoline-proof rubber tubing is reported as used in Europe. This development is highly important, not only for tubing, but for containers in which to carry liquid fuel. Some sort of fabric-and-rubber tank that would really resist the action of gasoline, would be of highest benefit.

A difficulty lies in the fact that the tanks are large (say 20 to 100 gal. capacity). The structural problems would be serious. The tanks now used are large and of metal. Vibration causes much difficulty and leakage.

e Metal Coating. The protecting of the metal parts of an aeroplane, especially the fittings and cables, is a serious problem. A material is desired that would really prevent dangerous corrosion. Nickel plating over copper is very good, but will not suffice. Rust strikes through very rapidly. Baked enamel is the best coating. It is impossible to apply in many cases.

f Sound. The question of eliminating the noises involved in the operation of aircraft is one of importance. The peculiar note of the propeller of a Zeppelin can be heard for several miles, and is usually the first warning of its approach at night.

III MISCELLANEOUS

a Physiological. Study the physiological and psychological effects of low-density air at high altitudes on the performance of pilots.

b Transparent Wing Covering for Aeroplanes. A wing covering which would answer the following general requirements would be of great value to military aviation:

Weight not more than 5 oz. per sq. yd. It should present reasonably great resistance to flame. It should be reasonably proof against action of salt water, moist air, extreme dryness, and quick temperature changes. It should not stretch in any direction. Its ability to retain original form as placed on the aeroplane is very important. It should have tensile strength of at least 75 lb. per in. width in any direction. Its tendency to tear and split because of tack holes through it, or because of bullet holes, should be as small as possible.

c Development of Light Alloys for Aeroplane Construction. Pure aluminum or aluminum alloys. It is believed that a great deal can be done in this direction. So far no alloy has been developed, except possibly in Germany, which can compare with average Alaskan spruce in its "specific tenacity."

d The Structure of Gusts. It is believed that this is of sufficient importance to aviation to warrant considerable expense in its study.

Painstaking investigation of the character of eddy formations caused when wind strikes trees, hollows, cliffs, etc., and the character of disturbances created by canyons, swamps, deserts, etc., would be of great value to aviators.

This can be done not only by smoke and toy-balloon work in the vicinity of obstructions such as the above, but also by photographic work in wind channels.

A set of simple rules laying down just what the aviator may expect on one side or another of canyons, cities, trees, lakes and swamps, would be very helpful in aviation.

e Radio-Apparatus for Aircraft. The subject of radio-intercommunication between aircraft in flight, and between aircraft and the earth, requires for its solution the highest possible efficiency and reliability combined with minimum weight.

A present tendency is to entirely separate the power plant from the main engine of an aircraft. The generator body in this case has a stream-line figure, and a separate small air screw is provided. Among other methods the oscillion is being tried as the actual source of continuous electromagnetic waves.

f Bullet-Proof Gasoline Tanks. Development of a material with which to line or construct tanks to contain the gasoline in an aeroplane in which a bullet hole will quickly close, entirely or partly at least. This would enable many a flier to beat back to his own lines after having been fired upon.

g Development of a Fabric as Good as, or Better than, Irish Linen, for the covering of aeroplanes. There has not

been manufactured in this country a fabric suitable for use in covering aeroplanes.

The fabric should answer all requirements laid down under Transparent Wing Covering, and be, in addition, such as to shrink the proper amount without harm when cellulose solution is applied.

It is possible that long-fiber cotton might be developed that would answer the purpose.

We must become independent in all lines affecting our military aviation. To-day we depend entirely upon Ireland and England for our linen, and the supply is becoming very low in this country.

h Aviator's Clothing. Much is still to be done in devising non-inflammable and protective clothing for aviators. This question is intimately connected with personal armor and safety in case of fall.

i Ground-Speed Indicator. An instrument which would measure the actual speed of an aircraft over the ground would be useful in the operation of military machines.

IV PHYSICS OF THE AIR

a High Frequency. At present we have no evidence of vibrations in the air much greater than 40.000 to 60,000 cycles per sec., but there is no reason to deny the possibility of vibrations of 100,000 to 200,000 or even a million cycles per sec. in the ordinary air we breathe. If these vibrations exist, may not they have an important function to perform in nature? The reason, of course, we do not perceive them, if present, is because they are above the upper limit of the human ear, and also do not directly affect any of our other senses. Although, in general, viscosity would operate to rapidly damp out these high vibrations, yet the real nature of viscosity at extremely high frequencies is not sufficiently understood at present to be dogmatic about it. The present efforts of the master physicists in the study of the constitution of matter should, before long, make the securing of high-frequency data in air of importance.

Electromagnetic waves of these frequencies existed through all time unperceived until Hertz devised a "detector." At present the detector for high-frequency air vibrations is the manometric flame, and it would be of great importance to invent a detector for air vibrations which would indicate their presence or absence up to 500,000 or a million per sec. If we had such a detector and also means for producing such vibrations in air, it would be possible to provide a system of intercommunication, over short distances at least, based upon ultra-audible sound waves. We could, for instance, devise a noiseless foghorn as an aid to navigation.

b Elasticity. The elasticity of the air has been made to serve in a great variety of machines to perform useful work. The original dynamite gun of Zalinski utilized the elasticity of compressed air as the explosive for propelling the projectile.

The best condensers for radio-telegraphy employ air as the dielectric. Any breakdown automatically repairs itself and thus adds greatly to reliability.

The passenger automobile itself has been made possible by the development of the pneumatic tire.

c Friction. The magnitude of the friction of the air against the surface of bodies moving through it may absorb large amount of energy. The average velocity of shooting stars is 25 miles per sec., and varies from 10 to 30 miles a second. The earth's orbital velocity is about 19 miles a second. It is sometimes added and sometimes subtracted from the shooting star's velocity according to the way the body enters the atmosphere. The friction of the air at these velocities is so great as to volatilize metals.

A mass of one gram of air moving with this velocity, 25 miles per sec., has a kinetic energy of 8.0937×10^{12} ergs, which is sufficient to lift one ton of matter, 2000 lb., to a height of 298 ft. above the earth's surface. One gram is a small amount of matter to possess this potentiality. This enables us to comprehend, in part at any rate, the disastrous results of the cyclone, where houses and forests are bodily cut down as by a giant steel knife.

d Mass. A cubic foot of air at 0 deg. cent. and 76 cm. pressure weighs 0.08071 lb., according to Rayleigh. A room $18 \times 20 \times 10$ ft. contains 3600 cu. ft. The air in it, therefore, weighs 290.556 lb. In liquid or solid form this air could be removed from the room with difficulty by a strong man.

On this view it appears that we have been passing our lives on the bottom of a deep ocean of comparatively heavy fluid, and that only recently have we learned how to utilize the dynamic reaction of this fluid to construct machines for transportation freely in three dimensions in the interior of this ocean. Who among us is wise enough to foretell what these machines may yet accomplish?

Automobiles

Truck and Tractor Engines, H. L. Horning

Practically only four-cylinder engines are used in truck and tractor service. There are several important differences in the conditions under which truck and tractor engines operate. Trucks are stopped and started many times during the day and operate with considerable variation in speed. The tractor demands a steady though heavy output from the engine at approximately constant speed, the changes varying from half to full load or overload.

In the truck it is not essential to strain the dust in the carburetor or to pay particular attention to dust entering the breather, but in the tractor it is absolutely essential to see that every particle of dust is removed from the air as it enters the carburetor or breather, as carelessness in this respect results in worn rings, pistons, cylinders and bearings.

Truck engines have flywheels capable of storing an average or double energy of truck-engine flywheels in order to meet satisfactorily the sudden peak loads of service.

It should be borne in mind that a pleasure car will turn over 20,000,000 revolutions in traveling 10,000 miles; a truck engine 60,000,000 in traveling 14,000 miles, while during the period of six months a tractor engine will turn over 70,000,000 revolutions in plowing 600 acres and in doing some road and belt work.

Piston displacements of American truck engines have been found to conform to the formula

$$D = 200 + 40\ T$$

in which D is piston displacement in cubic inches and T nominal pay load in tons. An investigation of American truck engines indicates the ratio of bore to stroke as 1.3, therefore

$$D = 0.7854B^2 \times 1.3B \times N = 4.1\ B^3$$

$$B = \sqrt[3]{\frac{200 + 40\ T}{4.1}}$$

where B is bore of cylinder and N the number of cylinders, which is four.

Fig. 1 shows the characteristics of a well known truck engine. This diagram shows that at three speeds in the curve peaks there occur, first, maximum torque at 783 r.p.m.; second, maximum horsepower at 1150 r.p.m., and third, maximum economy at 1011 r.p.m.

It would be ideal if these speeds were identical and if the truck engine could operate at all times at the one best speed. This is impossible, if only because of the influence of each characteristic on the other.

The speed of the maximum torque is established by the combined influence of cylinder cooling, flame propagation, volumetric efficiency, carburetion, compression leakage, and mechanical losses. At the speed of maximum torque the influence of cylinder walls on cooling the charge is on the decline. Turbulence of the charge and flame propagation are on the increase. Volumetric efficiency is dropping, while carburetion is improving with speed.

The speed of maximum economy, which is always higher than that of maximum torque, is established by favorable car-

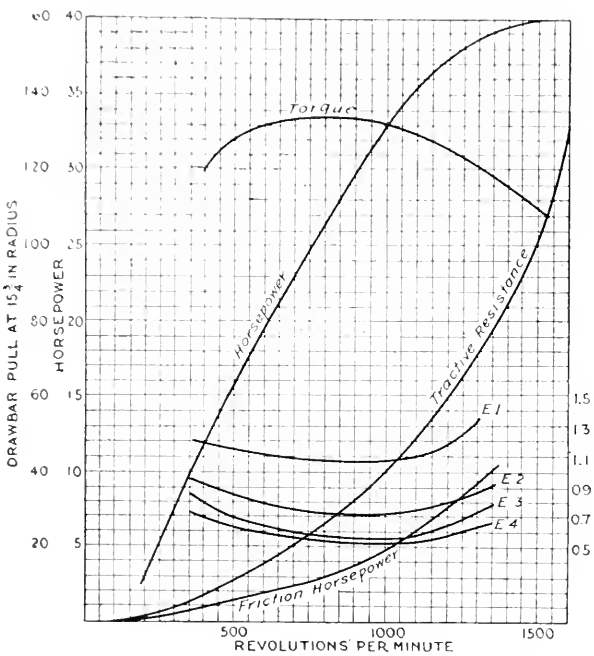


Fig. 1 Characteristics of Truck Engine

buretion, by the better atomizing of the nozzle, increased flame propagation resulting from increased turbulence, and the good, although decreasing, volumetric efficiency. The time element as affecting the radiation losses and the decrease in the unfavorable influence of water-jacket temperature on economy and torque, seem to combine for favorable theromodynamic conditions at the speed of maximum economy. Of all the influences affecting economy, carburetor setting has the greatest actual effects. Of all the influences favoring torque, engine design has the most effect.

The speed of maximum horsepower is increased favorably by violent turbulence, low cylinder-wall-cooling losses, and by the declining volumetric efficiency and rapidly rising friction losses.

From this the author proceeds to presentation and discussion of truck- and tractor-engine specifications. An interesting passage is that referring to the water pumps and engine cooling, which latter the writer calls the greatest problem in tractor engines. Little reliable information is available as to water circulation or radiator capacity. A well-known company is making capacity tests of different radiators and fan designs for tractor service and these will soon be available. A rough rule for water-pump capacity is

$$G = \frac{BHP}{V}$$

in which G represents gal. per min. water-pump discharge through outlet to water jacket, and V is a variable dependent on engine and radiator design. For an efficient design it is 1.5, and for a poor design, 3.5.

The efficient lubrication of truck and tractor engines is second in difficulty only to that of racing engines. Successful lubrication of heavy-duty engines requires that oil make a film between wearing surfaces and act as a conveyor of heat. As the duty of an engine increases, it is hard to tell which is the more important function. The writer throughly believes in the great benefit derived from a large quantity of oil carrying the heat through the lower part of the cylinders and crank case into the lower pan, where the design should be such as to permit dissipation of this collected heat. An abundant screen area for thoroughly straining the oil is of great importance in heavy-duty work.

The writer discusses in detail the application of tractor engines and gives formulae for the tractor drawbar pull and for the speed of tractor engines in terms of the bore. (*S. A. E. Bulletin*, vol. 11, no. 1, p. 1, October 1916, 19 pp., 3 figs., *et.A*)

Methods of Comparing Automobile Performance, Walter T. Fishleigh

The writer discusses the factors of automobile performance, and among other things states that automobile performance varies directly as S, the speed range in high gear in m.p.h., A, the average acceleration of car in ft. per sec. per sec. over the complete range of its operating speeds, E, the average fuel economy over the complete range of its operating speeds in miles per gal., and C, the riding comfort factor, which must be determined by each individual. The item C must be left to personal judgment, but the other items are each susceptible of scientific determination and measurement. The combination of these three factors $S\ A\ E$ constitutes what the author calls the "automobile performance factor," which affords a valuable comparison for cars.

The writer discusses the determination of the performance factors as well as performance or ability formulæ other than the one proposed by him, such as the old ability formula, Pr/WD, and the vehicle coefficients of Myers, Roebuck, and Thomas. The Thomas Sigma formula among other things includes the average gasoline consumption in m.p.h., while the Brush ability formula represents excess drawbar pull per lb. of weight, and in this way gives an accurate measure of hill-climbing ability and the approximate measure of acceleration.

In the discussion which followed, Cornelius T. Myers expressed the belief that the factor of speed range is open to argument because as the speed is decreased the difficulty in obtaining satisfactory operation is increased. If the speed range is an essential factor which should be considered in direct proportion, the ratio of the high to low speeds should certainly be used.

C. C. Hinkley cited in a modified form the formula brought out by the Franklin Company. Divide the product of displacement in cu. in. and the gear ratio by the weight times the wheel diameter. If it is desired to introduce other factors, set a standard test of from 5 to 50 m.p.h.

$$\text{Ability} = \frac{\text{Displacement} \times \text{Gear Ratio}}{\text{Weight} \times WD \times t}$$

The quicker the acceleration from 5 to 50 m.p.h., the greater the ability.

E. Planche suggests that in order to make the automobile performance formula more precise, it be given the form $S\ A\ E/L$, where L is the lowest speed that can be maintained on high gear with the car running smoothly. (*S. A. E. Bulletin,* vol. 11, no. 2, p. 123, November 1916, 22 pp., 5 figs. *p*)

RETARDATION, John Younger, Mem.Am.Soc.M.E.

Paper read before the Pennsylvania Section of the Society of Automobile Engineers, November 22, 1916. The author is chief engineer of the Truck Department of the Pierce-Arrow Motor Car Corporation, Buffalo, N. Y.

During the past two or three years emphasis has been laid on the accelerative ability of cars, while the significance of retardation has not gripped the people's imagination, even though it is of more vital importance. The automobile death rate increases in inverse proportion to the efficiency of the retardation curve.

Retardation can be studied under two heads: *A*, relative to the road, and *B*, relative to the forces acting on the car. The primary object of the former is to slow down and actually stop the car. The object of the second is to maintain the vehicle at a steady, safe speed, notwithstanding the forces such as effect of gravity in hill climbing that are tending toward acceleration.

TABLE 1. STOPPING TIMES AND DISTANCES OF CARS GOING AT VARIOUS SPEEDS UNDER COMPLETE BRAKING.

	Stopping Time. Sec.	Stopping Distance. Ft.
A car going 60 m.p.h.	11	484
A car going 30 m.p.h.	$5\frac{1}{2}$	121
A car going 15 m.p.h.	$2\frac{1}{2}$	$30\frac{1}{4}$
A car going 5 m.p.h.	0.625	$4\frac{1}{2}$

Retardation relative to the road is a function of the coefficient of adhesion or friction of the tire. The writer found an adhesion of 0.6 for solid rubber tires on cement and vitrified-brick roads, and only 0.5 under similar conditions for pneumatics. The author uses the term *adhesion* for the case where the tire does not slip relatively to the road. When the tire slips, the proper term is *friction*. As the coefficient of adhesion is greater than that of friction, this partly explains why the car stops more readily when the wheels are kept moving than when they are locked.

For possible retardation, the author gives a formula of retarding force, namely, $0.5\ W/2$, or a maximum retardation of about 8 ft. per sec. per sec. With this latter he obtains the data given in Table 1 for stopping time and stopping distance of cars going at various speeds. This table is of importance, as it disperses the claims frequently made of brakes being able to stop cars going at rates from 30 to 50 m.p.h. within the car's own length or thereabouts.

The discomfort produced by too rapid a deceleration is next discussed. Experience has shown that a deceleration of 6 ft. per sec. per sec. is about all that can be borne in comfort by passengers.

It is thus seen that for an average vehicle there is little to gain in putting brakes on more than the two rear wheels.

The question of continuous braking, such as on a long hill, is different, since here the problem is not inertia effect but absorption of energy, and hence reduction of heat. If a 5-ton truck, gross weight 20,000 lb., is going down a hill of 10 per cent grade a half-mile long, it has a gravitational component down hill of approximately 2000 lb. Assuming a road resistance of 50 lb. per 2000 lb., or 500 lb. gross, we have a net force tending to accelerate the truck down hill of 1500 lb. If a safe speed of 10 m.p.h. is maintained, the time of descent is 3 min. The energy absorbed by the brakes is 1500×2640 ft-lb. or 40 hp. or 1700 B.t.u. per mile, which means enough heat generated in 3 min. to raise the temperature of the mass from 60 deg. fahr. to 900 deg. fahr.

It is therefore the writer's impression that as the country roads get opened up more and trucks are used in outlying districts, the demand will arise for a third brake for hilly districts which will enable the vehicle to coast down a long incline at a predetermined safe speed with no wear and tear on the engine or undue heat of the brakes. (*The Automobile,* vol. 35, no. 22, p. 929, November 30, 1916, 3 pp. *tA*)

THE RESISTANCE OF IRON AND STEEL TO COMPLETE REVERSALS OF STRESS, W. C. Popplewell

A brief discussion of previous work in testing steel by alternating stresses, and description of three sets of experiments carried out by the writer himself.

An attempt was made to predict the limited stress for an unlimited number of direct reversals by the Bauschinger method of slow reversals, with two separate bars. Each of these bars was first subjected to ten slow reversals under specified stress, and then extensometer readings were taken in tension and compression to show the position of the elastic limits. The bars were than subjected to the same treatment, under successively higher loads in steps of $\frac{1}{4}$ ton.

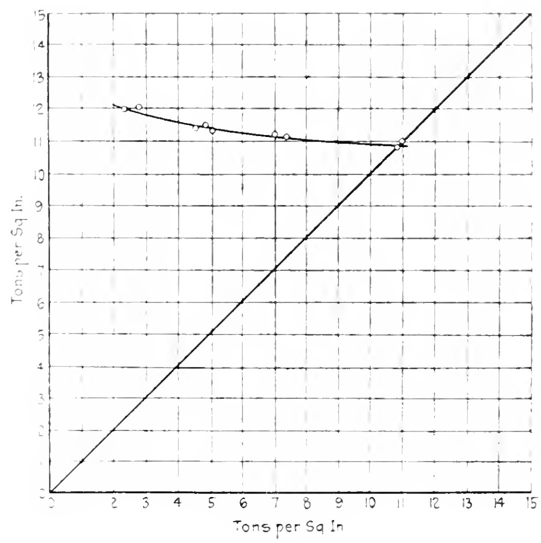


FIG. 2 DETERMINATION OF ELASTIC LIMIT BY SLOW REVERSALS

The results of these two sets are shown plotted in Fig. 2, from which it is seen that the line drawn to include the points of both bars cuts the 45 deg. line at the point just below 11 tons per sq. in., suggesting a limiting stress of not more than 11, or, say, $10\frac{3}{4}$ tons per sq. in., which corresponds to a range of $21\frac{1}{2}$ tons per sq. in.

The second set of experiments comprised the *rotating-beam tests*. In these the bar under test was $\frac{3}{4}$ in. in diameter and ran in ball bearings 20 in. apart from center to center. The

force causing the bending moment was applied at two points toward the middle of the bar, 5 in. apart. This force was derived from a hanging rod through a pair of ball bearings attached to the ends of the cross bar at the top of the rod carrying the load. The result was a constant bending moment in the 5-in. length in the middle, of magnitude $\frac{1}{2}W \times 7\frac{1}{2}$ in-lb., where W is the load. Any point in the middle 5 in. was subjected alternately to a tensile and a compressive stress each time the bar turned completely around, the value of these stresses being easy to calculate from the magnitude of the load. The speed of reversals was 350 per minute, which is lower than that employed in many cases of high-speed machinery in existence. It has been, however, proved before that for any speeds likely to be met with in running machinery the limiting stresses are independent of the speed.

The results of the rotating-beam experiments are shown in Fig. 3, where the applied stresses are plotted vertically and the number of reversals necessary to cause fracture, horizontally, the result being a curve which tends to become tangential to a line drawn through a stress, which is taken as the value for an unlimited number of reversals. In this case the limiting stress suggested by the direction of the curve appears to be somewhere about 19.6 tons per sq. in., or through a complete range of 39.2 tons per sq. in.

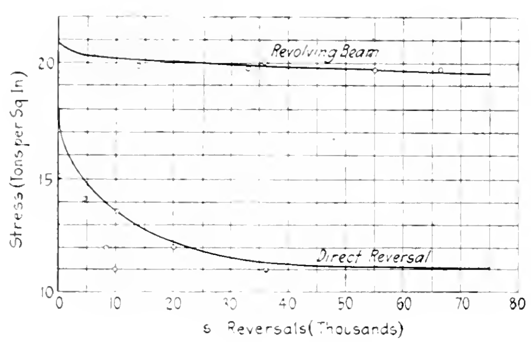


Fig. 3 Rotating-Beam Tests

For *experiments under reversals of direct stress* was used a combination of a reciprocating movement and the deflection of a flat spring. The former was derived from the movement in a milling-machine attachment, there being in this an eccentric with a throw of 3/8 in., giving a reciprocating movement to a slide block through a connecting rod 2.5 in. long.

The end of the slide block further from the eccentric has a continuation into which the end of the specimen under test is screwed, so that, as the shaft carrying the eccentric revolves, one end of the specimen is reciprocating through 3/8 in. on either side of its central position, the other end of the specimen being screwed into a holder which forms part of a clamp gripping the middle of the spring. This spring has a span of 14 in., its ends passing between supports which prevent movement in either direction.

When the machine is running and the point of attachment of the connecting rod with the sliding piece is in its mid-position, the spring is in a state of ease and there is no force applied to the specimen. But when the slide reaches its extreme position on the side further from the spring, the latter will have been deflected from its central position through 3/8 in. by a force in tension applied through the specimen. The net result is that during one revolution of the shaft the specimen is subjected to a complete cycle of stresses proceeding from a maximum in tension through zero to a maximum in compression and back again. This spring is made of 7 plates, each 0.075 in. thick and 2.25 in. wide, and it was found from experiment that a load of 110 lb. is required to deflect the spring through 3/8 in. on either side of its central position.

In order to simplify the experiment it was found convenient to vary the stress by changing the diameters of succeeding specimens, and with them the areas of their cross-sections.

The results obtained are plotted in Fig. B, where it is seen that the curve tends to become horizontal at a stress of 11 tons per sq. in.

The results obtained by the writer are tabulated in Table 2. Among other things it has been found that the actual form of the part of the rotating beam which carries the greatest stress has considerable influence on the numerical values of the results. It has been further found that, apparently, it is possible to find the stress which a given sample of steel is capable of sustaining for an unlimited number of reversals without damage, and that this can be done by "static" tests of the nature described above.

This plan has the advantage that an ordinary testing machine can be used, capable of exerting both tensile and compressive loads, and has the further merit of quickness as compared with endurance tests carried to destruction. (*The Engineering Review*, vol. 30, no. 4, p. 120, Oct. 16, 1916, 3 pp., 8 figs. *e*)

TABLE 2. RESISTANCE OF STEEL TO COMPLETE REVERSALS OF STRESS

Material	Primitive Limit	Yield Point	Tensile Strength	Range of Stress		
				Static	Rotating Beams	Direct
Steel Forging (The Writer, Former Experiments)............	12.50	14.0	28.56	18.4	24.4	. .
Steel Forging (Stanton & Bairstow)........	12.94	14.52	29.47	....	....	20.60
Steel Forging (Present Experiments)........	10.0	14.0	25.4	21.5	39.2	22.0
Cast Steel (Writer)....	22.24	....	55.70	40.50	44.8	....

The Annealing of Carbon Steels as Affected by Various Temperatures and Magnetic Fluxes, R. B. Fehr

Data of tests carried out at the Engineering Experiment Station, Pennsylvania State College, State College, Pa., with the primary object of studying the range of temperature in which the various steel heat-treating operations should be carried out.

The writer has been unable to find in published form any series of tests that would show the variation in physical properties due to small variations in temperature throughout the critical range. As usually the temperature is varied by 50 deg. cent. intervals, it would be of interest to find the effect of small temperature variations, with the object of determining what advantages could be derived from better temperature control.

In the same series of tests an attempt has been made to determine whether there was any unusual effect on the physical properties of steel from being subjected to heat treatment and the action of magnetic flux simultaneously. It was believed that, as heat brings iron and steel into a mobile condition, magnetic flux in connection with heat might facilitate this rearrangement of the structure, and thus help to bring about a more complete transformation, with a consequent beneficial effect on the physical properties.

At temperatures above 750 deg. cent., iron and steel are practically non-magnetic, and therefore cannot be affected by magnetism; but when steel cools below this temperature and regains its magnetic properties, it may be that magnetism might have some good effect if induced in the metal during the process of cooling past the magnetic critical point. The chances are that alternating currents would give the best result on account of the constant shaking or vibration of the molecules.

Among other things, the writer made a determination of the critical point of iron, with the result that an electromagnetic method was evolved, whereby the critical point of a piece of steel under heat treatment would be determined directly and accurately. This method depends upon the loss of magnetic properties of steel at a critical temperature, and upon electromagnetic induction. The writer describes the method and apparatus in detail. Essentially, an electromagnet was placed around the heating furnace in such a way that the magnetic circuit was completed through the piece of steel undergoing heat treatment, but, instead of placing the coil about the heated part, the writer located it outside the furnace, in such a position, with respect to the magnetic field, that the sudden change of residual magnetism at the critical point would be made use of. This change of residual magnetism was indicated very sharply on a millivoltmeter by breaking the electromagnetic circuit.

In order to obtain a strong magnetic flux which would be exerted on the bars at the same time that they were undergoing heat treatment, the field of an old Manchester bipolar, series-wound dynamo was set up on end with the end yokes removed.

The two steel rods under test served to complete the magnetic circuit. The magnetic field due to a few amperes was exceedingly strong, and the flux density was considerably beyond the knee of the saturation curve for every grade of steel tested.

In the determination of the critical point the method of procedure was to break the field circuit at regular intervals during the heating and cooling processes.

The tests were run on 0.04, 0.28, and 0.835 per cent carbon steel, ¾-in. round bars.

Several tests showed quite conclusively that the electromagnetic method of obtaining the critical temperature gave practically the same result with high-carbon steel as the thermoelectric method, but that with low-carbon steels the thermoelectric method was not sufficiently sensitive, which may be due to the fact that in these steels there are really three distinct critical points, each of which is characterized by only relatively slight evolutions of heat.

The results are given in the form of tables and curves. In particular, with 0.04 per cent carbon steels, the elastic limit of the rolled bar was decreased about 6000 lb. per sq. in. by the annealing treatments, but otherwise the curves of the plotted results (Fig. 4) show practically no change in the physical properties due either to annealing temperature, or to treatment with magnetic flux, except in the case of the elongation, which shows a slight jog just above the magnetic critical point. These results are therefore entirely in accord with the

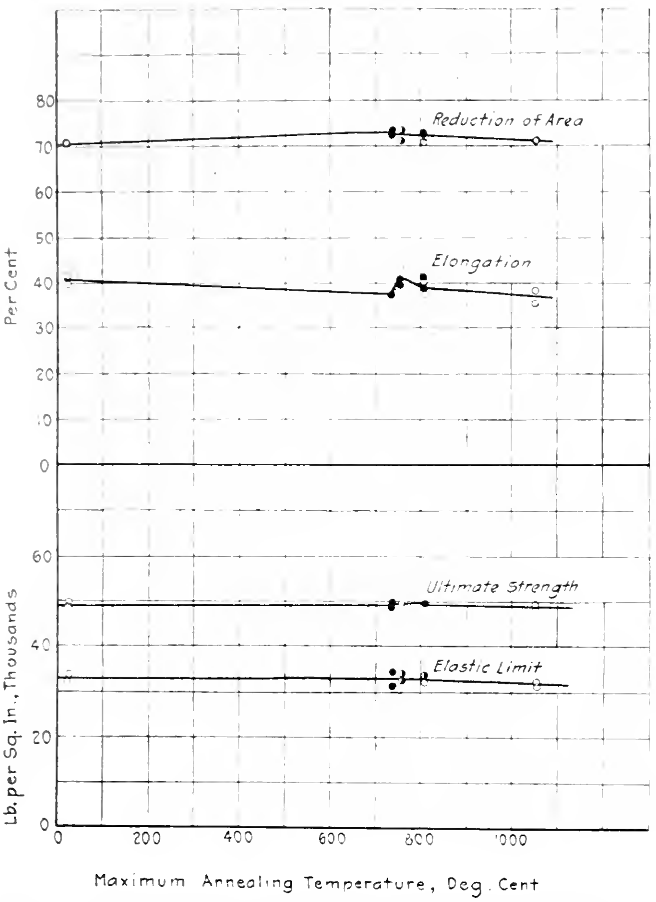


FIG. 4 VARIATION OF PHYSICAL PROPERTIES WITH ANNEALING TEMPERATURE, 0.04% CARBON STEEL

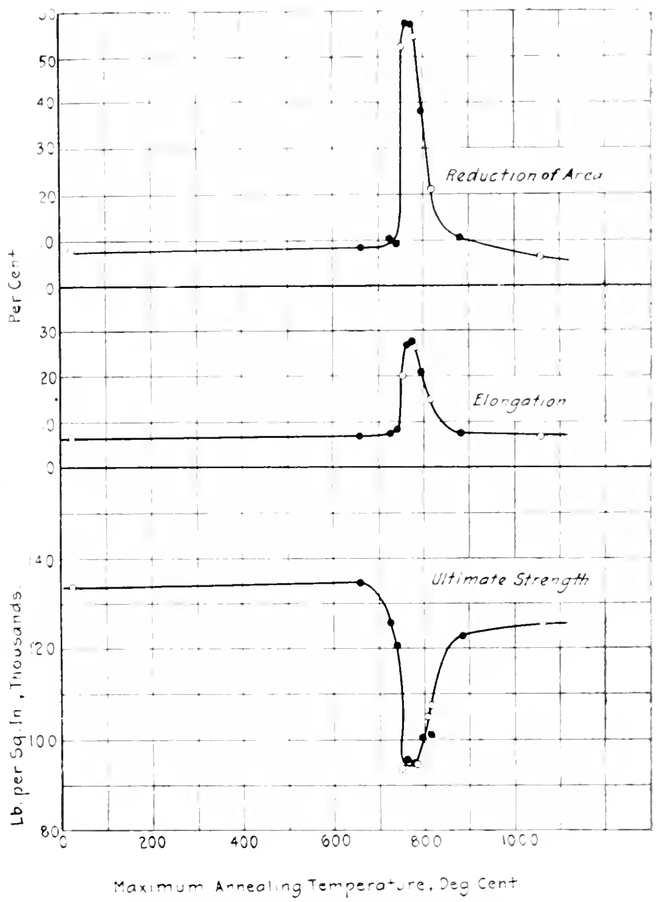


FIG. 5 VARIATION OF PHYSICAL PROPERTIES WITH ANNEALING TEMPERATURE, 0.835% CARBON STEEL

known fact that low carbon steels are very little affected by heat treatment.

The results of this series of tests with 0.28 per cent carbon steels show that the annealing temperatures around the magnetic critical point have considerable effect on the physical properties, especially the elongation and reduction of area. In raising the annealing temperature from 740 deg. cent. to 761 deg. cent. the elongation was suddenly increased 22 per cent. and the reduction of area 20 per cent, both of these properties falling off gradually to their former values at the temperature of about 880 deg. cent.

Finally, tests on 0.835 per cent carbon steels show (Fig. 5) the remarkable effects which the small variation in the annealing temperature has upon the physical properties of a high-carbon steel. Simultaneous treatment with magnetic flux did not appear to have any effect whatsoever. The author calls attention to the fact that the range of annealing temperatures recommended for this grade of steel was between 790 and 815 deg. cent., which would not have brought about maximum ductility or reduction of area, as shown by the tests.

The writer found that in all his tests the magnetic critical point indicated without exception the proper annealing temperature to give the finest grain, maximum ductility and reduction of area, and therefore the maximum shock-resisting qualities. This temperature in all cases lies within a range of 30 deg. cent. just above this critical point. It was found that, by careful temperature control, a high-carbon steel can be given the ductility of a low-carbon steel, and at the same time possess a higher elastic limit and ultimate strength than are to be found in low-carbon steels.

The experiments showed that in the annealing of carbon steels the ductility and reduction of area increase as the grain size decreases, but that the tensile strength and elastic limit decrease with decrease of grain size.

The results obtained by this investigation apply, as the author points out, only to the annealing of carbon steels. (*Abstract from advance copy of a paper to appear as Bulletin No. 18 of the Engineering Experiment Station, Pennsylvania State College*, State College, Pa. *e*).

MODERN IDEAS IN HEAT TREATMENT

Description of the methods used at the plant of the Steel Products Company, Cleveland, O., having for their purpose the elimination of variations in the quantity of heat-treated products.

The output of the Steel Products Company consists largely of automobile-motor valves, poppet valves, spring-shackle and steering-knuckle bolts and valve tappets, made of both common and alloy steel, demanding the best of heat treatment.

The uniformity of results is being secured here by maintaining a uniform quality in the gas supplied to the furnaces, which again involves the thorough mixing of scientifically predetermined proportions of gas and air. The mixture is distributed to the furnaces under a constant pressure, which is maintained by a constant-speed centrifugal fan located between the mixer and the furnaces. The gas-mixing apparatus developed by German engineers is based primarily upon the idea of mixing gas and air at the same pressure. This feature of equalizing the pressure of the gas and the air is essential if the proportions of each are to be accurately controlled, this control being accomplished by a counterbalanced gas governor into which the gas is received as it flows into the mixer from the gas meter. The governor is shown to the right in Fig. 6. The air is mixed at atmospheric pressure, with the gas entering from the gas governor. After leaving the mixer, the mixture is forced through the pipes to the different furnaces by a 15-hp. constant-speed centrifugal pump, which maintains a constant pressure regardless of the amount of the mixture being consumed.

As the mixture of gas and air in the proportions to produce perfect combustion is explosive, only part of the air necessary to insure this perfect combustion is taken in through the machine. The remainder is added to the burner itself by means of a Bunsen attachment.

The proper mixture for each installation is determined with the aid of a test Bunsen burner. These test burners operate on the principle that the height of the combustion cone is related to the pressure and proportions in which air and gas are mixed. With this system, only enough air is supplied to the burners to insure proper combustion, which results in a material economy of gas.

An interesting feature of this plant is the system of centralized control of furnaces. The gas from the pump is piped to the operator's house. Valves located in this house lead to the furnaces. Because of the fact that the gas is supplied to the furnaces through a single pipe for each furnace and because the mixture of gas and air is adjusted before it passes through the regulating valves, a pyrometer man is enabled to regulate the temperature of each furnace separately from his control board. The test burner and pressure gage located in the operator's house not only serve to indicate if the pressure and quality of the gas are being maintained as desired, but also serve to indicate the cause of trouble in case of accident to the mixer or pump. Furnace temperatures are indicated in the control house by pyrometers. (*The Iron Trade Review*, vol. 59, no. 21, p. 1047, November 23, 1916, 4 pp., 5 figs. *dp*)

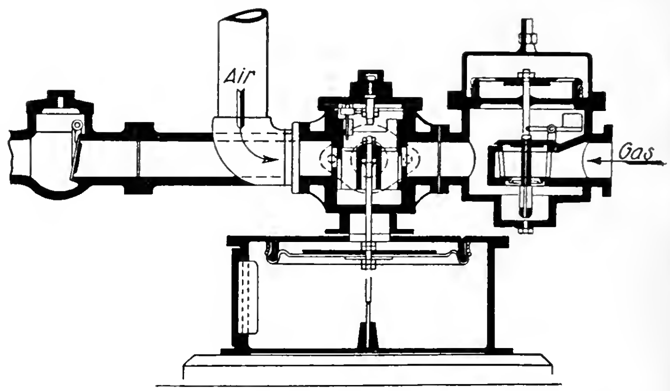


FIG. 6 COUNTERBALANCED GAS GOVERNOR FOR HEAT-TREATING FURNACES

THE TENSILE STRENGTH OF ASBESTOS ROPE WHEN EXPOSED TO FIRE, J. Bobaricoff and W. Mramornoff

As it has been suggested that asbestos ropes might prove serviceable as life lines at fires, the writers have investigated the strength of such ropes under conditions similar to those which they would have to meet if so used.

A. F. Cirkel has tested asbestos ropes having a core of other material. He states that a rope of this kind ½ in. in diameter was good for 200 lb.

The ropes tested in the present instance were three in number—two of asbestos and one of hemp. The larger of the two

asbestos ropes. No. 1 was 1 in. in diameter and was built up of 4 x 4 x 4 x 3 x 3 = 576 primary yarns. No. 2 rope, also of asbestos throughout, had 3 x 3 x 3 x 3 x 3 = 243 primary yarns, while No. 3, the hemp rope, consisted of 7 x 3 x 3 = 63 yarns. None of the ropes had a core of other material. The asbestos used was chrysotile from the Urals and had a hygroscopic water content ranging from 1.1 to 1.2 per cent at 18 deg. cent. with the air at 50 per cent humidity.

The first series of tests was made with the ropes in condition as received. As the ropes for use in fires would be liable to be wetted, it was also considered of interest to test asbestos ropes after three days' immersion in water. It was found that rope No. 1 lost 12.3 per cent of its strength and rope No. 2, 4.4 per cent.

A further series of tests was made on strands unwound from the ropes heated to different temperatures in a Heraeus electric furnace. The maximum temperatures reached were maintained for 3 hours in every case. The results are shown in Table 3, and indicate clearly that the strength diminishes

TABLE 3. TESTS OF STRENGTH OF HEATED ASBESTOS ROPE

Temperature of furnace. Deg. C.	Condition of test.	Breaking load Kg.	Absolute. Kg.	—Loss of strength.— Compared with unheated strand. Per cent.	Compared with merely cooled strand. Per cent.
	Unheated	85.0	...	...	...
220	Cooled after heating	87.5	−2.5	−2.9	...
220	Wetted after cooling	64.0	21.0	24.7	27.0
	Unheated	80.0	...	...	...
270	Cooled after heating	72.8	7.2	9.0	...
270	Wetted after cooling	53.5	26.5	33.1	26.5
	Unheated	73.0	...	...	...
360	Cooled after heating	54.8	18.2	24.8	...
360	Wetted after cooling	42.5	30.5	41.8	22.5
	Unheated	85.0	...	...	...
400	Cooled after heating	66.3	18.7	22.0	...
	Unheated	72.8	...	...	...
500	Cooled after heating	54.0	18.8	25.8	...

TABLE 4. EFFECT OF REPEATED HEATING ON THE STRENGTH OF ASBESTOS ROPE

	Breaking load. kg.	Loss. per cent.
Temperature 140 deg. cent.	119	15
Temperature 210 deg. cent.	29.6	81.5

very rapidly as the temperature of each rope heated is increased. The next series of tests was made on specimens first heated and then immediately cooled down again as soon as the limit temperature was reached. It was found that the loss in strength was increased by prolonged heating.

To see the reason for this loss of strength on heating, a determination was made of the loss of weight when the asbestos was heated for three hours in the electric furnace and allowed to cool in a desiccator. It was found that the loss rapidly increases after a temperature of 550 deg. cent. is reached.

On the whole it was found that loss of strength and loss of weight for the most part ran together, but that if the maximum temperature does not exceed 299 deg., this rule fails. The rapid loss in the resistance occurs at a somewhat lower temperature than the corresponding rapid loss in weight. This is apparently due to the heat destroying the cohesiveness of the constituents somewhat sooner than it is able to expel the products of decomposition.

The large loss both in strength and weight between 200 and 350 deg. cent. is due to the burning out of the organic matter.

Tests were made on strands heated in the furnace and loaded at the same time. The temperature was raised until the strand broke. In the first series the strand was loaded with a weight of 30 kg., and broke when the temperature reached 650 deg. cent. The same strand unheated showed a resistance of 70.5 kg.; heated and cooled, 39 kg.

Some additional experiments were made on the effect of repeated heatings followed by cooling in water. A number of specimens were first raised three times to 400 deg. cent., cooled twice, and then broken. It was found that repetitions of the heating process have relatively little effect on the strength. For purposes of comparison some tests were also made on the effect of temperature on the strength of the hemp rope No. 3, with the result shown in Table 4.

On the whole the tests indicate that asbestos ropes such as tested in this case cannot be considered as suitable for use as life lines at fires. Similar ropes with steel cores would be stronger, but the asbestos would then serve merely as a heat insulator, for which purpose it is not very well adapted, as it becomes very brittle at a temperature of 600 deg. cent.

All these tests were carried out in the mechanical laboratory of the Tomsk Institute of Technology, in Siberia, Russia. (*Engineering,* vol. 102, no. 2654, p. 451, Nov. 10, 1916, 2 pp., *c*)

THE COMBUSTION AND FIREPROOFING OF WOOD: SOME MINUTE REACTIONS, James Scott

The writer discusses the process of combustion of wood on the basis of some experiments made by him on pine shavings.

He laid a thin shaving, about 1 in. long and 1/4 in. wide, upon a glass slide, with nearly half of it projecting beyond the edge. This free part was then ignited, and when it had finished burning there remained the suspended white ash, the shape of which would be easily discerned by transferring the slide carefully to the stage of the microscope. It was then observable as a fine, delicate skeleton framework of the destroyed cells.

A glowing ember of wood affords a wonderful spectacle under the microscope, where one can see the flare traveling among the cells, charring them and leaving an ashy trelliswork of disclosed walls.

In the test with the pine shaving partly under the glass slide, one can distinguish the gradation from one condition to another in the process of burning. The heat, while consuming one area, liquefies the cell contents in the vicinity and drives some of them further away in the opposite direction, thereby expanding and bursting the cells and discharging from them gases which feed the oncoming fire.

Fig. 7 shows, on a dark background, a small portion of the burned shaving, wherein all phases from intact to destroyed wood are visible.

When wood is burning and water is played upon it, the main result, according to the view of the author, depends, first, on the mineral matter contained in the water, and, second, on the mineral ash released from the already consumed substance. Hence, he believes that purposely made hard water containing, say, excess lime, would check the progress of the flames at a quicker rate than would be the case with distilled water.

When wood is burning the fundamental carbon is given off as myriads of infinitesimal specks, and if it be allowed to rise onto a glass slide it shows remarkable patterns due to a particular arrangement of the particles. In Fig. 8 is shown the filigree occasioned in a thin, gray layer of wood smoke, the carbon molecules evidently having been contained in gaseous or semi-vaporous globules, which, on meeting the solid glass, subside so that their walls produce rings and their contents central nuclei of various forms. Some of the soot is found as shining, tarry films, and the rest as a lusterless powder. (*The Railway Engineer,* vol. 37, no. 442, p. 261, November 1916, 3 pp., 3 figs. *e*)

Internal-Combustion Engineering

Carburetion at High Altitudes

Symposium of Answers of Various Carburetor Manufacturers to an Inquiry on the Above Subject

C. W. Findeisen states that if the carburetor has been carefully adjusted at lower altitudes and shipped to high altitudes, it is necessary to cut down the supply of gasoline to some extent.

G. T. Briggs, of the Wheeler & Schebler, Inc., states that in their Model L carburetor it was found necessary for high-altitude work to change the adjustment—that is, to turn on a little more gasoline at the needle and use a weaker spring. It was found that turning on more gasoline did not change the fuel combustion, owing to the rarity of the air. The Model R carburetor works well without changing the adjustment at high altitude, although a change will decrease the consumption. The experience of this company is that in order to get satisfactory results a little more gas must be supplied, also the spring must be changed in order to get more air into the carburetor through the auxiliary valve. This is due to the fact that the suction is much lower at the higher altitudes. If no change in adjustment is made, the carburetion is bad and the fuel combustion high at over 5000 ft. elevation.

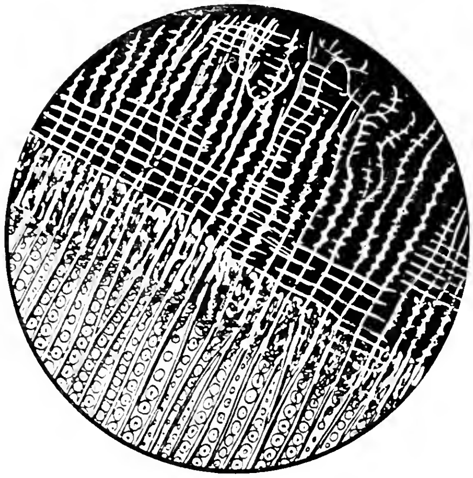


Fig. 7 Magnified View of Pine Shaving, the Upper Part of which has been Burned to an Ash, with an Intermediate Charred Zone. Diameter of Space about 1/24 in.

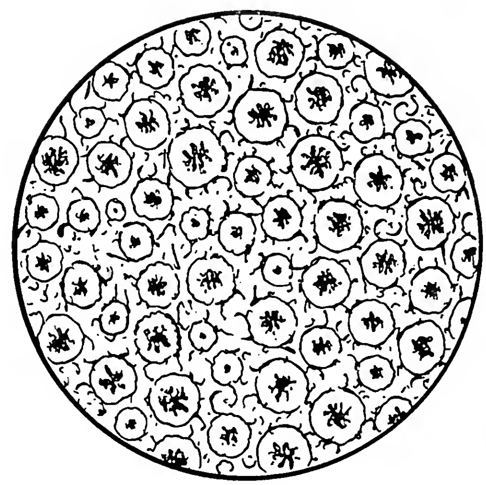


Fig. 8 Magnified View of Film of Carbon from the Burnt Pine Shaving. Actual Diameter of the Space about 1/24 in.

Arthur B. Browne, of the Malleable Iron Fittings Company, in discussing the theory of carburetion at high altitudes, calls attention to the fact that the mean effective pressure of the engine is a function of the compression pressure. An engine having 70 lb. per sq. in. compression in New York should have a mean effective pressure of about 91 lb. per sq. in.; in Butte, which is at an elevation of nearly 6000 ft., this same engine would give a mean effective pressure of only about 81 lb. per sq. in., as a result of the lowered compression only. Hence a truck engine developing 40 hp. in New York, would develop but a little over 35 hp. in Butte if supplied in both cases with the same mixture. The loss would in fact be even greater because of a slower flame propagation in the mixture at lower compression and other considerations, while the decreased negative work of compression would be a factor on the other side.

The author makes the following practical suggestions: (1) Reduce the gas in the carburetor and the adjustments at all speeds as accurately as the instrument will permit; (2) advance the spark as far as possible; in fact, until the engine gives a sharp knock, when it should be retarded until the knocking ceases; (3) remove the governor or at least set it much faster than usual.

According to F. C. Mock, of the Stromberg Motor Devices Co., the rareness of the air decreases the relative opening of weight- or spring-control air valves. This is taken care of by using larger primary openings and lighter springs. The change in mixture proportion is only a small part of the difficulty, as the heat-up of the engine makes its operation uneconomical.

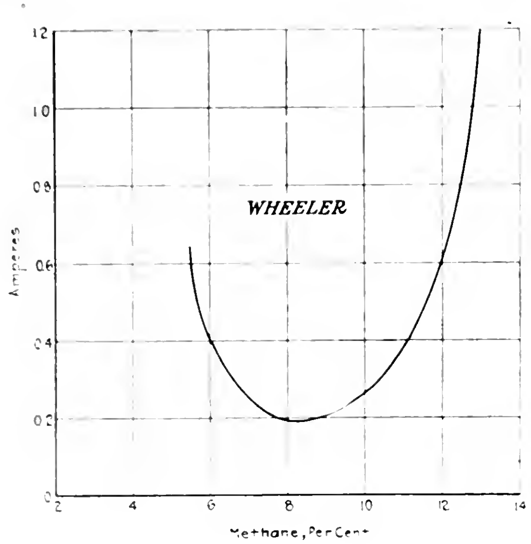
Geo. M. Holley, of Holley Bros. Co., states that his company has adjusted carburetors at Kenosha, Wis., on Rambler cars, and shipped them to Denver, Colo., which is at an altitude of 5000 ft., but could find absolutely no difference in the operation of the device.

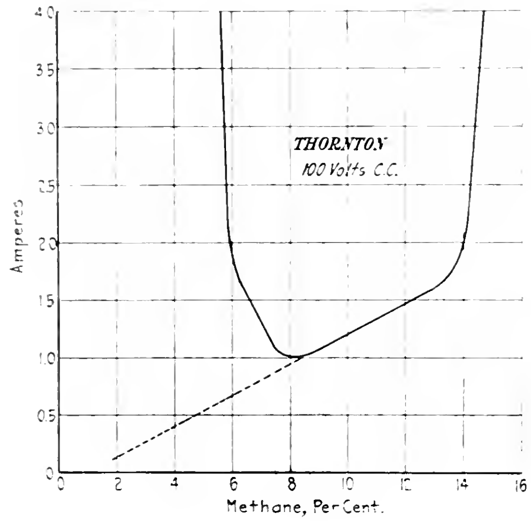
In this connection it may be of interest to compare the experiences with Diesel engines at high altitudes described in The Journal, October, 1916, p. 833. (*S. A. E. Bulletin*, vol. 11, no. 1, pt, Oct. 1916, 3 pp, *p*)

Ignition of Explosive Gas Mixtures by Electric Sparks, J. D. Morgan

The ignition of an explosive gas mixture by a spark is commonly considered to depend upon the communication of heat from the spark to the gas, but experimental investigation tends to indicate that ignition depends, at least partly, and perhaps entirely, upon some other cause than this. It does not seem likely either that temperature is the determining factor in ignition, because it is known that if the temperature is not accompanied by a sufficient quantity of heat, ignition will not occur.

Further, if it be assumed that heat alone, when accompanied by sufficient temperature, is capable of causing ignition, it would apparently be right to suppose that the mode of producing electric sparks containing sufficient heat would have no effect upon the igniting property of such sparks, which again is found not to be the case. For example, Prof.





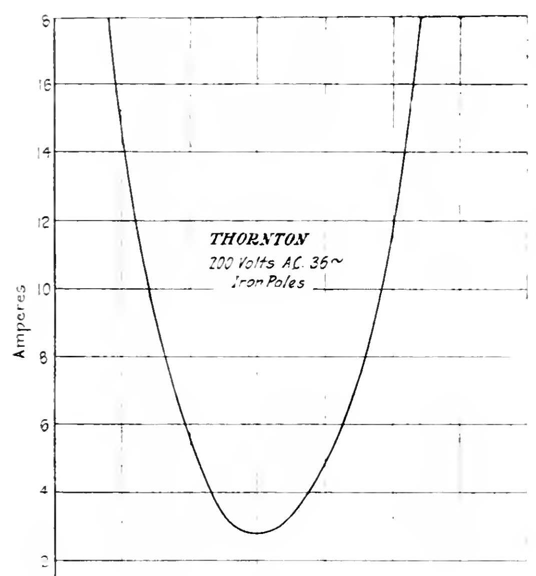


FIG. 9 (TOP) AND FIG. 10 (MIDDLE) VARIATION OF LEAST CONTINUOUS CURRENT REQUIRED TO PRODUCE A SINGLE IGNITING SPARK, WITH THE GAS MIXTURE; FIG. 11 (BOTTOM) SAME, WITH ALTERNATING CURRENT

W. M. Thornton found that a greater amount of energy is required to produce an igniting spark by an alternating current than by continuous current, and the relationship between the number of volts and amperes in the circuits immediately prior to the production of the spark differs in character in the two cases.

These and other experiments suggest ionization as the origin of ignition. Dr. H. F. Coward expresses the opinion that the ignition of an inflammable gas mixture is largely governed by two factors, namely, its thermal conductivity and the energy degraded when the discharge is passed.

In a general way it is known that gas mixtures are only combustible when the proportions lie within certain limits. Fig. 9, taken from R. V. Wheeler's Home Office Report on Battery-Bell Signalling Systems, shows how the least continuous current required to produce a single igniting spark varies with variations in the gas mixture.

From this it is seen that the most sensitive mixtures lie between 7.5 and 9 per cent of methane. The first value of this curve is to show the limits of inflammability and the general character of the current variation between these limits. This curve has been obtained on an alternating-current circuit, and Professor Thornton, who used a continuous current, obtained a curve of a different form, as shown in Fig. 10. It must be borne in mind, however, that the ordinates of these two curves are not comparable, since the least igniting current diminishes as the voltage or inductance increases.

In Fig. 10 a portion of the curve follows closely the straight line which passes very nearly through the origin. From this Professor Thornton argues that the igniting current is proportional to the number of molecules of combustible gas in unit volume of the mixture. With alternating current, Fig. 11, the character of the curve alters, the current varying as the "square of the excess of either of the combining gases on each side of the point of maximum inflammability."

The writer considers the validity of the method of determining the ability of the spark to ignite the gas, or the "incendivity" of the spark, by specifying the number of volts and amperes or the number of amperes and the inductance in the circuit prior to the formation of the spark.

With alternating current the amount of current for a given voltage is always higher than in the case of direct current, but all data show that the amounts of voltage and current or current and inductance capable of producing dangerous sparking are comparatively small. This emphasizes the necessity of adequately protecting electrical apparatus to which explosive gases are accessible, which in particular applies to the case of electric bells.

The author finds that a single spark which, when repeated slowly will not ignite the gas, will, after a more or less definite interval, produce ignition when repeated rapidly, which indicates that the element of time is a factor of importance in ignition phenomena. If, instead of a single-break device, a vibratory make-and-break device, such as the trembler of a bell, be employed, the ability of a spark to ignite a gas mixture is found to depend upon the duration of the spark as well as upon the circuit conditions.

A writer in the *Electrical Review* (vol. 77, p. 65, 1915), on the basis of the work of Professor Thornton and Dr. Wheeler, states that the igniting power of a break-flash depends on the $Li^{.354}$ of the circuit, where L is the inductance and i the circuit current.

As regards the use of the product volts times amperes, vi, as in measure of the power of the arc, the author points out that the value of vi is not necessarily the same during arcing as

when the contacts are brought together, and there is no reason for assuming them to be the same when the arc is only of momentary duration. Therefore, *m*, as it exists prior to sparking, is not a measure of the power of a hot-point spark.

The general conclusion to which the author has been led by his experiments is, that it is necessary to distinguish between the energy which produces a spark and that quality of the spark called by him "incendivity," which enables the spark to cause ignition, and that the magnitude of the one is not a measure of the other, although there may be a more or less regular relation between them when certain physical conditions are kept constant.

Ignition seems to depend on the ionization caused by the spark during the interval of sparking. The ionization may be rapidly dissipated or neutralized. If the neutralizing action predominates, there is no ignition of a gas mixture. If there is little or no neutralizing action, ignition occurs immediately. Between these two limits there are a variety of intermediate conditions which apparently account for the delay of ignition found in some of the experiments and much of the great irregularity that is often experienced in experimental work on the subject.

The rest of the paper refers to dangerous sparking of electrical apparatus for mining and of electric bell-signaling circuits. In this connection, the writer believes that the British Home Office Regulations, limiting the highest permissible voltage in bell-signaling systems to 25, does not secure safety, and the limit ought to be reduced to 6 volts. The fixing of the voltage limit in itself, however, is not sufficient to insure safety, and there should be added the condition that sparks produced in the system should not be capable of igniting a specified mixture of methane and air, which result can be easily obtained with a relay.

E. A. Watson, in a written discussion on the above paper, expressed his belief that the value of the minimum energy in the spark required to ignite a gas would be affected by the pressure, and still more certainly by the temperature, of the explosive mixture before ignition. The fact that, although one spark will not ignite a given mixture, yet a rapid succession of sparks will do so, might be due to the heating of the mixture by the energy liberated. The problem of how the horsepower given by an engine depends, other conditions remaining the same, upon the energy given by the magneto, is one which would well repay investigation. There are, however, no data available to show whether an increase in brake horsepower might be obtained by increasing the energy at the spark plug. (Some rough experiments made on a comparatively low-speed gas engine give a negative result, but these experiments were only very rough and cannot be considered as being at all conclusive, especially as the effect would be most marked at high engine speeds.) (*The Journal of the Institution of Electrical Engineers,* vol. 54, no. 254, p. 196, January 15, 1916. 13 pp., 11 figs., *et*)

INTERNAL-COMBUSTION TURBINE. A. W. H. Griepe

Description of the construction and operation of a 100-hp. internal-combustion turbine which, it is said, has made a number of runs with an efficiency estimated by a rough test at about 20 per cent.

The turbine consists of a rotor similar to that used in a reaction-type turbine, with the blades distributed in four equally spaced groups around the periphery of the wheel, each group occupying one-eighth of the circumference. On the rotor is mounted a valve band which acts as an admission and cut off valve between the explosion chamber and the fuel and air supply. The stationary element contains the explosion chamber and ring chambers for the fuel and air supply. The nozzles are mounted so that the gases flow from the inner to the outer periphery of the wheel.

The operation of the turbine is as follows: Compressed air enters the air chamber from the storage tank at from 45 to 75 lb. and gas from the fuel chamber at approximately atmospheric pressure. The compressed air flows in through specially formed passages, and in doing so acts as an injector and draws the fuel in through a small, straight nozzle in the center of each valve. By means of a special arrangement in the valve ring, the port between the fuel and the explosion chamber is closed an instant before the port is opened from the explosion chamber to the blade, and at this instant the charge is ignited and expands.

The operation of the turbine may be seen from the cycle diagram in Fig. 12. Starting at I, explosion is complete and the ring valve is just beginning to open the air valve,

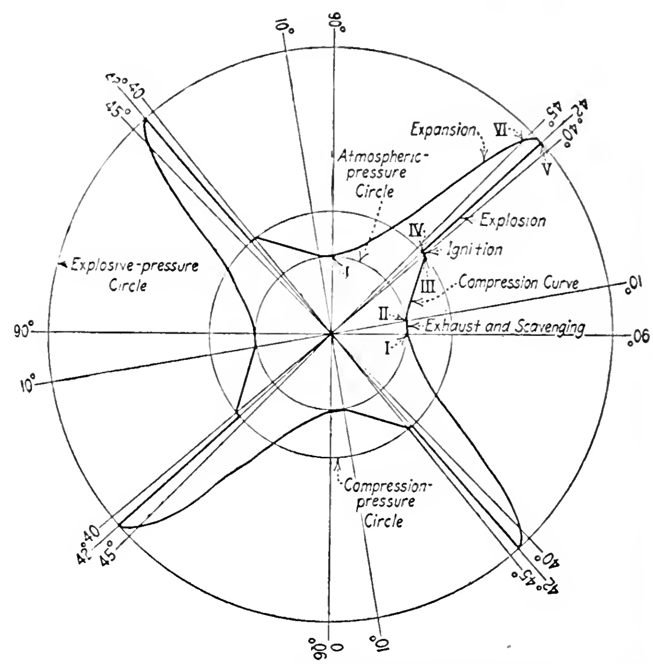


FIG. 12 CYCLE DIAGRAM OF AN INTERNAL-COMBUSTION TURBINE

with the explosion chamber still open to atmosphere. Air is admitted to the explosion chamber, blows out through the exhaust, and scavenges the explosion chamber. This continues for 10 deg. of the revolution, at which point the nozzle from the explosion chamber is closed by the inner rim of the rotor. At II, the valve band opens the fuel valve, admitting a fresh mixture into the explosion chamber, and the pressure rises, owing to the pressure of the compressed air. At III, 40 deg., the valve band closes the admission opening. When the valve band has overlapped one degree, at IV, 41 to 42 deg., ignition takes place. At this point the highest pressure, V, is obtained. From 42 to 45 deg. the nozzle is opening from the explosion chamber and expansion begins. From 45 deg., VI, to 90 deg. the nozzle is wide open and expansion takes place. At 90 deg. the cycle is complete and begins over again.

In the first installation a 3-in. by 4-in. Gardner compressor was used. The amount of air delivered was large enough for two explosion chambers, the air leakage between the tank and the explosion chamber being at that stage about 25 per cent.

Adjusting nozzles were then installed and reduced the losses to about 10 per cent. A 6-in. by 6-in. double-cylinder Curtis compressor was then installed with modified means to reduce the leakage. With the best arrangements thus far developed, the power necessary to compress the air was about 12 per cent of the whole power developed.

The combustion never gave any trouble.

The blades are made of cast iron and inserted in the rotor. The sections are cast in one piece.

No data of any tests are given, but from a statement made in another connection it appears that runs were made at speeds up to 3500 r.p.m. (*Power*, vol. 44, no. 23, p. 785, December 5, 1916, 3 pp., 14 figs., *d*)

Machine Parts

Friction Clutches. Wm. G. Gass

The writer divides all clutches into a number of distinct types, such as claw couplings, friction cones, internal-segment-and-band clutches, external-segment-and-band clutches, plate clutches, brush clutches, magnetic clutches, and automatic clutches, and discusses the distinctive features of each type separately.

As to friction materials, the author believes that while they are of advantage for brakes, there are difficulties in the way of using them for clutches. In most cases rivets have to be depended on, and these are apt to give way. The material is liable to glaze, particularly in a clutch thrown in and out many times. Where steel is employed it should not be used on cast iron unless its surface is chilled very hard. The trouble of driving surfaces is that they wear away, and this wearing is greater or less as the clutch slips or not. If there is slippage, the surface generally being dry, a small portion of matter gets embedded into whichever of the surfaces is softer and acts as a kind of plow into the other. It is not necessarily the softer of the two which gives way, but often the harder.

Clearance is the main difficulty with clutches, and the smallness of it is the cause of a considerable amount of wear when running out of gear. In all cases where the setting up is done by screws, the clearance between the driving part and the driven is relatively smaller. Attempts have been made to increase the clearance by racks to rotate the screw through a pinion, but this does not enable the necessary pressure to be put on the screw, and there is consequently a loss of efficiency. Generally speaking, clutches of all kinds wear away more quickly out of gear than when they are in gear, even where they are strong enough to easily cope with the load. Clearances are, therefore, a weak spot in almost all types of clutches, being so small that any wear which occurs in the bushes of the free part of the clutch affects its running.

Setting-up Gear. The action of setting up a clutch is the conversion of a sliding movement along the shaft carrying the clutch into a pressure between the clutch surfaces. This may be properly divided into two operations. The first, that which is in the clutch itself, and the other, that by which the power for operation is applied. The locking and concentration of power may be obtained either by a double joint or by a wedge, but in both cases a slight application is necessary to transmit the power from the stationary lever to the rotating shaft carrying the clutch. The power may be applied to the clutch either to set it in gear or to release it, i.e., to put it out of gear, the clutch being in this case kept in gear by means of springs.

The matter of *pressure on working faces* is a crucial point in the efficiency of any clutch and its power to drive. It is usually considered that if an actual pressure of 50 lb. per sq. in. can be put on the surfaces, it is as much as is desirable for good working conditions, but if for any reason a less pressure is put on than that required to transmit the power, the clutch will, if it begins to slip, grind itself away quickly and, in the spring-center type, grind away all the available spring in the metal. As to pins, in spite of all that can be done they will wear away, so that if a clutch is set up correctly a very small wear on the pins and links of the toggle will rapidly reduce the effective pressure of the faces.

The *power transmitted* is proportional to the speed of rotation, and the clutch which will transmit 10 hp. at 100 revolutions will transmit 50 hp. at 500 revolutions.

Lubrication in clutches is of the greatest importance, particularly where the clutch is running idle for a considerable part of its time. If the outside portion of the clutch is the driven part, it runs on the shaft and may have to be stationary while the shaft rotates in the clutch bushes, or, if the outside is the driver, it has to run loosely on stationary shaft. This is a source of trouble with many clutches, and the lubrication of these bushes requires the closest attention, both in design and on the part of the attendant.

In starting up any friction clutch a certain amount of rubbing takes place, and when two metal surfaces rub on one another, fine particles of metal are given off. In an enclosed chamber these cannot get away, become mixed with the lubricant, and form an excellent abrasive which does not increase the life of the part. This can be obviated by an occasional cleaning of the chamber, which, however, is not usually done.

Another peculiarity of lubrication in the case of plate clutches is that where the resistance to the idle clutch is not very great, if the oil becomes thick the plates adhere because all the air is driven out between them and the resistance may not be able to make the clutch stop. Springs between the plates have been tried to obviate this, but without great success. Excessive lubrication also reduces the driving power materially.

The speed at which the clutch is to run is an important point to consider, as well as the balance of the clutch. The clutch is rapidly affected by any want of balance if the speed reaches a point at which the want of balance becomes operative. The clutch should, however, be properly balanced for any speed. The cone having no moving parts is undoubtedly the easiest to balance and keep in balance; it has, however, certain inherent defects which stand in the way of its more extensive use. Another point which sometimes affects the use of the clutches is the overall space required.

The writer discusses further the field of application of clutches. In his opinion the *ideal friction clutch* should be a combination of a friction drive and a positive drive, i.e., a friction arrangement should be used for starting up and then a positive drive should come in operation and all driving be taken off the frictional portion. The clutch, however, should be able to be thrown out of gear with the same ease that the friction drive can give, and should have all the running parts with ample clearance when running out of gear. While this is not impossible, it is very difficult to attain, especially as the clutch should always be in perfect balance, with no projecting parts, properly lubricated, and free from complications. (Paper read before the Manchester Association of Engineers, October 28, 1916; abstract made from a reprint in the *Mechanical Engineer*, vol. 38, no. 980, p. 342, November 3, 1916, 4 pp. *dg*)

Mechanics

Recent Observations on the Critical Speed of Shafts, Prof. A. Stodola

In observing the critical angular velocity of smooth shafts, the writer has been surprised to find that the deflections at the critical speed were in nowise "infinite," but that the values always remained finite, even when the shaft was entirely free and without support at one end. This finite characteristic of values and deflection appears in a still more striking form in the interesting observations communicated to him by Brown, Boveri & Co. They submitted a photograph of a rotating shaft having a slight taper, this photograph being taken at the second critical speed of the shaft. If now the trough in which the shaft is located be filled with water, the shaft at the same speed takes an entirely different shape and the deflections, which even before were not very large, disappear practically entirely. This experiment shows that in the case of shafts immersed in a liquid, for example, propeller-screw shafts sticking out from the side of the vessel, the critical speed may be permitted without any danger of producing thereby excessive vibrations. It also indicates a possible explanation for the phenomenon referred to above, namely, that apparently the deflection of a shaft is affected by the viscosity of the medium surrounding it. One may assume that a certain amount of the fluid adheres to the shaft, revolves with it, and thereby reduces the critical velocity.

This question is entirely elucidated by the data published by Dr. O. Föppl, according to which, in the case of a heavy disk, the center of gravity of the disk, the point of "breakdown" of the shaft, and the point of intersection of the geometric axes through the center of the bearing will not rotate on a straight line as has been hitherto theoretically assumed. Such a deviation from the straight line can, however, occur only if the resisting forces are not negligibly small as compared with the centrifugal and shaft forces, which must be the case in the rotation of turbine disks either in free air or in steam. (*Neuere Beobachtungen über die kritischen Umlaufzahlen von Wellen*, Prof. Dr. A. Stodola, *Schweizerische Bauzeitung*, vol. 68, nos. 18, 19, pp. 197, 209, October 28, November 4, 1916, 5 pp., 10 figs. *etA*)

Steam Engineering

Pressure Tests of Welded Boiler-Tube Vessels, Robert Cramer

Data of tests of simply welded joints tested under hydraulic pressure.

The samples were welded either by simple butt welding or in various improved ways. Among other things dished-in heads were welded on to seamless steel tubing. Some of the samples were annealed before testing, while in others the joint was welded in the same manner as the Winslow boiler tubes are welded into their headers.

The tests, in the opinion of the author, seem to show that acetylene welds of joints of the type tested can be made as strong as the tube itself. Sections of welds have been etched with a mixture of sulphuric and hydrochloric acid for about 6 hours, and the difference in appearance between the original tube and the added material was hardly discernible.

In the test with dished-in heads welded on to a seamless steel tubing, at a pressure of about 2500 lb. one dished head bulged out, the action having the appearance of the head being of rubber. This distortion strained the weld, which tore at 3000 lb. per sq. in. It is also interesting to note that in several cases a rupture occurred, not in the weld, but near it.

Similar tests were made with electrically welded joints, with the result that they appeared to be poorer than acetylene-welded joints under pressures exceeding 3000 lb. Many of the samples discharged sufficient water through a large number of very fine holes to prevent the pressure from being carried higher than 5000 lb. per sq. in. (*Power*, vol. 44, no. 23, p. 772, December 5, 1916, 3 pp., 10 figs., *e*)

Steam Motor Vehicles, Abner Doble

General discussion on steam-driven road vehicles such as automobiles, with a description of the Doble system.

One great disadvantage of the steam car has been the insufficient mileage that was obtained from the water that could be conveniently carried. The usual car did not carry condensing apparatus which would enable it to make continuous runs of much more than 100 miles without refilling. The honeycomb radiator was not used because it was feared that the thick oil was liable to clog the extremely small passages and that the exhaust steam was liable to melt the solder. It

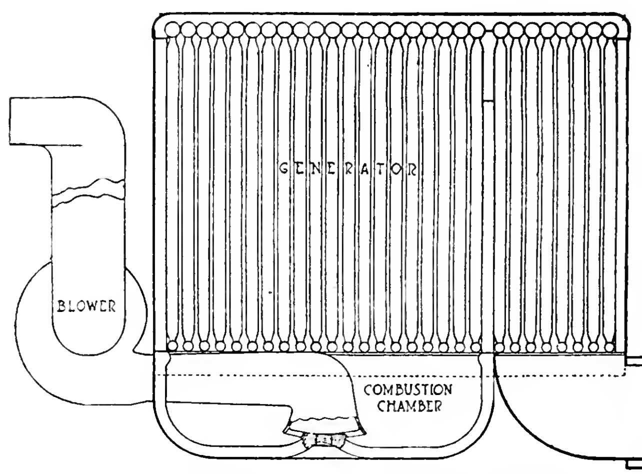


Fig. 13 Doble Steam Generator for Motor Vehicles

was also believed that oil would injure the boiler by causing violent foaming, as the successful lubrication of the steam engine required a heavy oil. The writer states that he put a honeycomb radiator on a car and operated it with a fire-tube boiler in 1913. He found that the car would run anywhere from 1000 to 1500 miles at one time on 24 gal. of water, the boiler operation being entirely unaffected by the oil pumped into it from the engine cylinder.

The selection of the type of boiler was a serious problem. The steam generator, Fig. 13, is a flash generator in theory, yet has the appearance of a water-tube boiler and has a water level in the evaporating zone. The close and regular heating surfaces give heat-transfer conditions resembling those of a fire-tube boiler, but the water flow in counter-current to the flow of the gases and with no circulatory flow is characteristic of the flash type. The water enters at the bottom of an economizer zone and flows to the top under the action of the pumps and gravity, the hottest water collecting at the top. From there the water overflows through a connecting pipe into an evaporating zone, where it is converted into steam. The water level is maintained to half way up the generator by an automatic by-pass valve so arranged that when the regulator tube is filled with steam the by-pass valve is closed

by the expansion of the tube, forcing the water from the pumps to lift the check valve. The water can then enter the generator. As the water level rises, the regulator tube is filled with water from an exhaust pipe leading from the water manifold. This water is not in circulation in the generator and therefore remains quite cool. The regulator tube then contracts and opens the by-pass valve, allowing the water to return to the tank.

The generator tubes are vertically swaged at the ends to half their diameter and welded into horizontal headers top and bottom.

An important disadvantage of steam cars in the past has been the loss of time in getting the burner started to raise steam. The writer tried to use a carburetor and spark plug with the blower driven by an electric motor to furnish the requisite air. Means were also found to use kerosene for starting, without recourse to gasoline. For this purpose conditions were established under which kerosene could be ignited by an electric spark. Thus, in the complete apparatus there is an electric motor directly connected to a multivane blower and a graduated kerosene pump. This pump draws a measured quantity of fuel from the supply tank and forces it through the atomizing nozzle, the resultant fog being ignited by a spark plug. To stop the combustion it is only necessary to break the blower-motor circuit. The starting of the fire takes about 6 min. and requires the care of the operator until it is going well. After the fire is started, steam is made quickly. The engine used is a single-expansion uniflow engine with a cut-off at 5 per cent of the stroke. The engine directly geared to the axle with a 47 to 48 ratio can produce enough torque to slip the driving wheels on dry ground. (*S. A. E. Bulletin*, vol. 11, no. 2, p. 158, November 1916. 8 pp., 3 figs. *d*)

Gas-Firing Installations for Steam Boilers, Pradel

Continuation of a serial article. The beginning of the article has not been abstracted, as the issues of the paper containing it have not yet been received by the Library, apparently because of the delays and uncertainties in the delivery of mails coming from Germany. It may also be stated in this connection that a number of technical periodicals have not been received because of the prohibition, by the German Government, of the export to the belligerent and neutral countries of certain technical and medical publications.

Among other things, the article describes safety devices used on the burners and piping in gas-fired boiler plants. Wherever gas firing is used, there is always the danger of the formation of an explosive mixture of gas and air. In particular, irregularities in gas pressure, such as excessive pressure or excessive velocity of the flow of gas, may tear away the flame and extinguish it for a short period. Then the continuation of the flow of gas into the firing chamber will gradually fill it with the mixture of gas and air, which may be subsequently ignited by contact with the hot walls and cause an explosion. Excessively low pressure in the gas piping may also lead to an explosion through the penetration by suction of air into the gas piping, and the consequent formation of an explosive mixture.

The Moll safety shut-off valve is proposed as a means to combat this danger. The Moll burner can be applied only where each firing chamber has one separate burner. Where a single firing chamber requires such a large amount of gas that several burners have to be installed, the Moll burners are arranged in such a manner that one burner, usually the middle one, acts as an igniting burner.

Such an arrangement is shown in section in Fig. 14. The main firing burner *a* has an auxiliary igniting burner *b* supplied with gas independently from the main burner installation, and so arranged that it can be operated independently of the same. The flow of gas from the main burner installation is automatically cut off until the igniting burner is cut in, and until it has, by the use of the reducing flame, entirely consumed the oxygen present in the air in the firing chamber. With this in view, the igniting burner is provided with a valve gear connected with the handwheel of the cut-off valve *d* regulating the gas admission to the main firing system. When the igniting burner is cut out, this mechanism grips the handwheel of the valve, and does not relieve it until the igniting burner has been cut in again.

Safety devices to protect against variations of pressure in the supply of gas and explosions produced thereby, are usually built into the gas piping proper. Essentially, they are regulators of pressure, limiting the pressure either outward or downward. In the first place, when the maximum pressure is exceeded, a by-pass is opened for the gas; in the sec-

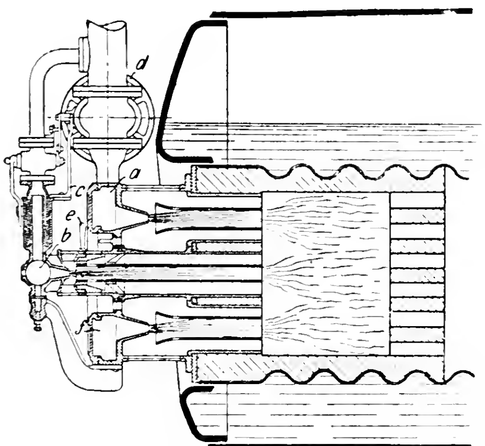


Fig. 14 Moll Burner with Pilot and Main Fires

ond place, when the pressure reaches its lowest limit, the gas supply is entirely cut off. Salau & Birkholz, for example, use a device wherein the gas-admission cocks on the burners are provided with wires attached to a minimum pressure regulator. At a certain definite minimum pressure, the regulator releases a weight, the fall of which instantly closes the cocks on all the pipes leading to a given battery of boilers.

In safety installations of this kind it is essential that the opening of the by-pass or the closing of a gas valve by the pressure regulator be of such a nature that the reverse action should not take place when the pressure reaches its normal level. The device should be so arranged that it can be reopened only by hand. This is so provided in the safety cut-off valve of the Westfalische Maschinenbau-Industrie Gustav Moll & Co., A.-G., in Neubeckum, shown in vertical section in Fig. 15. The pressure governor consists of a bell *a* immersed in a cup on the gas piping *b* filled with an inert liquid, the device being so arranged that the immersion takes place when the supply of gas falls below a certain limit. When the bell reaches its lowermost position, the pendulum *c*, suspended from the cover of the valve, moves downwards until it reaches a small groove in the bell, and thereby prevents it from rising again. The pressure of the gas then begins to act on the

liquid [illegible] at level a_0 and raises it to the position indicated by [illegible], corresponding to the highest permissible gas pressure, in such a manner that no further flow of gas can occur. The rise of the level of the liquid in the gage glass indicates to the fireman that full gas pressure is again available. In order to admit gas again to the burners, the pendulum holding the bell must be released by pulling on the handle f, or pressing down the lever g, whereupon the bell will be raised by the gas pressure far enough to permit the flow of gas through the orifices h.

The valve can be so devised that the bell may be held in place during the course of operation, that is, even when the pressure is below normal.

The article also describes the safety cut-off valve built by P. Hoss in Langenbockum, shown in section in Fig. 16. The chamber a is built in onto the gas pipes l and g, the pipes entering into the chamber by means of elbows b and b_1. Over the chamber a is located a water-filled chamber i, with a valve p on the bottom, this valve closing the short pipe k leading to the chamber a. The valve p is operated by the lever rod f,

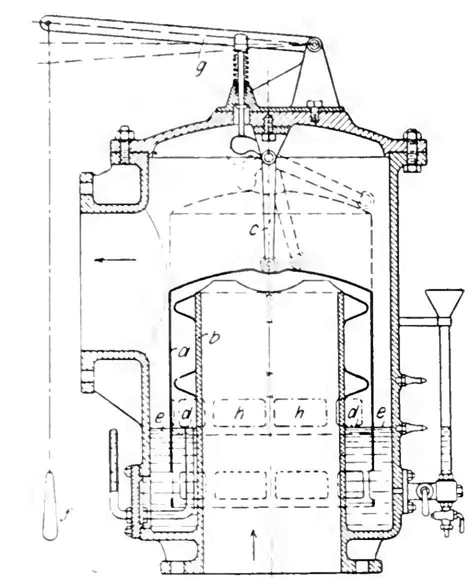


Fig. 15 Moll Automatic Safety Cut-off Valve

of which the dead weight may be equalized by the adjustable weight m in such a manner that the flow of gas is prevented from opening the valve p, which in this case is no longer supported by the flap v. In the chamber a are likewise located the floats c and c_1, running in guide cages e and e_1, these floats being arranged in such a manner that when the water level in chamber a rises they press against the openings of the elbows b and b_1. With the lever system f is connected an electric contact, in such a manner that it announces, by the ringing of the bell, the closing of the valve. The amount of water is so proportioned that the openings in the elbows b and b_1 are just covered over, but no water can penetrate into the gas piping proper. In order to start the flow of gas after some trouble has occurred, all that is necessary is to let off some water from chamber a by the cock n, and to fill anew the water chamber i, which is usually provided with a water gage and peep glass.

Gasteuerungen für Dampfkessel, Pradel, *Zeitschrift für Dampfkessel und Maschinenbetrieb*, vol. 39, no. 40, p. 315, October 6, 1916, serial article, not finished, *d*)

Varia

The Engineering Society, Its Past, Present and Future Activities, Ernest McCullough

Discussion of the objects and policies of engineering societies, with special reference to the conditions in Chicago.

The writer claims that while the engineer has become a technical man with a vocation recognized alongside the older professions of law, medicine and theology, the technical and engineering societies have not kept pace with this development. They still consider themselves as institutions organized solely for educational purposes, and the society proceedings have become encyclopedias which are consulted less frequently than are the pages of the journals maintained purely for profit.

The writer believes that the young man in the engineering society feels that he has not been paid the proper attention, and that "Engineering societies have for many years past been mutual admiration societies of successful men." The discussions at the meetings are too frequently inadequate, and real criticism is seldom developed when the author of a paper is of a commanding eminence. The young man learns something from the papers, but he feels diffident about discussing them, as he fears that his opinion would not be well received. "Get a reputation first," is the attitude of too many authors when they write a closure to a discussion.

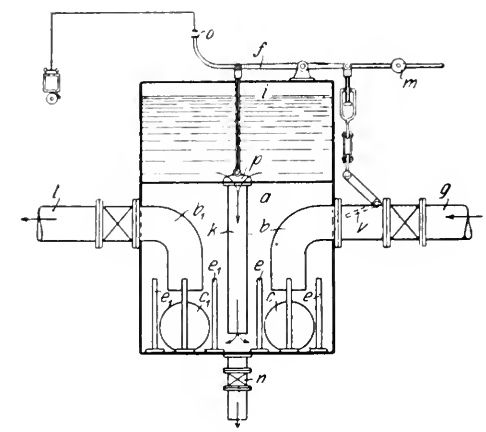


Fig. 16 Hoss Safety Cut-off Valve

The young man does not want this. He wants fellowship, companionship, and definite recognition. He is glad to attend a meeting where he knows refreshments will be served, not because of the refreshments, but because something to eat and drink signifies a lack of formality and perhaps an opportunity to mingle freely with men who have made their mark. He wants to feel that the society is more than an editorial body or an encyclopedic compilation of engineering facts.

The writer states that the young man is the central idea of the present policy of the Western Society, beginning with the new constitution of 1911, which provided for a grade known as student members.

The writer proceeds to discuss technical societies organized in Chicago by the younger generation of engineers, such as The Associated Technical Men and The American Association of Engineers, and in discussing their programs touches upon the activities of the Western Society of Engineers in connection with legislation—in particular, the licensing of engineers in the State of Illinois. As the author states, engineers were opposed to legislation to license engineers, but conditions in

the State of Illinois became so intolerable on account of the monopoly given to architects that The Western Society of Engineers obtained last year the passage of a law to license structural engineers. Further effort is being made to secure a lien law for engineers.

As regards publicity, the writer believes that the societies heretofore have concerned themselves with the publicity work of individuals. What is now a crying need is publicity work of a proper sort by the societies for the benefit of the membership, and incidentally of the technically educated men not members of any society.

It is the duty of engineering societies to break away from precedent and get back to first principles. They must become again the places where the interests of the young men are the concern of the older men. (*Journal of the Western Society of Engineers*, vol. 21, no. 8, p. 697, Oct. 1916, 12 pp. *g*)

Some Essential Features of High-Speed Engines. A. F. Milbrath

Discussion of the design of high-speed engines.

Such engines are built primarily for racing, where maximum output is the main consideration. To adapt them for stock cars certain modifications would be required to insure durability as well as to reduce the cost of manufacture. All of these modifications tend to reduce speed and mean effective pressure, so that the output is smaller as compared with that of the racing engine. The result is a compromise between high output on the one hand and durability on the other. The data presented in this paper are the result of several years' experimental work. Only the most important features are here abstracted.

In a high-speed engine a small diameter of cylinder with the long stroke is favorable, since the weight of the piston increases with some power of the diameter between the second and third, while the inertia forces on the piston vary likewise as long as the piston speed is constant. On the other hand, however, the weight of the engine will increase with the longer stroke, while the valve area will decrease with the smaller bore unless large valve pockets are used. The heat lost to the jacket water will be the less the smaller the area exposed to the gases in the cylinder. A shorter stroke has therefore its advantages. In Europe, stroke-bore ratios as high as 2 have been used successfully. From the author's experience ratios of 1.70 or 1.75 have given good results in 300-cu.-in. engines.

The volume of compression space should be about 18 to 20 per cent of the total volume, which will give compression pressures of about 90 to 110 lb. per sq. in. gage.

As to ignition, the author prefers two-point ignition with spark plugs on opposite sides, as, in his opinion, this gives more rapid combustion, more power, and reduced fuel consumption. As to valve springs, in actual practice at engine speeds of 3000 r.p.m. spring tensions of 80 lb. with valve seated have been satisfactory on $1\frac{3}{4}$-in. valves weighing, with accompanying reciprocating parts, 0.9 lb. For higher speeds greater spring tensions are necessary, which, however, involves difficulties in securing springs that will stand up for any length of time.

As to pistons for high-speed engines, the most important consideration is light weight. Aluminum-alloy pistons have the advantage of ease of manufacture, light weight, heat conductivity, and ample strength. Wristpin bearings can be formed directly in the aluminum. Thicker rings should be used, however, as thin rings are apt to wear into the aluminum, and this causes a gradual widening of the grooves.

Connecting rods should be light, but great strength is also necessary. Connecting rods, pistons and all the reciprocating parts must be balanced perfectly to insure freedom from vibration.

The writer discusses in detail the matter of crankshafts. He believes that with the shaft of liberal dimensions, sufficient mass is secured to absorb any vibrations set up by the light pistons and rods. No further balance weights are necessary, especially if the ratio of connecting-rod length to stroke is 2 or slightly greater. (*S. A. E. Bulletin*, vol. 11, no. 2, p. 115, November 1916, 8 pp., 1 fig. *g*)

Specification and Tests of the Transparency of Paper and Tracing Cloth

The Bureau of Standards, Department of Commerce, has just published a Circular under the above title (Circular No. 63). It describes a method of quantitatively specifying transparency for practical purposes, states the form of the specification and gives a description of the apparatus used to make measurements.

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

A gasoline-driven two-furrow plow used in England weighs about 2300 lb. and develops about 11 h.p., requiring about 2 gal. of gasoline per acre plowed.

According to *The Engineer* (London), silver alloyed with 2 per cent of palladium forms a good substitute for platinum in contact-point and spark devices. The alloy which gives the greatest resistance to spark erosion is 60 per cent palladium and 40 per cent silver. Palladium raises the melting point and lowers the thermal conductivity.

In an interesting publication entitled "Personal Reminiscences of James Mapes Dodge," Charles Piez, Mem.Am.Soc. M.E., tells of the struggles, early failures and final great successes of one of the most commanding figures in American invention and engineering, and shows the genial, charming personality of Past-President Dodge, who did much to shape our present-day industrial ideals.

Professor W. F. Durand, on behalf of the National Advisory Committee for Aeronautics, is planning during the coming year to install at Leland Stanford Junior University, California, an aerodynamic laboratory for experimental investigation of problems in which the committee is concerned, and with special reference to the investigation of aerial propellers. He will undertake during the coming year in this laboratory an experimental investigation of such propellers, covering some fifty different forms of models, and with a view to the establishment of reliable design constants and characteristics for the use of naval and military designers and as a general aid to commercial designers in the development of this feature of the aeroplane.

SELECTED TITLES OF ENGINEERING ARTICLES

AIR MACHINERY

Air Delivery Factors of Blowing Engines, W. Trinks. The Blast Furnace and Steel Plant, December 1916, 3 pp., 3 figs.

High Pressure Air Compressors, Joseph M. Ford. Engineering, vol. 102, no. 2653, November 3, 1916, 2 1/6 pp., 7 figs.

AUTOMOBILES

The Necessity for Limiting the Load, Speed and Size of Vehicles, Eugene W. Stern. Motor Travel, vol. 8, no. 6, November 1916, 4 pp., illustrated.

† Many Factors in Brake Design, John Younger. The Automobile, vol. 35, no. 22, November 30, 1916, 3 pp.
Tire adhesion, road and wind resistance and the personal equation—brakes on two wheels are enough.

† Methods of Comparing Automobile Performance, Walter T. Fishleigh. S. A. E. Bulletin, vol. 11, no. 2, November 1916, 23 pp., 5 figs.

Plant at the Martino's Treating and Testing Works, Ltd. The Automobile Engineer, vol. 6, no. 96, November 1916, 3 pp., 7 figs.

The Determination of Headlight Glare. The Automobile, vol. 35, no. 21, November 23, 1916, 3 pp.

CONVENTIONS

Safety Engineers Hold Huge Meeting. The Iron Trade Review, October 26, 1916, 5 pp.
Fifth annual congress of the National Safety Council convened in Detroit at a record breaking gathering; many lines of industry represented; iron and steel sessions are of unusual interest.

Railway Electrical Engineer's Convention. Railway Electrical Engineer, vol. 7, no. 18, 9 pp., illustrated.

Industrial Accident Prevention Conference. Monthly Bulletin, Pennsylvania Department of Labor and Industry, vol. 3, no. 5, May 1916.

Naval Architects' Annual Meeting. International Marine Engineering, vol. 21, December 1916, 10 pp.

National Founders' Association Meeting. The Iron Age, vol. 98, no. 21, November 23, 1916, 1 p.

A New National Industrial Organization. The Iron Age, vol. 98, no. 20, November 16, 1916, 3 pp.

ENGINEERING MATERIALS

† The Combustion and Fireproofing of Wood: Some Minute Reactions, James Scott. The Railway Engineer, vol. 37, no. 442, November 1916, 2 pp., 3 figs.

Sulphur Effects on Low Carbon Steels, Carle R. Hayward. Steel and Iron, November 1916, 3 pp., 1 fig.

† The Tensile Strength of Asbestos Rope When Exposed to Fire. Engineering, vol. 102, no. 2654, November 10, 1916, 1 p.

Theory and Practice of Alloys with Low Fusing Points. The Metal Industry, vol. 9, no. 10, Setpember 8, 1916, 2 pp.

† Modern Ideas in Heat Treatment. The Iron Trade Review, November 23, 1916, 3 pp., 4 figs.

Recrystallization after Deformation. The Iron Trade Review, November 23, 1916, 3 pp., 2 figs.

Heat Treatment of Brass in Neutral and Reducing Atmospheres, Alfred H. White and Bert A. Standerline. The Metal Industry, vol. 9, no. 19, November 10, 1916, 2½ pp.

Cupro-Vanadium: Its Value in Vanadium Bronzes, James Scott. The Metal Industry, vol. 9, no. 19, November 10, 1916, 1¾ pp., 3 figs.

Special Aircraft Steels, I. Defects. The Practical Engineer, vol. 54, no. 1551, November 16, 1916, 3¾ pp.

Heat-Treatment of Automobile Steels, Robert R. Abbott. S. A. E. Bulletin, vol. 11, no. 1, October 1916, 12 pp., 11 figs.

Aluminum in Modern Automobile and Aviation Construction, James E. Diamond. S. A. E. Bulletin, vol. 11, no. 1, October 1916, 16 pp., illustrated.

Heat-Treatment of Steel, Martin Syte. Machinery, vol. 23, no. 4, December 1916, 6 pp., 13 figs.

Preventing the Corrosion of Pipe, F. N. Speller. The Iron Trade Review, vol. 59, no. 22, November 30, 1916, 4 pp., 3 figs.

Air Furnace Iron for Cast Iron Wheels, Charles V. Slocum. The Foundry, vol. 44, no. 12, whole no. 292, December 1916, 4 pp.

Carbonization of Wrought Iron in Gases, F. W. Harbord. The Blast Furnace and Steel Plant, December 1916, 2 pp., illustrated.

Effect of Sulphur and Phosphorus on Steel. The Iron Age, vol. 98, no. 23, December 7, 1916, 3 pp.

Properties and Defects of Steel Ingots. The Iron Age, vol. 98, no. 23, December 7, 1916, 2 pp.

Pruefung von Gummi und Chromleder auf Verwendbarkeit als Fugendichtung bei Schleusen, Von B. Stock. Mitteilungen aus dem Königlichen Material prufungsamt, vol. 32, January 1914, 11 pp., 5 figs.
Tests of rubber and chrome-leather for use in cup packing.

FOUNDRY

Moulding and Casting Cylinder Liners, F. Andrew. Mechanical World, vol. 9, no. 1559, November 17, 1916, 1 p., 10 figs.

Use of Borings in Cupola Operations. The Foundry Trade Journal, and Pattern Maker, vol. 18, no. 179, November 1916, 2 pp.

FUELS AND FIRING

Alcohol—The Fuel of the Future, Bernard N. Glick, M.Sc. The Automobile, vol. 35, no. 22, November 30, 1916, 3 pp., illustrated.

A Pneumatic System for Burning Powdered Coal. Compressed Air Magazine, vol. 21, no. 11, November 1916, 1 p., 1 fig.

The Cost of Coal, Geo. Otis Smith and C. E. Lesher. Science, vol. 44, no. 1144, December 1916, 10 pp.

The Cost of Coal, Geo. Otis Smith and C. E. Lesher, United States Geological Survey, November 14, 1916, 13 pp.

The Economic and Scientific Treatment of Coal, Sydney H. North. Cassier's Engineering Monthly, vol. 1, no. 5, November 1916, 4½ pp.

Modern Practice in Fuel Briquetting, W. P. Frey. Coal Age, vol. 10, no. 24, December 9, 1916, 4 pp., 6 figs.

Feuerungsanlagen mit Künstlichem Zug. Schweizerische Bauzeitung, vol. 68, no. 15, October 7, 1916, 2 pp., 2 figs.
Firing installations with mechanical draft.

FURNACES

Electric Ovens in an Automobile Plant. The Iron Age, vol. 98, no. 22, November 30, 1916, 5 pp., illustrated.

HEATING AND VENTILATION

Betrachtungen über mechanische Lüftung, Konrad Meier. Schweizerische Bauzeitung, vol. 68, no. 20, November 1916, 5 pp.
Mechanical ventilation.

The Frequent Bursting of Hot Water Pipes in Household Plumbing Systems, F. C. Brown. Physical Review, vol. 8, no. 5, second series, 4 pp.

Newly Collected Data on Heating and Ventilation, Edward B. Johnson. The Heating and Ventilating Magazine, vol. 13, no. 11, November 1916, 6 pp., 4 figs.
Heat losses through building materials, B.t.u. required for heating air, rules for computing radiation, recessed radiators, enameling radiators.

Central Heating and Power Plant, University of Toronto, L. M. Arkley. The Power House, vol. 9, no. 11, November 1916, 6½ pp., 14 figs.

HYDRAULICS

Macchine idrauliche, Prof. Ing. J. Dejust. L'Industria, vol. 30, no. 44, October 29, 1916, 3 pp., 2 figs.
Hydraulic machines.

Large Modern Lock Gates, Malcolm Elliott. Journal of the Western Society of Engineers, vol. 21, no. 8, October 1916, 37 pp., 7 figs., plates.

Meeting Increased Load Demands. Practical Engineer, vol. 20, no. 22, November 15, 1916, 6 pp., 7 figs.
Large hydraulic elevator and modern air conditioning and sewage disposal apparatus added to power plant equipment of Boston Store, Chicago.

Sur la Transmission des Coups de Bélier dans les Conduites Présentant des Bifurcations. Application aux Cheminées d'Équilibre, M. Dennis Eydoux. Comptes Rendus Hesdomadaires des Séances de L'Académie des Sciences, vol. 163, no. 15, October 9, 1916, 5 pp.
Transmission of water-hammer in forked conduits.

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Concerning a rational theory of the coefficient of hydraulic contraction.

IGNITION

Philbrin Battery Ignition System. The Horseless Age, November 15, 1916, 2 pp., 5 figs.

Spark Plugs, Lieut.-Com. J. O. Fisher, U. S. N. Journal of the American Society of Naval Engineers, vol. 28, no. 4, November 1916, 6 pp.

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INTERNAL COMBUSTION ENGINEERING

SKANDIA ENGINES MADE IN SAN FRANCISCO. Motorship, vol. 1, no. 6, October, 1916, 2 pp., illustrated.

350 B. H. P. CROSSHEAD TYPE DIESEL ENGINE. The Engineer, vol. 122, no. 3176, November 10, 1916, 3 pp., 9 figs.

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CONSTANT PRESSURE CYCLE TRULY EFFICIENT. Arthur B. Browne and Herbert Chase. The Automobile, vol. 35, no. 22, November 30, 1916, 2 pp., 1 fig.

AUTOMOBILE-ENGINE CYCLES OF THE FUTURE. Herbert Chase. S. A. E. Bulletin, vol. 11, no. 2, November, 1916, 21 pp., 3 figs.

LUBRICATION OF SLIDE VALVES FOR SUPERHEATER. Cassier's Engineering Monthly, vol. 50, no. 3, September, 1916, 3 pp.

TESTS WITH GASOLENE-KEROSENE MIXTURES. The Gas Engine, vol 18, no. 12, December, 1916, 1 p.

FOUR-CYLINDER DOUBLE ACTING GAS ENGINE. The Engineer, vol. 122, no. 3177, November 17, 1916, 1 p., 4 figs.

†SOME ESSENTIAL FEATURES OF HIGH SPEED ENGINES. A. F. Milbrath. S. A. E. Bulletin, vol. 11, no. 2, November, 1916, 8 pp., 1 fig.

TRIALS OF A DIESEL ENGINE, AND APPLICATION OF ENERGY-DIAGRAM TO OBTAIN HEAT BALANCE, F. Trevor Wilkins. The Journal of the Institution of Mechanical Engineers, no. 8, November, 1916, 25 pp., 10 figs.

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THE KNOX 300-H.P. AERO ENGINE, G. Douglas Wardrop. Aerial Age, vol. 4, no. 10, November 20, 1916, 2 pp., illustrated.

KNOX AVIATION TWELVE TESTED. The Automobile, vol. 35, no. 20, 5 pp., illustrated.

†TRUCK AND TRACTOR ENGINES, H. L. Horning. S. A. E. Bulletin, vol. 11, no. 1, October, 1916, 19 pp., 3 figs.

MACHINE SHOP

GALT MACHINE SCREW COMPANY—ITS PLANT EQUIPMENT AND PRODUCT. Canadian Machinery and Manufacturing News, vol. 26, no. 18, November 2, 1916, 5 pp., illustrated.

MESTA DEVELOPS NEW GEAR PLANER. The Iron Trade Review, October 26, 1916, 1 p., 2 figs.
Pittsburgh company designs new machine for cutting herringbone gears and pinions. The gear blank is held rigid while tool goes through three different motions to properly cut tooth.

PRINCIPLES AND APPARATUS EMPLOYED IN TESTING LIMIT GAUGES, R. T. Glazebrook. Canadian Machinery and Manufacturing News, vol. 16, no. 20, November 16, 1916, 4 pp., 4 figs.

CONTROL MECHANISM OF BORING AND TURNING MILLS. The Mechanical Engineer, vol. 38, no. 982, November 17, 1916, ½ p., 1 fig.

BOILER REPAIRS MADE BY OXY-ACETYLENE AND ELECTRIC WELDING PROCESS AT WAYCROSS SHOPS, D. M. Pearsall. Southern and Southwestern Railway Club, vol. 13, no. 11, September, 1916.

TOOLS USED IN THE MACHINING OF MOTOR PARTS. Robert Mawson. American Machinist, vol. 45, no. 23, December 7, 1916, 3 pp., 11 figs.

UNUSUAL FLUE WORK AND TOOLS IN A RAILROAD SHOP. American Machinist, vol. 45, no. 23, December 7, 1916, 2 pp., 5 figs.

SCREW MACHINE EQUIPMENT, Oskar Kylin. The Iron Age, vol. 98, no. 22, November 30, 1916, 2 pp., illustrated.

JIGS USED IN THE MACHINING OF MOTOR PARTS. Robert Mawson. American Machinist vol. 45, no. 22, November 30, 1916, 2 pp., illustrated.

DOUBLE-HELICAL GEAR CUTTER. American Machinist, vol. 45, no. 22, November 30, 1916, 3 pp., 4 figs.

THE MANUFACTURE OF PUNCHINGS, C. W. Starker. American Machinist, vol. 45, no. 21, November 23, 1916, 6 pp., 7 figs.

PLANTS OF REMINGTON ARMS COMPANY, Hugh M. Wharton. American Machinist, vol. 45, nos. 21 and 22, November 23 and 30, 1916, 11 pp., 18 figs.

PROFILE AND INDICATING GAGES, Douglas T. Hamilton. Machinery, vol. 23, nos. 3 and 4, November and December, 1916, 27 pp., 108 figs.

ACIERS À OUTILS—TRAVAUX DE CHARIOTAGE ET DE FRAISAGE, P. Denis. Revue de Métallurgie, vol. 13, no. 3, May, June 1916, 3 pp.
Tool steels in cutting and milling.

MECHANICAL DIE-SINKING, Edward K. Hammond. Machinery, vol. 23, no. 3, November, 1916, 6 pp., 14 figs.

CHANGE-GEAR TABLES FOR SCREW CUTTING, Martin H. Hall. Machinery, vol. 23, no. 3, November, 1916, 1 p.

SPIRAL TYPE BEVEL GEARS, Reginald Trautschold. Machinery, vol. 23, no. 3, November, 1916, 7 pp., 12 figs.

LES ROUS DENTÉES À RESSORTS DES LOCOMOTIVE ELECTRIQUES DU LÖTSCHBERG, TYPE 1 E-1, Prof. Dr. W. Kummer. Bulletin Technique de la Suisse Romande, vol. 42, no. 19, October 10, 1916, 3 pp., 1 fig.
Elastic gear wheels of the Loetschberg electric locomotives.

TAPER THREADING—I. Machinery, vol. 9, no. 215, November 9, 1910, 7 pp., 14 figs.

MEASURING APPARATUS

PROTECTION OF TRACK SCALE PARTS FROM CORROSION. Scale Journal, vol. 3, no. 2, November 10, 1916, 2 pp.

LIQUID MEASURING PUMPS, F. J. Schlink. Technologic Papers of the Bureau of Standards, no. 81, October 27, 1916, 27 pp., 27 figs.

MEASURING THE VISCOSITY OF OIL, H. C. Hayes and G. W. Lewis. The Iron Trade Review, October 26, 1916, 2 pp., 5 figs.
Several existing types of viscosimeters are discussed, the authors believing that most of these are subject to error. A meter based upon a new principle is described.

A LENGTH COMPARATOR FOR DETERMINING LINEAR COEFFICIENTS OF EXPANSION, Wm. L. DeBaufre. Journal of the American Society of Naval Engineers, vol. 28, no. 4, November 1916, 14 pp., 8 figs.

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L'APPLICATION DU PRINCIPE DE SIMILITUDE EN MÉCANIQUE. Bulletin Technique de la Suisse Romande, vol. 42, no. 19, October 10, 1916, 2 pp., plates.
The application of the principle of similitude in mechanics.

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Calculation of foundations for masts.

†FRICTION CLUTCHES, W. G. Gass. Mechanical World, vol. 60, no 1558, November 10, 1916, 2 pp.

†NEUERE BEOBACHTUNGEN UBER DEI KRITISCHEN UMLAUFZAHLEN VON WELLEN. Schweizerische Bauzeitung, vol. 68, no. 18, October 28, 1916, 3 pp., 9 figs.
Modern observations on the critical speeds of shafts.

THE TORSION OF SOLID AND HOLLOW PRISMS AND CYLINDERS, Cyril Batho. Engineering, vol. 102, no. 2656, 2 pp., 2 figs.

STRESSES IN IMPACT, Armin Elmendorf. Journal of The Franklin Institute, vol. 182, no. 6, December, 1916, 20 pp., 9 figs.

SPRINGS, C. E. Squire. The Mechanical Engineer, vol. 38, no. 984, 3 pp., 2 figs.

DE EVENWICHTSVOORWAARDE BIJ SPANNINGS BEREKENINGEN, F. A. Vening Meinsz. De Ingenieur, no. 45, November 4, 1916, 4 pp.

SLAB DEFLECTION AND SUBSIDENCE OF COLUMN SUPPORTS IN A FLOOR TEST OF INTERNATIONAL HALL, CHICAGO, MADE SEPTEMBER 1913, Henry T. Eddy. Journal of The Franklin Institute, vol. 182, no. 6, December, 1916, 10 pp., 2 figs.

DESIGN OF SYMMETRICAL HINGELESS CONCRETE ARCHES, Victor H. Cochrane. Proceedings of The Engineers' Society of Western Pennsylvania, vol. 32, no. 8, November, 1916, 68 pp., 22 figs.

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MANUFACTURING PARTY OF TYPE 80 TIME FUSES, Donald Baker. Machinery, vol. 23, no. 4, December, 1916, 6 pp., 23 figs.

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UNITED STATES MUNITIONS. American Machinist, vol. 45, nos. 20, 21, 22, and 23, November 16, 23, 30 and December 7, 1916, 39 pp., illustrated.

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HARNESSING A VOLCANO TO A 15,000-HORSE-POWER ELECTRIC POWER HOUSE, Professor Luiggi. Engineering, vol. 102, no. 2655, 2 pp.

PUMPS

THE CONDENSATION PUMP: AN IMPROVED FORM OF HIGH VACUUM PUMP, Irving Langmuir. General Electric Review, vol. 19, no. 12, December, 1916, 12 pp., 8 figs.

THE CONDENSATION PUMP: AN IMPROVED FORM OF HIGH VACUUM PUMP, Irving Langmuir. Journal of The Franklin Institute, vol. 182, no. 6, December, 1916, 26 pp., 8 figs.

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DIE LOKOMOTIVEN DER FURKABAHN. Schweizerische Bauzeitung, vol. 68, no. 16, October 14, 1916, 1 p., 1 fig.
Locomotives of the Turka Railroad.

In[illegible] and Intake Lines in Railway Water Service. Railway R[illegible]w, vol. 59, no. 21, November 18, 1916, 5 pp., 10 figs.

P[illegible] Fuel Application to Steam Locomotives, Joel S. Coffin, Jr. Canadian Machinery, vol. 16, no. 21, November 1, 2, 3, 1916, 4 pp., 2 figs.

Car Weight Reduced by Steel Construction. Electric Railway Journal, vol. 48, no. 21, November 18, 1916, 3 pp., 3 figs.
A description of the new steel interurban passenger car recently received by the Northern Ohio Traction and Light Company, Akron, Ohio. These cars combine reasonable weight with substantial construction and weigh 12,000 lbs. less than steel-underframe cars of the same type.

Large Mikado Locomotive Mounted for Fuel Tests. The Railroad Herald, vol. 20, no. 12, November, 1916, 5/6 p., illustrated.

Rail Corrugation Studied in Chicago. Electrical Railway Journal, vol. 48, no. 20, November 11, 1916, 4½ pp., 8 figs.
Investigation of 72 miles of single track reveals corrugations to be as prevalent on ballast foundations as on concrete. Study also leads to the conclusion that curved head rails would greatly reduce the rate and amount of corrugation.

The Kiesel Train Resistance Formulas, A. J. Wood. Railway Mechanical Engineer, vol. 90, no. 12, December, 1916, 2 pp., illustrated.

Modern British Goods Locomotives, E. C. Poultney. Railway Mechanical Engineer, vol. 90, no. 12, December, 1916, 7 pp., illustrated.

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Refrigeration of Perishable Freight in Transit, M. E. Pennington. Railway Age Gazette, second half of 1916, no. 20, November 17, 1916, 5 pp., 6 figs.
A discussion of the efficiency of different types of refrigerator cars and results of tests made on them.

Low Temperature Compression System, Harry Sloan. A. S. R. E. Journal, vol. 3, no. 3, November, 1916, 5 pp.

A Theory of Cooling Towers Compared with Results in Practice, B. H. Coffey and Geo. A. Horne. A. S. R. E. Journal, vol. 3, no. 3, November, 1916, 16 pp., 2 figs., 7 plates, 4 tables.

A Five-Hundred-Ton High Speed Booster Ammonia Compressor, F. L. Fairbanks. A. S. R. E. Journal, vol. 3, no. 3, November, 1916, 9 pp., 10 figs.

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Investigation of Safety Goggles at Underwriters' Laboratories, Sidney V. James. The Armour Engineer, vol. 9, no. 1, November, 1916, 9 pp., illustrated.

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A Study of Heat Transmission in Steam Boilers, Victor R. Gage, The Sibley Journal of Engineering, vol. 31, no. 2, November, 1916, 11 pp., 26 figs.

Draught and Temperature Regulator for Marine Boilers, John Ingham. Cassier's Engineering Monthly, vol. 1, no. 5, November, 1916, 6⅓ pp., 4 figs.

Power and Steam Tests in Central Florida, E. W. Kerr. Sugar, vol. 18, no. 9, September, 1916, 2⅓ pp., 4 figs.

Uniflow Engines as Rolling Mill Drives, W. Trinks. The Blast Furnace and Steel Plant, December, 1916, 4 pp., 5 figs.

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Model underground distribution system employed in connection with power plant of University of Cincinnati.

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†The Engineering Society—Its Past, Present and Future Activities, Ernest McCullough. Journal of the Western Society of Engineers, vol. 21, no. 8, October, 1916, 12 pp.

The Selling of Lead and Zinc, H. J. Stander. University of Arizona Bulletin, no. 39, Metallurgical Series no. 3, November 7, 1916, 8½ pp.
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The Ladder. Iron Tradesman, vol. 76, no. 3, October, 1916, 4 pp., illustrated.

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Production of Chart Used by International Machine Company to Record Progress in Building Machine Tools, Machinery, vol. 9, no. 215, November 9, 1916.

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Chart for Giving Stroke and Floor Space of Cross-Compound Pumps under Different Conditions. Practical Engineer, vol. 20, no. 22, November 15, 1916.

Chart for Selecting Rawhide Pinions, N. G. Near. Machinery, vol. 23, no. 3, November 1916, 2 pp., 2 figs.

Fuel Consumption and Cost Curves on Diesel Engines. Practical Engineer, vol. 20, no. 22, November 15, 1916.

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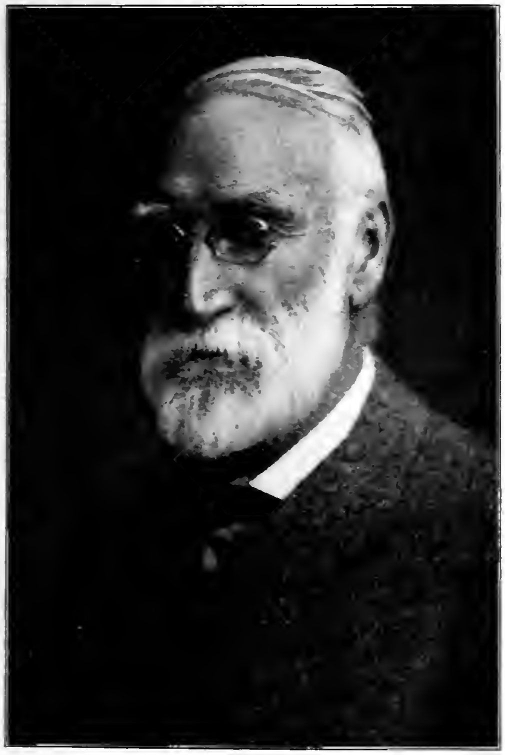
LIBRARY NOTES

From the Library of the United Engineering Society, Engineering Societies Building, New York. Includes Accessions to the Libraries of the Four Founder Societies

Dr. Douglas's Gift

Plans for the expansion of the library of The United Engineering Society are being made which will render the library unique, not only in the collection of technical books and periodicals, but also in the service it will be prepared to render to the members of any branch of the engineering profession.

These plans have been made possible by the initial gift of $100,000 from Dr. James Douglas, as the beginning of an endowment fund which it is hoped will reach $1,000,000. One



Dr. James Douglas

of the initial steps in these plans is to place on the library shelves every engineering periodical published in the world, no matter in what language, and the same broad policy will be followed in the acquisition of reference books.

Dr. Douglas's gift has suggested large possibilities, and with the consolidation of the library of the American Society of Civil Engineers with that of the three original Founder Societies, the ultimate should be a library of universal service to the engineering profession.

Am. Soc. M. E. Accessions

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How You May Save Money in Operating Your Steam Boilers. Ed. 3. Revised by E. L. Webster. Gift of A.S.M.E.

Institution of Civil Engineers. Minutes of Proceedings. Vol. CXCIX. *London, 1915.*

Mechanical Equipment of Buildings, Louis Allen Harding and Arthur Cutts Willard. *New York, John Wiley & Sons, 1916.* Gift of Louis Allen Harding.

Messerschmitt Process for the Reproduction of Hydrogen, H. L. Barnitz. Reprinted from Metallurgical and Chemical Engineering, vol. 15, no. 8, 1916. Gift of author.

Mosquito Control in Panama. The Eradication of Malaria and Yellow Fever in Cuba and Panama, J. A. Le Prince and A. J. Orenstein. *New York, G. P. Putnam's Sons, 1916.* Price $2.50. Gift of publishers.

The joint authors were associated with General Gorgas in Cuba and Panama as chief and assistant chief sanitary inspectors. This book gives a detailed account of the conditions found, the measures adopted for mosquito extermination, and the results obtained. No engineer doing or planning work in the tropics should miss reading this work. The extermination of the mosquito made possible the completion of this gigantic engineering feat. W. P. C.

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An important use for worm gearing is rapidly developing in connection with the reduction of steam turbines for marine propulsion. Other uses are for automobile gears and gears for driving line shafting from electric motors. The mere fact that a second edition is demanded so soon as in three years shows the great interest in this branch of applied mechanics. The author has added to this edition appendices devoted to efficiency, reversibility, and an alternative method of calculating stresses. W. P. C.

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Hunt, Rodney Machine Co. *Orange, Mass.* Catalogue no. 30, Section WCA. Water controlling apparatus.

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Handling coal and ashes in the power house of William H. Grundy Co. with Link-Belt machinery. (Book no. 288.)

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EXCHANGE

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GIFT OF F. K. GILLESPIE

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PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary and items should be received by January 16 in order to appear in the February issue

CHANGES OF POSITION

Manning E. Rupp, for a number of years with the Panama Canal, has accepted a position as superintendent with the Curtis Pneumatic Machinery Company, St. Louis, Mo.

H. O. C. Isenberg has been made chief engineer of the Scripps-Booth Company of Detroit. He was formerly associated with the Ferro Machinery and Foundry Company of Cleveland, O.

Kenneth A. Meserole, formerly in the engineering department of the American Beet Sugar Company, Oxnard, Cal., has become associated with the Stearns-Roger Manufacturing Company, Denver, Colo.

W. M. Imbrie, Jr. recently resigned as superintendent of the Chattanooga Chemical Company to become engineer in charge of construction for the Atlantic Pulp and Paper Company, Savannah, Ga.

Clarence W. Huntington, vice-president and general manager of the Minneapolis and St. Louis R.R., has resigned to accept the chairmanship of the directorate of the Virginian Railway, with office in New York City.

Arthur V. Farr, for the past three years advertising manager of the S.K.F. Ball Bearing Company, Hartford, Conn., has resigned to accept the position of sales manager of the Hess Steel Corporation, Baltimore, Md.

Philip Jones, until recently associated with the Pinal Dome Oil and Refining Companies, Santa Maria, Cal., in the capacity of consulting engineer, has assumed the duties of general superintendent of the Mid Co. Gasoline Company, Tulsa, Okla.

H. H. Lauer has resigned his position as head of the Bureau of Prices of the Midvale Steel Company, Philadelphia, Pa., to accept the position of chief engineer of construction of the Atlas Portland Cement Company, Northampton, Pa.

Charles F. Carpenter has severed his connections with the Fire-Proof Furniture and Construction Company, Miamisburg, O., and has become affiliated with The Recording and Computing Machines Company, Dayton, O., in the capacity of manager of works.

Arthur K. Howell has resigned as sales representative of the Worthington Pump and Machinery Corporation, Memphis, Tenn., and has become associated with A. A. Bonsack, formerly St. Louis manager of the Ingersoll Rand Company. Messrs. Howell and Bonsack plan to carry on a general machinery sales business.

ANNOUNCEMENTS

E. G. Spilsbury has returned from a professional visit to Cuba.

John R. Freeman, Past-President, Am.Soc.M.E., has been elected president of the Providence (R. I.) Gas Company.

The colleges of electrical engineering and civil engineering of the University of Kentucky, Lexington, Ky., have been consolidated, with E. Paul Anderson as dean.

Henry L. Doherty was one of the speakers at the reception to President Wilson in New York when the flood lighting illumination was turned on the Statue of Liberty, December 3.

Clarence E. Kinne of the Bagley and Sewall Company, Watertown, N. Y., has started on a several months' trip through China and Japan for engineering exploitation work, especially in relation to paper mills.

George H. Shepard, until recently connected with the Gould Storage Battery Company, Depew, N. Y., in the capacity of factory superintendent, has taken up consulting practice in efficiency work, with offices in Buffalo, N. Y.

Cornelius Vanderbilt, who has been divisional inspector of the New York National Guard with the rank of major, has been commissioned colonel of the 22d New York Engineers' Regiment, one battalion of which is still on the Mexican border.

APPOINTMENTS

Robert R. Jones, assistant mechanical engineer of the Firestone Tire and Rubber Company, Akron, O., has been appointed chief engineer of the company.

William M. Bastable, manager of the pump department of Fairbanks, Morse and Company, New York, has been appointed manager of the Baltimore branch of the company.

Albert H. Israel has been serving as assistant chief inspector of ordnance for the E. W. Bliss Company, since his return from South Bethlehem as resident inspector.

John Hunter, chief engineer of steam plants for the Union Electric Light and Power Company, St. Louis, Mo., has been chosen to succeed the late A. C. Einstein, as a member of the company's board of directors.

Martin Nixon-Miller, recently assistant engineer, contracting department of McClintic-Marshall Construction Company, in charge of the building operations of their new $1,000,000 bridge shop at Pottstown, Pa., has been appointed by the U. S. Government to take charge of the eight new factory building operations and to install the machinery after the completion of the buildings, at the Frankford Arsenal, Philadelphia, Pa.

AUTHORS OF PAPERS, ETC.

Halbert P. Gillette is the author of a Handbook of Rock Excavation Methods and Costs.

A. W. H. Griepe is the author of Internal-Combustion Turbine, which appears in the December 5 number of *Power*.

George L. Fowler is the author of a book on Anatomy of a Steel Hopper-Bottom Coal Car.

Clinton H. Scovell is the author of a book entitled Cost Accounting and Burden Application.

S. S. Wyer is the author of a book on The Reasonableness and Legal Right of the Minimum Charge in Public Services.

Robert Cramer has contributed an article entitled Pressure Tests of Welded Boiler-Tube Vessels to the December 5 issue of *Power*.

A. A. Potter and W. A. Buck have contributed an article on Four-Cylinder Best Tractor Engine to the December 7 issue of *The Automobile*.

Arthur J. Wood has contributed an article entitled The Kiesel Train Resistance Formulas to the December issue of the *Railway Mechanical Engineer*.

Frederick W. Salmon has contirbuted a brief article on Safe Loads on Rope Slings to the December 21 issue of *Engineering News*.

William Knight has contributed an article on Safe and Noiseless Operation of Cut Gears to the December 14 issue of the *American Machinist*.

Walter V. Turner gave an amusing and instructive address on the subject of Freak Patents before the Railway Club of Pittsburgh, December 18.

Reginald Trautschold contributed an article on Bucket Loaders for Manufactories to the December, 1916, number of *The Engineering Magazine*.

Arthur M. Greene, Jr., vice-president Am.Soc.M.E., is the author of a book on the Elements of Refrigeration: A Text-Book for Students, Engineers and Warehousemen.

W. Trinks is the author of an article on Air Delivery Factors of Blowing Engines which is published in the December number of *The Blast Furnace and Steel Plant*.

Charles P. Steinmetz is the author of an article on Scientific Research in Relation to the Industries, which appears in the December issue of the *Journal of The Franklin Institute*.

Edward C. Poultney is the author of an article on Modern British Goods Locomotives which is published in the December number of the *Railway Mechanical Engineer*.

John E. Starr presented a paper on Accidents in Refrigerating Plants at the December 4 to 6 convention of the American Society of Refrigerating Engineers, held in New York.

R. H. Rice and Sanford A. Moss presented a paper, illustrated by lantern slides, on Blast-Furnace and Steel-Mill Power Plants at the December 12 meeting of the Engineers' Society of Western Pennsylvania.

An abstract of the paper on Specifications for Concrete which was read before the American Society for Testing Materials by Cloyd M. Chapman, appears in the December 7 issue of *The Canadian Engineer*.

H. V. Haight is the author of Special Lathes for 8-In. Shells, which appears in the December 7 number of the *American Machinist*.

Frederick H. Wagner is the author of a book on Coal and Coke, published by the McGraw-Hill Book Company, Inc.

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"To the West, When Wind, Tide and Weather Serve, There is Sufficient Water to Let Out the Fleet . . . Over This Lower Channel, Aswing from Wire Cables from Two Towers, Hangs the Trap's Iron Gate. The Towers Rise from a Populace Friendly to Every Nation in the World but Its Own . . . and Fond of Explosives."—*Sea Power.*

THE DEVELOPMENT OF OUR FLEET AND NAVAL STATIONS

By W. L. CATHCART, PHILADELPHIA, PA.

Member of the Society

My subject, "The Development of Our Fleet and Naval Stations," is so broad that only a rapid review of its salient points will be possible to me.

I need scarcely say that this whole question of naval strength is one of impelling interest to engineers. The European conflict has shown in many striking ways that war by land and sea is now very largely but a matter of applied science, of physics and chemistry, and chiefly of engineering in all its branches.

Years ago, Theodore Roosevelt said, in an expression which has become classic, that the naval officer of our time is fundamentally a "Fighting Engineer." This description is wholly accurate with regard to the structures and mechanisms of naval war—its huge hulls and giant turbines, its colossal guns, its dynamos, wireless, torpedoes, and air craft. The naval officer has added functions as a strategist and tactician, but it is clear that the engineer is a mighty factor in the sea power of our time.

WHY WE NEED A GREAT NAVY

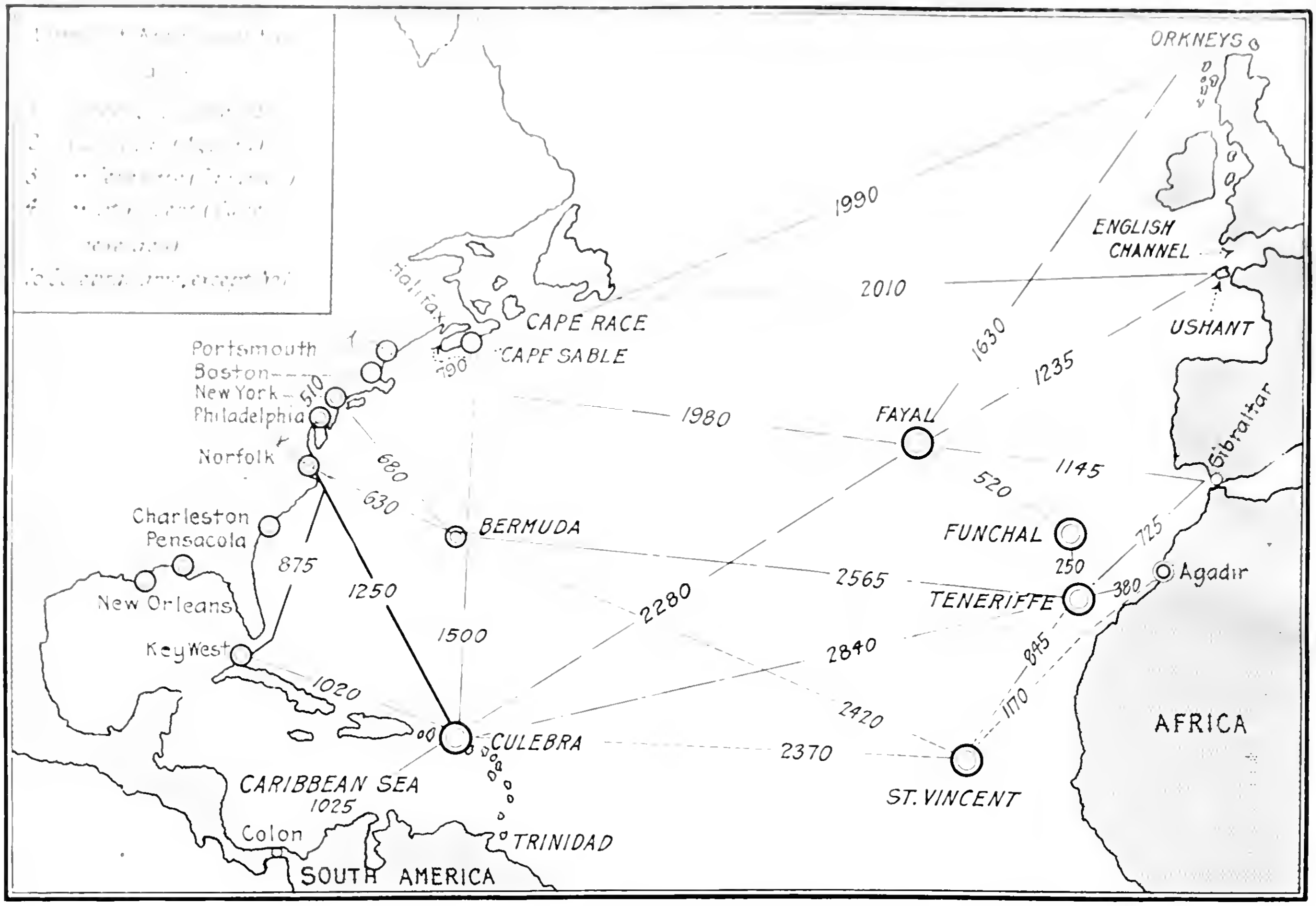
Why does the United States need a great navy? In the first place, our country is the richest, and, owing to its vast extent of coast line, the most vulnerable of all the great Powers. And, second, like a modern Atlas, it staggers—diplomatically and militarily—under the weight of some national policies which, while just, are as world-irritating and war-breeding as any that history has known. These policies are: The Monroe Doctrine, The Neutralization of the Panama Canal, The Maintenance of the Rights of Neutrals, The Exclusion of Asiatic Races, and The "Open Door" in China.

The Monroe Doctrine extends our "political suzerainty over two continents, comprising a fourth of the habitable earth and one-half of its unexploited wealth." Excluding Canada and the United States, this vital and yet war-inviting policy covers twenty republics, having a total area of nine million square miles, a population of eighty millions, and a foreign trade of nearly three billion dollars. And all this is to be guarded from European seizure by the force behind a doctrine which is not international law, but simply a bluff declaration by the United States that Europe shall not enter in!

This doctrine has been a sleeping danger to this Republic for nearly a century now. Its slumber has been due chiefly to the lack of means for the swift transfer of fleets and armies across the Atlantic, and the extreme delicacy of the balance of power in Europe. The progress of steam navigation has swept the first of these away, and, as for the second, who dare predict political conditions in Europe when this war closes?

Now, take the Panama Canal. By international law, it is a part of the territory of the United States, and it is also, as a military and commercial highway, one of the world's greatest prizes. So, we must defend it. Further, by the provisions of the Hay-Pauncefote Treaty of 1901, we agreed that "the canal shall be free and open to the vessels of commerce and of war of all nations"—that is, we guaranteed its neutralization. Either of these obligations necessitates a powerful, fully sup-

Address (abridged) delivered at the Annual Meeting of The American Society of Mechanical Engineers, December 8, 1916.



Courtesy of U. S. Naval War College.

PARTIAL STRATEGIC CHART, NORTH ATLANTIC OCEAN

ported fleet, and neutralization presents as well most complex and dangerous problems for the future.

We have glanced at the possible effects of but two of our national policies, and they alone hold menace enough for the future. Trans-oceanic attack can be met primarily only by a fleet. Do you wonder, then, that naval strategists foresee a time when—not in aggression, but in national defense—the mighty thunder of American guns will roll out in mid-Atlantic or on the sun-lit Caribbean, along the coasts of Europe or at the threshold of the Far East?

The surest way to delay the coming of that time is to have behind the parleys of our diplomacy a naval force stronger than those of our possible foes. All history shows that diplomacy, when backed by guns enough, can keep the peace, but notes without powder behind them are futile.

STRATEGIC SITUATION, EASTERN COAST

The elements of naval strength are: First, the fleet—its ships and men; and, second, its shore stations—navy yards at home and naval bases in our island possessions—which dock, repair, and supply the ships, and from which the fleet may strike. Manifestly, the location of these stations with regard to our possible battlegrounds of the future is of primary importance. Let us glance briefly at the strategic situation of our eastern and western coasts in this respect, as shown by charts whose use is permitted through the courtesy of Rear Admiral Knight, President of the Naval War College, and Captain J. S. McKean, Assistant to the Chief of Operations.

When invasion by a European Power is threatened, our Navy Department will know only that the enemy has set sail from some port across the Atlantic. His specific course and objective—on our coast or in the Caribbean—will be unknown. Our fleet, if strong enough, would take the offensive-defensive, and attack the enemy a thousand miles or more at sea. To locate him, our admiral would send out a long line of scouts to scour the seas in a great arc from Cape Sable in Nova Scotia to Trinidad at the lower entrance of the Caribbean Sea.

There would be four principal points of departure for this enemy fleet: from the Orkneys, the northern base of the British Grand Fleet; from the mouth of the English Channel; from the Straits of Gibraltar; or from some point on the African coast, as Agadir.

On these four lines of approach to our coast the distances range between 2800 and 4200 sea miles. To Culebra—which, if we do not acquire St. Thomas, will be our challenging Caribbean outpost—these lines are from 3200 to 3900 miles long. In the present state of naval science, these relatively great distances make successful invasion impossible, if the enemy fleet must conduct *continuous operations* on our coast *from its home bases*, or even from these eastern Atlantic islands.

There are two main reasons for this. In the first place, a naval force, steaming far from its bases, must be followed by a train of supply vessels, which train becomes huge when that force is large. And, second, fleets cannot invade. So the enemy fleet must be followed by troop transports.

And, further, unless the enemy had previously gained command of the sea, these helpless fleets of transports and supply ships of his must be guarded always while en route throughout the whole period of his operations, and by a stronger force than we could bring against them.

From these considerations, several things are clear: First—disregarding the Caribbean for the time—any enemy but Great Britain must, for successful invasion, first *seize a naval base on our coast*, from which to conduct succeeding operations. To seize that base, he must first *defeat decisively* our fleet—either destroying it, blockading it, or forcing it to withdraw to a distance. Then, and then only, when the enemy has *won command of the sea, will his convoys* of troops and supplies *be safe*.

Naval bases suitable for hostile operations are fairly numerous on our coast. For example, Delaware Bay, Narragansett Bay, Provincetown, Mass., and several others, in their present defenseless state, could be seized with ease if our fleet were first defeated.

As to our naval stations on this coast, they all lie within an air-line distance of 500 miles, although our Atlantic and Gulf coast lines are more than 3000 miles long.

If an enemy should gain possession of these 500 miles of coast, our dreadnaughts would be homeless, unless the fleet could flee to the Bay of Panama, since the yards at Charleston, Pensacola, and New Orleans are equipped for small craft only. As to these conditions, Rear Admiral Edwards says:

"There is not a dry dock owned by the Government or by anyone else on the South Atlantic and Gulf coasts which will take any of our super-dreadnaughts. There is not a single stationary or floating crane on these coasts which will remove from or install in a battleship either a modern turret gun, a Scotch marine boiler, or an assembled low-pressure turbine of the kind now fitted in our large naval colliers, tankers, and battleships."

These conditions give our strategists just cause for concern in their bearing on our undefended line of communications, 875 miles long, from Cape Hatteras to Key West, and on the distance, one-half greater, from Culebra to Norfolk.

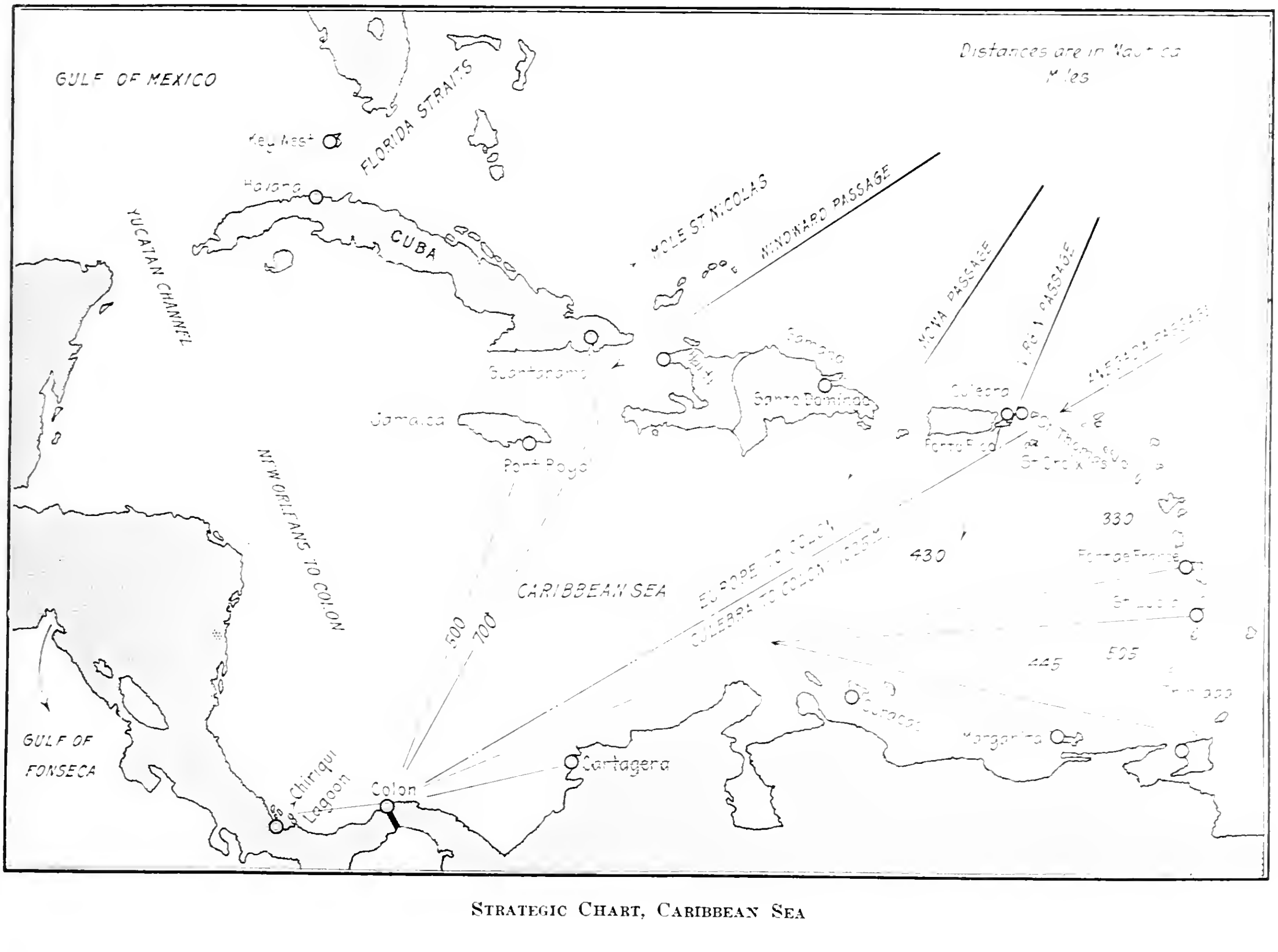
STRATEGIC SITUATION, CARIBBEAN SEA

The Caribbean Sea is—as Admiral Mahan once wrote of it—"preëminently the domain of sea power." For its size, it has more strategic positions than any other important expanse of sea on the globe. For the United States, its mastery in war is almost vital, since that mastery is the bulwark of our defense of the Monroe Doctrine and the Panama Canal.

No invasion of the United States is possible until our fleet has first been put out of the reckoning. If, then, the enemy must thus eliminate our fleet, it seems probable that he would endeavor to force action where our naval strength is most vulnerable—that is, off Culebra, where our ships would be more than 1200 miles from their home bases.

Again, *for continuous operations*, the enemy must have a naval base of his own on or near our territory, and the seizure of a small island would be far easier than that of a base on our coast.

Finally, if thus established at some point like St. Thomas or Culebra, with our fleet negligible for the time, the enemy could raid our South Atlantic and Gulf coasts at will; could flank all our routes to the Caribbean, and when—with full command of the sea—his convoys of troops had come he could invade the Canal Zone, 1040 miles from St. Thomas. Possession of the Canal would give him not only a powerful lever in bringing pressure on our Government, but would enable



Strategic Chart, Caribbean Sea

him to block the retreat of our defeated fleet to Gatun Lake or the Bay of Panama, and to prevent the coming of reinforcements from the Pacific.

Glance now at the geography of the sea. On its northern border lie Porto Rico, which we own; Haiti and Santo Domingo, which are under our virtual protectorate, and Cuba, whose independence we have guaranteed. Doubtless, every port in these islands would be open to our use in time of war.

There are five entrances to the sea along this northern border – the Yucatan Channel via the Florida Straits from the Atlantic, and the Windward, Mona, Virgin, and Anegada Passages. Dominating the Florida Straits stands Havana like a new-world Gibraltar. Near the southeastern end of Cuba lies our base, Guantanamo, which, with Mole St. Nicolas in Haiti, commands the Windward Passage. Similarly, Samana Bay in Santo Domingo controls the Mona Passage, Culebra and St. Thomas the Virgin Passage, and the latter and St. Croix the Anegada Passage, which is the main route from Europe to the Canal.

Jamaica, with its naval base, Port Royal, seemingly dominates all by its central location. But, while Jamaica has thus a commanding strategic position, it is lacking in strength against attack and in its resources for supplies and refitting. Hence, for military support and supplies, it would be dependent in war on its lines of communication with other British colonial and home ports, and from those ports it is both distant and isolated. Further, our base at Guantanamo flanks its communications with all of these ports.

Now as to our two naval bases, Guantanamo and Culebra: Guantanamo is but 700 miles from the Canal, and, as it flanks all routes to Colon except that from Jamaica, its location centrally is almost as good. Further, it has surpassing advantages in the fact that it is on a large island, which has not only great native resources, but also direct railway communication with manufacturing centers in the United States except for the short sea link between Key West and Havana. Hence, supplies can reach Guantanamo by interior land lines immune from attack by sea if the Florida Straits be guarded effectively.

As compared with Guantanamo, Culebra is about 600 miles farther to the eastward, and hence it has a far better command of the eastern entrances to the sea, flanking all routes through them by short runs of 350 to 500 miles. Again, it is but a few miles from Porto Rico, which is in itself difficult of defense. Further, as a little island, it could be fortified and garrisoned at proportionately low expense. And finally, as a salient, it flanks the lines of approach to our coast.

All of these advantages, and more, hold for St. Thomas, just across the Virgin Passage from Culebra. It also is a small island, it is still farther eastward, has a better command of the Anegada Passage, and its harbor can be strongly defended by fortifications in the high hills surrounding it. The best argument for its acquisition by the United States is, however, the negative: Suppose the unthinkable—that we should let St. Thomas pass into the hands of a strong military power unfriendly to us. Then our base at Culebra would be confronted by a rival fortress on the further shore of that narrow Virgin Passage. These conditions would be as if Gibraltar faced an equally formidable and alien "Rock," with but the Straits between.

And *the menace of that fortress would stretch far beyond the Caribbean* to our trade routes to South America, and even to our coast. For within a radius of 1000 to 1400 miles from it lie New Orleans, Key West, Charleston, Norfolk, and New York—a distance through which raiding battle cruisers or even a dreadnaught fleet could steam and fight, with ample fuel remaining for their return, if necessary, to St. Thomas.

We find, then, that the destiny of nations has given the United States full opportunity for holding the strategic mastery of the Caribbean Sea through its present and prospective tenure of predominating positions there. But strategic dominance on the sea means nothing if the sites on which it depends are not fully equipped, fortified, and garrisoned and an adequate fleet based there, since a more powerful enemy would simply wrest them from us. So these neglected West Indian bases of ours give cause for grave concern. *With them, some day, the fate of this Republic may rest.*

STRATEGIC SITUATION, NORTH PACIFIC

Let us close our strategic review with a brief consideration of our western coast and our outlying possessions in the North Pacific Ocean, where remarkable conditions exist.

In the first place, the United States owns on the shores from Panama to Kiska in the Aleutian Islands every important strategic position except three—the Galapagos Islands, Magdelena Bay in Mexico, and Esquimault, the fortified port of British Columbia. Thus, strategically—if these be developed—our power over these shores is predominating for two-thirds the width of that great ocean.

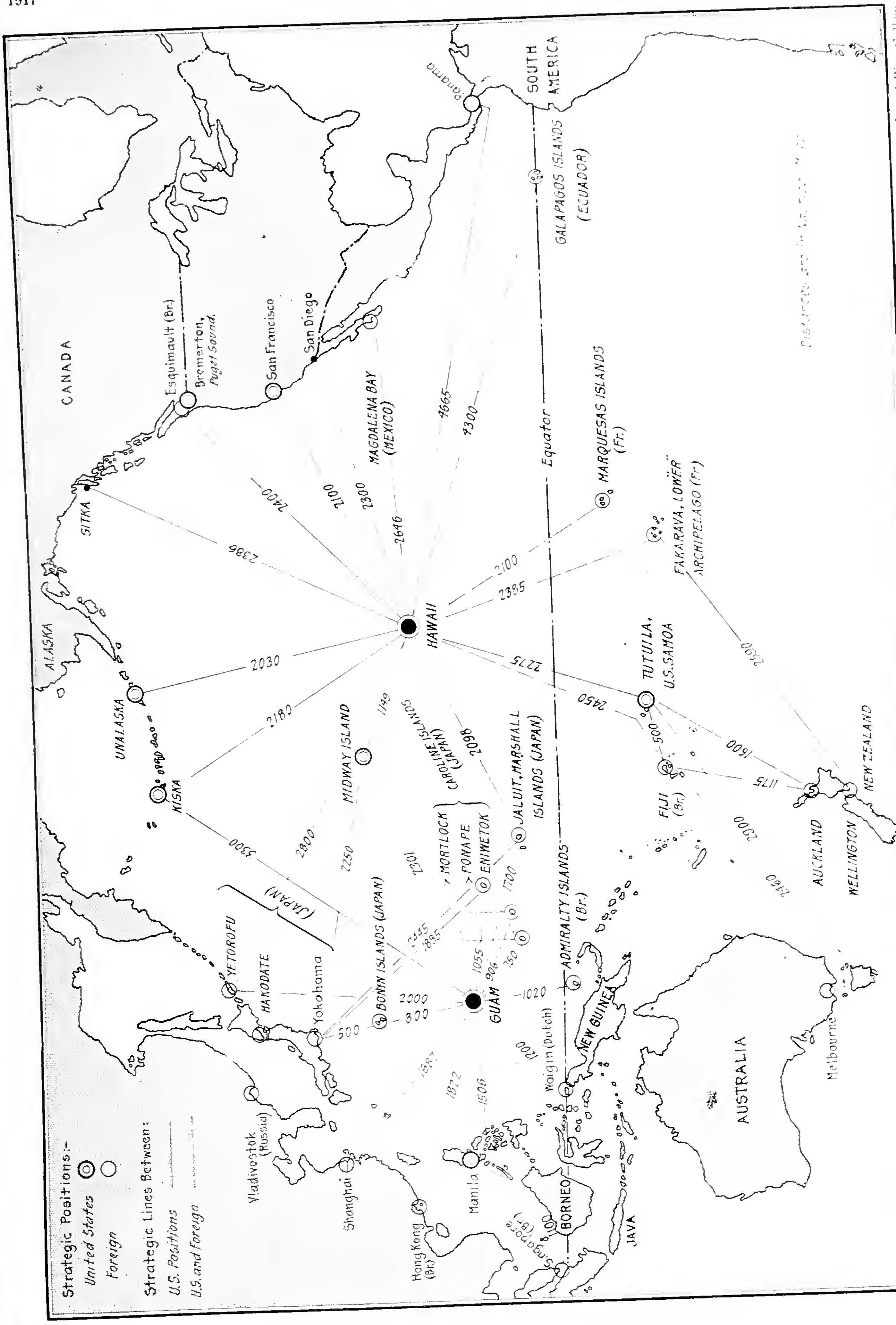
Further, spanning the Pacific like the piers of a colossal bridge from Panama lie our islands of the Hawaiian Group, and our other island, Guam, in the Ladrones, which is *the key to the military control of this northern ocean.* Then 1150 miles west of Hawaii is Midway, useless to us except as a future coaling station. And finally, 2300 miles southward, is Tutuila in American Samoa, one of the noblest harbors in the South Seas.

Steaming at 12 knots an hour from Panama, it would take a fleet 12 days to reach San Francisco, 16 days to Honolulu, 28 to Guam, and 33 to Manila. So no fleet stationed on our western coast in war could protect the Philippines and our interests in the "Open Door" in China. Hence, *for their defense and that of Alaska*—which is virtually an overseas possession 2000 miles from San Francisco—*we must rely on our island bases, Guam and Hawaii.*

Hawaii is the center of communications—*the strategic focus*—of the eastern half of the North Pacific Ocean. This means that a fleet based there can strike with equal ease, in offense or defense, at all points on the great arc of coast line from Kiska to Panama. *Hawaii thus dominates the whole strategic front formed by the shores of the eastern half of the North Pacific Ocean.*

Similarly, the strategic lines of the western Pacific all intersect near our possession, *Guam, which is thus the strategic focus of that half of the ocean—and hence a menace in war to every important position there,* from Japan's northernmost one at Yetorofu and that of Russia at Vladivostok, down the Chinese coast to Singapore in the Straits Settlements. Well within the circle of Guam's protective area lie the Philippines, indefensible of themselves, whose single stronghold is the little island, Corregidor, in Manila Bay. And also, well within its reach, stands that—now closing—"Open Door" in China. Guam is small—about seven by twenty-nine miles—has a harbor which, by dredging and building a breakwater, would shelter a fair-sized fleet, and is readily capable of defense by fortifications and mines.

Finally, a noteworthy fact as to our chain of bases bridging the North Pacific, is that the strategic line from Panama through Hawaii to Guam cuts the similar British line from



PARTIAL STRATEGIC CHART, PACIFIC OCEAN

Courtesy of U. S. Naval War College

Esquimault to Australia and New Zealand. In view of this and of the focal relations of Guam and Hawaii to that northern ocean, *the strategical predominance of the United States in these waters is—in a geographical sense, at least—unquestionable.*

Guam and Hawaii, if made ocean fortresses, would be our Malta and Gibraltar against aggression by any enemy sailing from the Far East—from Vladivostok, Yokohama, or Singapore. If in war we had strong fleets based there, no enemy from Asiatic waters would dare to pass Guam without masking or reducing it, and destroying or dispersing its fleet. And, later, he would have a similar victory to win off Hawaii before the Pacific coast would meet the shock of war. And yet, like Guantanamo and Culebra, Guam lies neglected and undeveloped there, at the very threshold of the Far East—an easy prey for any foreign nation which would dare war with us to take it. And, too, the fortification and equipment of Hawaii proceed but slowly.

As to the very striking relation of these ocean outposts to Pacific coast defense, Captain McKean, formerly of the Naval War College and now Assistant to the Chief of Operations, says:

"With Guam converted into a Pacific Gibraltar, Honolulu . . . . becomes a secondary base, and can be less strongly held against attack from the West. . . . In effect, their (Guam and Honolulu) fortifications would be an expanded and intelligently elaborated coast defense, which, combined with an adequate fleet to bind them together, would keep the enemy from ever approaching our coast."

THE NEEDS OF OUR NAVAL STATIONS

In the upbuilding and maintenance of the Navy, we shall need all the navy yards we have—and more. As a whole, these yards lack much, not only in the dredging of their channels of approach, but in modern equipment for building and repair, both as to hulls and machinery. The need of dry docks and of channels to these yards, which would be deep enough for our largest vessels at all stages of the tide, is an amazing instance of naval unpreparedness. We have been building, and are to build, giant dreadnaughts, which, at present, can be docked at only four widely separated navy yards—New York, Norfolk, Puget Sound and Hawaii. The possible consequences, after but one great naval battle, are appalling. I have pointed out the imperative need of repair facilities on our southern Atlantic coast for war vessels of the largest size. At present, Charleston seems to be the only suitable location there. Admiral Benson, Chief of Operations—in recommending a navy yard of the first-class on this southern coast—says, if "there should be any naval engagements south of Hatteras, it would be of vital importance to be able to use all the facilities that the Charleston yard offers"—and that yard is now but a very minor affair.

As to the naval bases for the defense of our outlying possessions and as frontier outposts for our coasts, the admirable locations which we now have are as yet but "the substance of things hoped for," and fatally lacking in much.

Admiral Knight, President of the Naval War College, says: "It is my opinion that the completed bases at Guam and Culebra, including the defenses * * * would cost in the neighborhood of $15,000,000—in other words, about the price of a battleship." Shall we hazard the safety of our fleet and imperil our national defense to save an amount equal to the cost of but one dreadnaught?

Every important naval station on our coast and island possessions should have its Flying Base and be equipped also with its "Mother Ship," carrying from ten to twenty aeroplanes, all fitted with wireless. These flying scouts could report the location and formation of an enemy fleet some days in advance of its appearance off the coast.

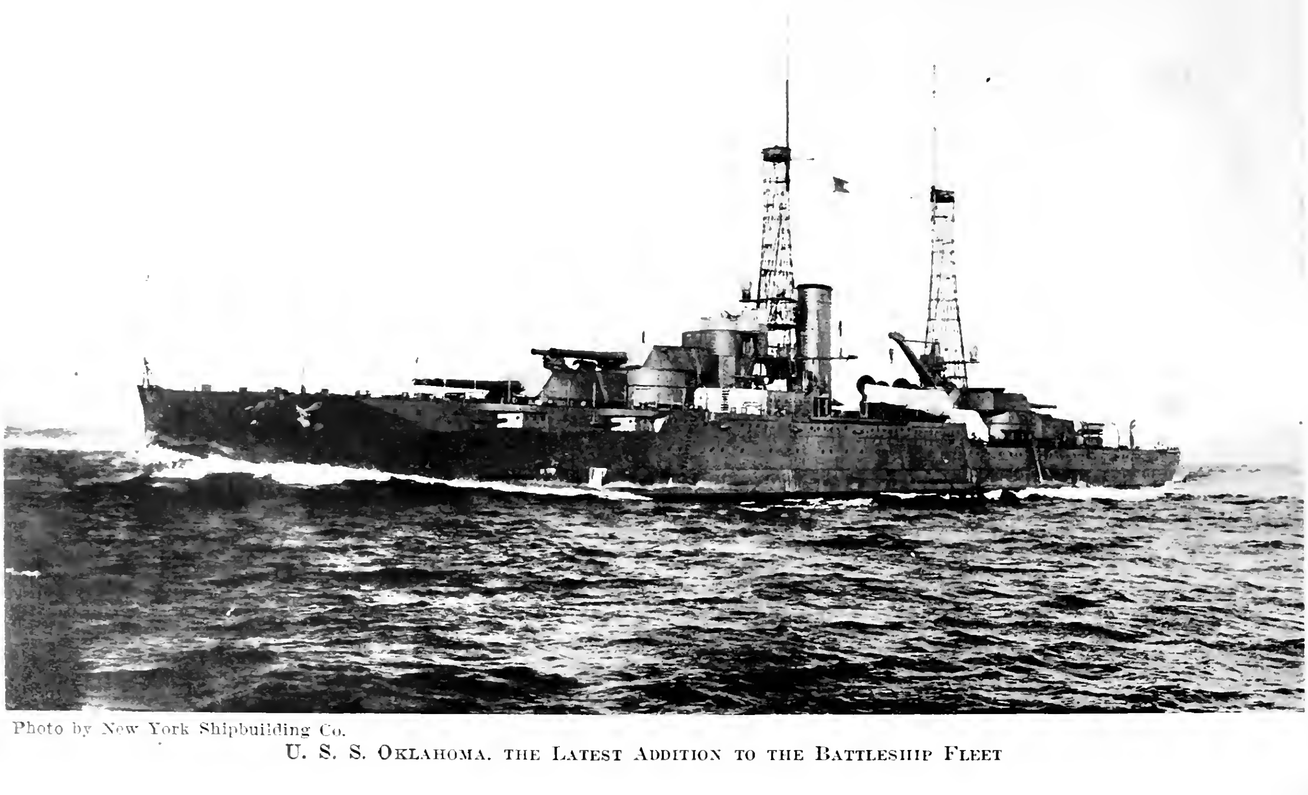


Photo by New York Shipbuilding Co.

U. S. S. Oklahoma, the Latest Addition to the Battleship Fleet

HOW LARGE SHOULD OUR NAVY BE?

Not for aggression, but to keep the peace, and to exert fitly what Mahan called "the silent force of sea power," the United States needs a great Navy. How big should that Navy be?

Several conditions affect the answer. First, our unequaled and ill-defended wealth, inviting spoliation. Second, our immense territory, which—from Eastport, Maine, to Manila—stretches more than half around the world. Third, the factor of distance with regard to that territory—which factor has no parallel in Europe. England, for example, is today waging the greatest naval war of all history at but 400 miles from her own shores, while, with us, the distances to the Caribbean Sea, to the Panama Canal, to Alaska and the Philippines, are from three to twenty times greater. Fourth, the fact that "the United States Navy is really a 'Disunited States' navy," since, like Russia, with her Baltic and Black Sea littorals, we have two widely separated coasts, linked, in our case, by a canal which may fail us in a crisis—either by slides or by treacherous or direct attack with high explosives on its locks.

It would take 60 days for our fleet to steam from the Caribbean Sea around South America to Panama. The Austro-Prussian War of 1866 was won at Sadowa in nineteen days after its beginning. The Franco-Prussian War of 1870 ended at Sedan in fifty-one days after its declaration. The British Fleet—the very keystone of Allied success in the existing war—was started instantly on its fateful run of but 400 miles by the telegraphic order, "Go!" By sixty days' delay in sudden war we might lose the lands of an empire—Alaska, Hawaii, Guam, and Samoa—in the Pacific Ocean.

Hence, from every viewpoint—of strategy and of common sense—the conclusion is inevitable that we should keep permanently in each ocean a battle fleet strong enough to defeat decisively any probable enemy there.

This in itself means a great Navy, but the General Board states that we should go farther still, that "the Navy of the United States should ultimately be equal to the most powerful maintained by any other nation of the world."

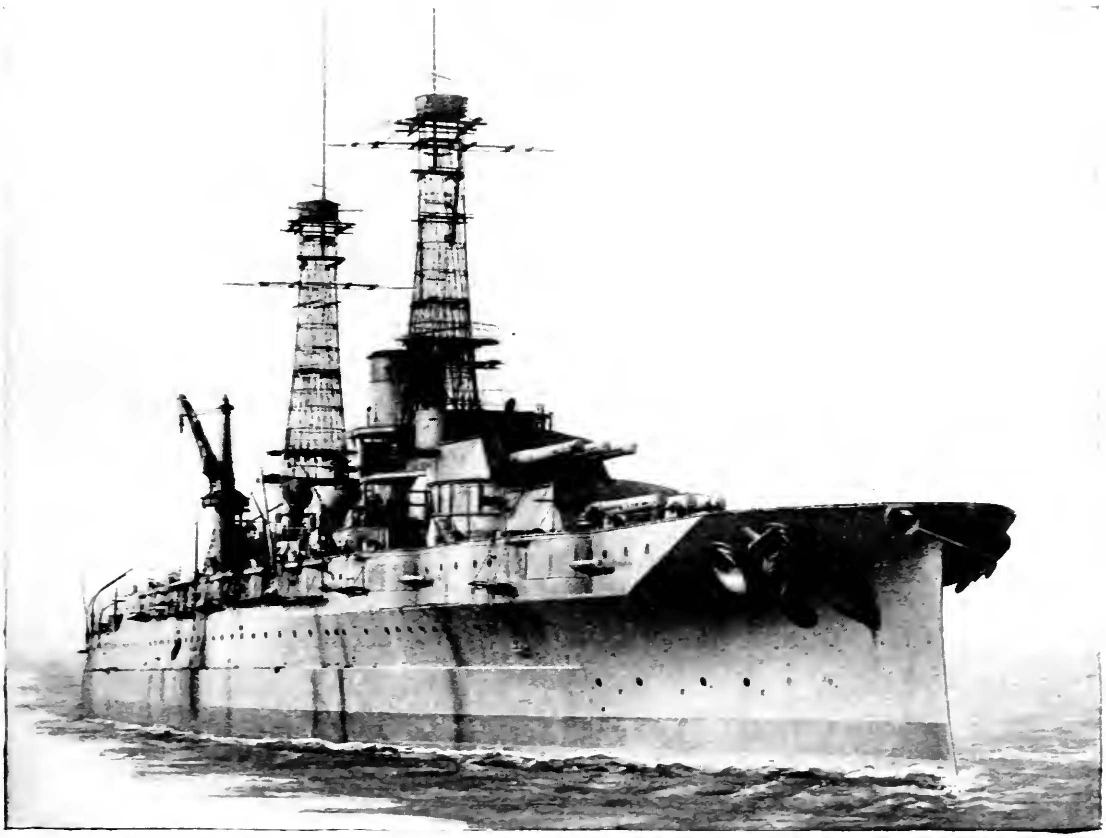
MODERN BATTLE RANGES

The great growth in the possible battle range during recent years has been forced by the increase in torpedo range, which, officially, is now 10,000 yards (5.7 miles), but probably is considerably more.

Since guns can now hit with straddling salvos as far as the fire control officer in the top can see the decks of the enemy ship, the question of the limiting battle range is now in theory one of visibility only—of extending, instrumentally, the range of human vision beyond the horizon which the curvature of the earth makes.

In discussing this subject, Commander Ralph Earle of our Navy gives the distance of the sea horizon from the turret sights as 11,400 yards (5.7 sea miles) in perfectly clear weather. But the "spotter's" platform at the top of the mast of an enemy ship would be about 110 feet above his sea level, and hence would be visible—just above our turret-sight horizon—for a distance of 12 sea miles more, making the total distance of visible objects 17.7 sea miles, or 20.4 land miles (35,400 yards).

However, other conditions than visibility affect this fighting limit. These are, first, the small percentage of hits at extreme ranges; and, second, the wearing out of the guns by erosion of the bore.



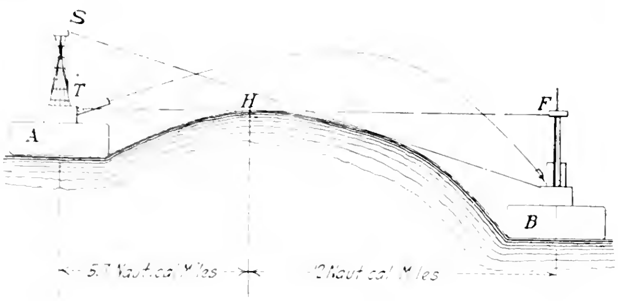
Courtesy of *Sea Power*.

U. S. S. Pennsylvania, the Greatest Fighting Ship in the World

The British, during the battle off the Falkland Islands, scored but two per cent of hits out of a total of 750 shots. As to erosion, it is due primarily to the high temperature of the exploding charge and the friction of its gases, although chemical action probably plays a part. With nitroglycerine powder, this temperature reaches 3178 deg. cent. The propelling powder used by our Army and Navy is a low explosive of the nitrocellulose type, which has less tendency to burn out the bore of the gun. Owing to erosion, the accuracy-life of our 12 in., 45 caliber naval guns is but 120 rounds. I am enabled to show the effect of erosion, during a test to destruction, through the courtesy of Major Edward P. O'Hern, U. S. Army, who says:

"The illustration indicates the condition of the interior of a 0.30 caliber machine-gun barrel, after a rapid-fire test of 3000 rounds in which nitroglycerine powder was used. The firings were made with unusual rapidity, and without the presence of the usual water jacket surrounding the barrel."

In view of these facts many gunnery experts believe that, under present conditions, no battle, broadside to broadside, is probable at a greater range than 8 miles (14,000 yards), if closer action can be forced, since no admiral would be justified in wasting his ammunition and wearing out his guns by firing at a greater distance. In chasing, however, guns will doubtless be fired at any range at which a hit is possible.



Limiting Battle Range of a War Vessel

A U. S. ship
B Enemy ship
H Horizon
S Spotter's platform, U. S. ship
T Turret sight, U. S. ship
F Spotter's platform, enemy ship

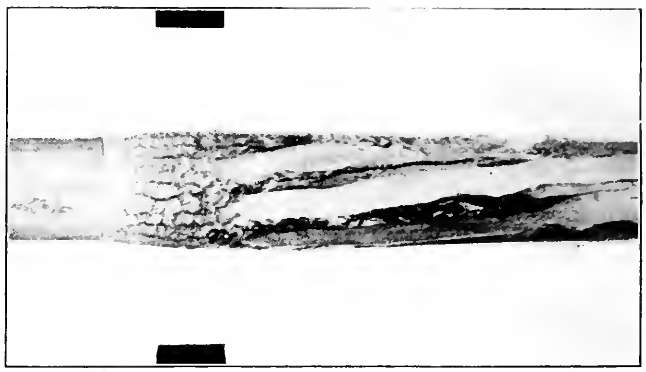
THE MARKSMANSHIP OF OUR NAVY

A battleship is essentially but a mobile gun platform, and its ability to hit with that primary weapon, the gun, is virtually its sole reason for existence. Occasionally there appear in the press adverse, and usually uninformed, criticisms of the Navy's target practice, of the failures of our "Hitless Navy." The facts, however, as furnished by Admiral Fletcher, tell a different story. In the salvo firing of one of our dreadnaughts in West Indian waters last winter, five shots were fired simultaneously at the same moving target, 30 ft. high by 90 ft. long. The results were photographed. The distance between the extreme splashes in the line of fire was taken as 400 yd.—the maximum dispersion of our projectiles in the line of fire. In one position between the extreme splashes, three shots would have struck a battleship, and in almost any position between she would have been hit by two or more shots.

This salvo was fired at a range of 9000 yards (5.1 land miles), with reduced charges so as to give the same angle of fall as that with a full charge at a range of 16,350 yards (9.3 miles). The hits for these two ranges would thus be the same, since all conditions as to aiming would be identical except the apparent size of the target, which does not matter with the telescopic sight. The firing ship was steaming at high speed, 15 knots. The target was towed at 6 or 7 knots on a non-parallel course, so that the range was changing constantly.

Admiral Fletcher also refers to some later practice, in which one of our ships made seven hits on this small target out of 12 shots. The ship was the battleship *Michigan*. Her commanding officer, Captain Brittain, stated that he opened fire at 18,000 yards (10.2 miles), and continued at an average range of 16,000 yards (9.1 miles). As before, the firing ship was moving at 15 knots and the target was towed on a non-parallel course.

This shooting has not been surpassed—if, indeed, it has been equaled—by any navy, and we are warranted in the belief that the *Michigan* and her consorts are making our dreadnaught fleet the equal of any in the world in marksmanship. The nation hears little of their work in this, since the reports of target practice are confidential. The two examples I have given were revealed only by statements drawn from officers by the House Committee on Naval Affairs.



Courtesy Maj. Edward P. O'Hern, U. S. A.

Cross-Section of a Machine-Gun Barrel After Firing 3000 Rounds with Nitroglycerine Powder

FIRE CONTROL

The accuracy of the target practice which has just been described is due primarily to fire control, which is vital to precision in modern gunnery, and hence to victory in a sea fight. For example, compare the *Michigan's* abnormally high percentage of hits with the similar results at the battle of Santiago. There, under the old hit-or-miss methods, our fleet fired 9000 shots at relatively short range, and made but 120 hits, or 1.3 per cent.

The reasons for this amazing inaccuracy—common to all navies then—were, as Captain Sims says, because "each gun pointer estimated the distance of the enemy for himself, made his own estimate for deflection (*i.e.*, the speed of the enemy across the line of fire), decided at what point on the ship's roll to fire, and how fast his line of sight was moving across the target and consequently how far his line of sight should be off the target (approaching it), when he pulled the lock string. It was because no man could acquire this skill to a high degree, and, particularly, because no group of pointers could acquire it to the same degree, that we could not hit anything except at very short ranges."

The foundation of modern methods of fire control was laid by Commander (now Rear-Admiral) Bradley A. Fiske of our Navy, in his invention and successful application of the telescopic sight to naval guns in 1892. The credit for originating the present system of accurate aiming belongs to Vice-

Admiral Sir Percy Scott of the British Navy. The introduction of this system into our own Navy is due wholly to Captain William S. Sims, who, in 1902—supported vigorously by Theodore Roosevelt, then President—overcame the opposition of the Navy Department, and virtually forced the New Gunnery on the United States Navy—to its great advantage, ultimately.

Fire control, while fairly simple in principle, is complex in detail, and, as it is a progressive art, those details are naturally military secrets. Speaking broadly, the system replaces independent operation of each gun by team work for the whole battery, directed by the fire control officer from the top of the cage mast, 100 ft. above sea level. If this station is shot away in action, the control party shifts to the other mast, or to the conning tower, or, as a last resort, to the turrets.

The general method is: (1) The range of the enemy ship is found by the range finder and its bearing by the gyroscopic compass. (2) Two sets of these observations, with a known interval between, give the data required to compute the enemy's speed and relative course, and the rate of change of range. (3) Instrumental observations are checked by "spotting"—that is, observing the fall of the shell, which usually makes a splash about 200 ft. high, visible in a clear day for 15 miles.

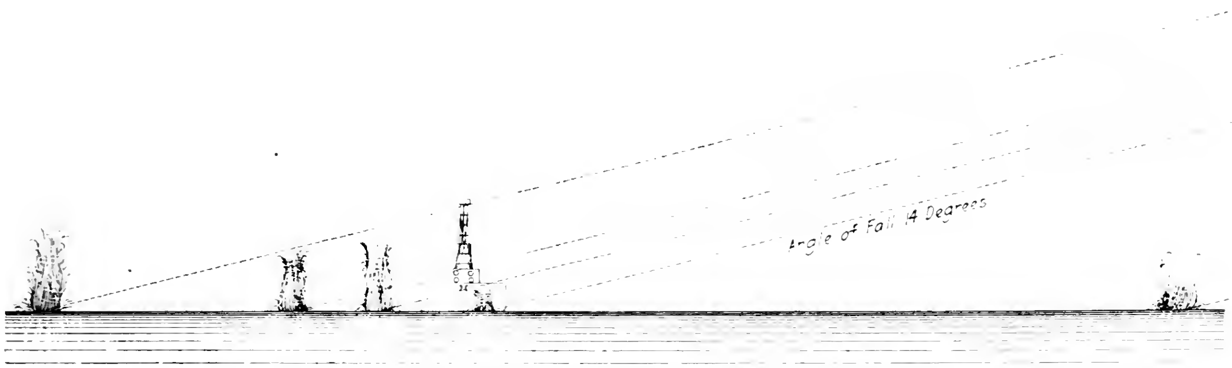
Now, no nation will attack us with any but a dreadnaught fleet, and only dreadnaughts can fight it. Hence, our naval strength lies fundamentally in the number and relative power of our dreadnaughts. At the beginning of the European war Great Britain had, built or building, 38 dreadnaught battleships, of which she has since lost one; similarly, Germany had 20, of which she has probably lost one; and the United States, 12.

As to dreadnaught battle cruisers: Great Britain had 10, of which she has lost 3; Germany, 9, but 3 have been sunk and one sold to Turkey; and the United States, none.

The relative dreadnaught strength of battleships and battle cruisers, based on pre-war figures and deducting losses, is, then: Great Britain, 44; Germany, 24; and the United States, 12.

No one outside of England or Germany knows what they have built or are building since the war started. There have been persistent reports, however, as to feverish energy in ship-building in both countries, and Germany has ample facilities for building at the rate of 25 dreadnaughts a year, while England could probably double this figure under stress.

So the United States has a hard road to travel to reach even second place among the navies of the world. It is true



Effectiveness of Salvo Firing of a U. S. Dreadnaught

(The extreme splashes are 400 yd. apart. In the position shown, three shots would have struck a battleship.)

OUR NAVAL STRENGTH

The battleship has been the backbone of every fleet since navies existed. There is nothing else on land or sea which is its equal in the concentration of enormous power. The energy of one 14-in. shell is, according to Admiral Fiske, equal to that of 60,000 muskets. On this basis, the 12 guns of the battleship *Pennsylvania* are equivalent to the aggregate musket-energy of 720,000 men. Each of her 14-in. projectiles has a muzzle energy of 70,000 foot-tons. Under stress, her main battery of twelve 14-in. guns can be fired about three times per minute—a delivery of 2,520,000 foot-tons during that period.

Essentially, the dreadnaught battleship is, first, an all-big-gun ship—that is, it has a main battery of the same caliber throughout, whose guns are capable of piercing modern armor belts at battle ranges; second, it has a speed of 21 knots or more, so as to be capable of acting in company with other dreadnaughts; third, it has the maximum armor protection which is possible with this armament and speed. The battle cruiser is a modified battleship, having roughly about three-fourths the latter's armament and armor and about 50 per cent more speed.

that, since July, 1914, we have laid down 3 dreadnaughts, that the keels of 2 more will soon be laid, and that 4 more have been authorized for immediate construction. But it takes at least three years to build a battleship or battle cruiser, so that the last of the total of 16 dreadnaughts authorized by the recent Naval Appropriation Act will not be completed before 1922—at which time our dreadnaught strength will be 27, as against the pre-war strength, deducting losses, of 44 for Great Britain and 24 for Germany.

And this is not all. A well-balanced fighting fleet includes cruisers, destroyers, and submarines, in addition to battleships and battle cruisers. The cruiser has two functions: First, the protection of commerce; second, as a scout and for general service with a fleet. In future fleet actions, if we shall not have enough battle and scout cruisers to force the enemy's screen and ascertain his strength and formation, our fleet will be blind and helpless. From all viewpoints an adequate increase in our cruiser strength is imperative, and this increase should far exceed what is proposed now by the Administration and Congress—not by naval officers who know our needs.

The question of destroyers is even more pressing. Primarily,

the destroyer's function is torpedo attack on an enemy fleet in battle. It can act also in protecting commerce and as a scout in moderate weather. But its surpassing service during this war has been in guarding Allied battleships from submarine attack.

England's pre-war proportion of destroyers to battleships was about 4 to 1, and this number she has found far too few as time went on. It takes five of them to convoy a battleship, and it took all she had at first to guard her Grand Fleet off the Orkneys, leaving her 1800 miles of coast line wide open for submarine attack on merchant vessels. To the British lack of these small, swift, and handy craft is due very largely her great losses of merchant vessels.

In 1922 our proportion of destroyers to battleships will be short by about 100 vessels of the British pre-war proportion of 4 to 1. Our deficiency with regard to the present proportion in the British fleet must be far greater. And yet, as the recent raid of the U-53 off Nantucket Shoals proves, we may need them in swarms on our 3000-mile eastern coast line. We might better lack a dreadnaught or an adequate fleet of submarines of our own than a strong force of destroyers.

As to submarines: The coast-defender type has shown its value during this war, and an adequate force of these vessels —not exceeding 800 tons' surface displacement and operating from protected bases—would worry an invading fleet seriously, and force it to make ceaseless attempts to trap or sink its under-water foes.

The fleet submarine—the large boat which, submerged, could charge with the fleet in action—is still but a dream. Her requirements are beyond the present state of the art. The ardent desire of every navy is to have such a vessel, with an engine exhaust which will not leave a white trail on the surface to betray her. She will surely come some day. Captain Simon Lake, the Nestor of submarine inventors, writes me:

"The high-speed submarine is going to come. How soon, I do not know. I do not believe anyone else can answer that question, as it all depends on the engines. Germany is, in all probability, away ahead of us in engine development today, but progress is being made, and as soon as we can get reliable high-powered engines, we shall have reliable high-speed submarines capable of accompanying a fleet."

Admiral Fiske's Greeting

When this paper was projected I wrote to a distinguished officer of our Navy, Rear Admiral Bradley A. Fiske—whose frank and fearless statements as to our naval unpreparedness stirred this country like a bugle-call—and asked him if, in view of the engineer's relation to naval war, he would favor me with a message to this great national body of engineers, through its representatives here assembled. In answer, the Admiral writes:

I am very glad indeed that you are going to address the American Society of Mechanical Engineers on "The Development of Our Fleet and Naval Stations."

There are no other men in the United States so immediately and directly powerful in developing the fleet and naval stations as the engineers. While the strategist estimates the general situation, and determines the application of the general principles of strategy to each situation as it arises; and while the tactician handles the units of personnel and material in actual battle and in preparation for it, it is the engineer who provides the strategist and the tactician with the mechanisms with which to carry out their respective and collective aims.

It is the engineer who enables the strategist and the tactician (and who often forces the strategist and the tactician) to keep his art abreast of the developments of the physical arts and sciences, and to take advantage of them. It is the engineer who has given to the world the gun, the torpedo, the submarine, the battleship, the wireless telegraph, the searchlight, and the aeroplane. It was the original military engineer—the youthful David, afterwards king—who made the first recorded triumph of science and art over mere physical strength, when, at a distance great in those days, he killed Goliath with his sling.

Therefore, for the reason that the engineers of any country have so much power to exert for the safeguarding of their country, and because men are always responsible for the power committed to their keeping, it is the high duty of all American engineers, and of you gentlemen who represent them, so to direct this power as to secure the peace and prosperity of the United States.

With respectful salutations to the Society, I am,

Ever sincerely yours,

(Signed) Bradley A. Fiske.

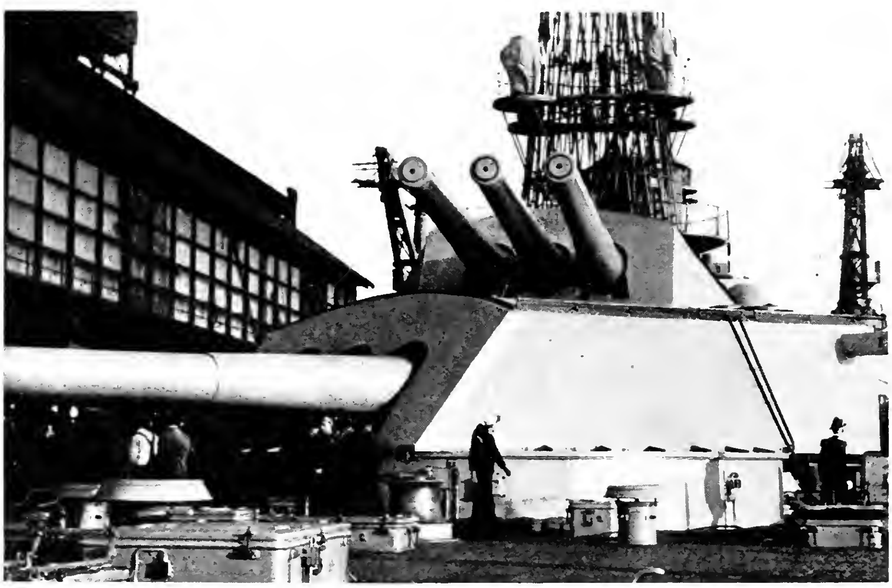


Photo by Paul Thompson.

The Arizona's Quarterdeck, Showing Her Two After Turrets, Each Mounting Three 14-In. Guns

VIBRATION IN TEXTILE-MILL BUILDINGS

By G. H. PERKINS,[1] LOWELL, MASS.

ABSTRACT OF PAPER

The author first states the nature of vibration in textile-mill floors and then enumerates the causes of such vibration, namely, unbalanced machines, heavily loaded trucks, weaknesses of building structure, poor soil conditions for foundations, and sympathetic vibrations originating outside the building.

He then discusses the objectionable effects of vibration in textile mills in regard to the security of the building, the quality of output of textile machinery, and also the nervous systems of the operatives. The methods usually employed in eliminating vibration in an existing building are stated, as well as the precautions to be observed when textile machines are mounted on rigid floors.

In the analysis of specific cases of building vibration, graphical records of the motion produced have proved of much value to the author, and he has accordingly included in the paper reproductions of several such records made by an instrument resembling the seismograph, together with particulars of the building in which they were taken.

IT is the purpose of this paper to outline the principal causes and effects of vibration occurring in buildings occupied by textile-manufacturing processes, with the view of stimulating investigation and promoting discussion on a subject which has received but scant attention from those most vitally concerned. The importance attached to the question of vibration in many other fields of work is strongly emphasized by efforts made for its elimination from high-speed machinery, such as marine engines, steam turbines, electrical machinery and motor cars. Therefore, if vibration of a textile mill can be shown to produce any prejudicial effect on either buildings, machinery, product or employees, it would seem worthy of serious study. Information on this question must necessarily be of a fragmentary character, and nothing is here offered purporting to be a full analysis of the subject. The many and varied influences contributing to the resultant vibration of an entire mill building containing machinery in motion make the problem a complex one, and it is often impossible to even ascribe specific results to specific causes.

Vibration is unquestionably present in every textile-mill building to some degree, although its amplitude may be so minute that it passes undetected either by the senses or by any material effect. While most textile manufacturers will concede that vibration exists in certain parts of their plants, they are rarely convinced that any real damage is done, except when exaggerated or serious conditions affecting production make remedial action imperative. In many of our older mills, extraordinary conditions of vibration have existed for years without apparent serious results. Like conditions of production, except for vibration effects, are so rarely found and so difficult to create, that it is practically impossible to separate the losses due to vibration from those attributable to other causes, or to measure them in economic terms.

NATURE OF VIBRATION IN MILL FLOORS

The physical laws underlying the vibration of simple bodies, such as rods and plates, have been clearly defined and are well understood, but their application to the complex structure of a mill floor will not admit of any simple mathematical treatment. It is well known that all structures, simple or complex, have their inherent periodicity or rate at which "free" vibration will take place when they are set in motion, and that this period is dependent upon the mass, dimensions, and elasticity of the body.

In the textile mill, vibration most commonly results from the unbalanced resultant of forces set up by certain classes of machines, synchronizing to some extent with the natural period of the structure, or of one of its elements, usually the floor. From any evidence available it would appear that the actual movements do not agree, except for exceedingly brief periods, with the "free" natural vibration of the floor and are therefore of a "forced" character. This is doubtless a fortunate circumstance, so far as integrity of the structure is concerned, and cases are rare where vibration has been the direct cause of a building failure. The historic Pemberton Mill disaster occurred in a building noted for its freedom from vibration.

Two distinct classes of movements are commonly found in textile-mill floors:

a Horizontal movements of floor, more or less independent of walls, of comparatively low frequency and large amplitude. These may properly be classed as oscillations.

b Movements of higher frequency and less amplitude, often in a vertical plane, which may be considered as no more than tremors.

While vibrations may exist in all three planes simultaneously, they are under textile-mill conditions more apt to be strongly emphasized in only one direction. These motions may properly be considered as truly harmonic in character, and their period, frequency and amplitude defined as from a sine curve.

CAUSES OF VIBRATION IN TEXTILE MILLS

The principal factors contributing to vibration in textile-mill buildings are:

I Unbalanced machines, of which the following are the most important:

a Looms. The lay and pick motions of practically all looms are unbalanced reciprocating movements in a horizontal plane. Harness motions, including Jacquard heads, are reciprocating movements in a vertical plane. The frequency of these motions ranges from 90 to 180 picks per minute, depending upon type of loom and class of work.

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[1] Head of Textile Engrg. Dept., Lowell Textile School.

Presented at the Annual Meeting, December 1916, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Pamphlet copies of complete paper may be obtained without discussion: price 10 cents to members, 20 cents to non-members.

b Noble worsted combs. The dabbing brushes are actuated by vertical reciprocating motions at from 1000 to 1200 r.p.m., with two brushes per machine. Cotton combers, on which the nipping motion oscillates at from 100 to 125 nips per minute, giving slight vertical throw.

c Mules. The carriage of a mule moves with a variable alternating motion in a horizontal plane at from 4 to 6 draws per minute.

d Unbalanced drums, cylinders, rolls and pulleys are frequent causes of local vibration. Worn or defective gearing also often causes trouble on heavy roll drives, as on calenders.

e Heavily loaded trucks moving over light floors cause deflection of beams and plank and some vibration.

II Inherent weaknesses in the structure, such as thin walls, light floors with long spans, and unsuitable connections between floors and walls.

III Poor soil conditions contributing to relative freedom of foundations and footings.

paper will best be served by confining the results shown to those obtained from one typical weaving mill.

Description of building:

Length, 270 ft. 0 in.	Spans: 4 of 26 ft. each
Width, 116 ft. 0 in.	1 of 12 ft.
Basement, 10 ft. 6 in.	Bays, 7 ft. 6 in.
Two Stories, 16 ft. each	Roof of Saw-Tooth Type
Walls: 24 in. on first story, 20 in. on 2d story	
Pilasters, 28 in. wide	Windows, 5 ft. 0 in. wide
Floor Beams, 10 in. by 18 in.	Floor Plank, 4 in.

Floor plans and arrangement of machinery are shown in Figs 1 and 2. Stations at which records were taken are numbered on floor diagrams. It will be noted that all looms are arranged across the mill and records show longitudinal vibration only. Records taken with instrument set transversely showed no appreciable motion on either floor.

Records taken in this mill after the installation of additional looms, indicated a decrease in the maximum amplitude, fewer cyclic variations and a somewhat higher average amplitude. (See Figs. 3 to 7.) The reduction in the maximum

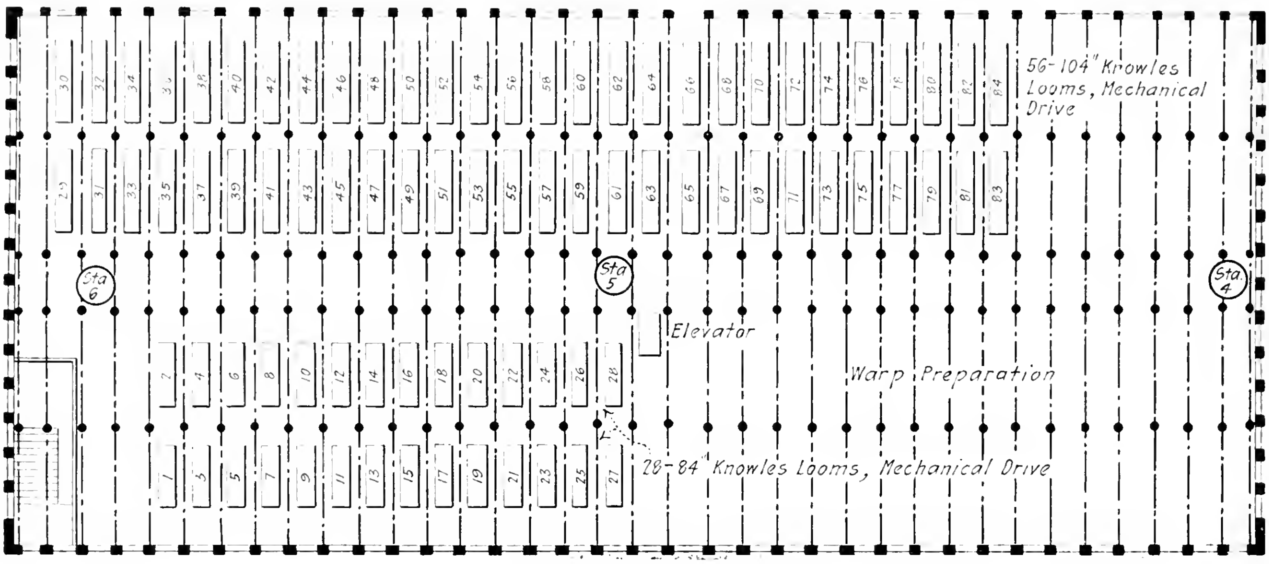

Fig. 1 First-Floor Plan

IV Sympathetic vibrations originating outside the building. These are frequently set up by water falling over dams, reciprocating engines in adjacent buildings, or by railroad trains. Their mode of transmission is often obscure, although it is sometimes direct, as through pipe lines or solid ledge.

VIBRATION RECORDS

In the analysis of specific cases of building vibration, graphical records of the motion produced have proved of much value. Such records showing the period, amplitude and cyclic variations of the vibrations serve as a guide in tracing their origin and assist materially in estimating the effects produced on building and machinery. Numerous instruments for this purpose, which need not be described here, have been constructed, involving the basic principle of the seismograph originally developed for the study of earthquake phenomena.

The partial records presented are portions only of results obtained in the course of investigations carried on under various conditions in textile-mill buildings. As it is obviously impossible to present any extended records, the purpose of the double amplitude was from 0.059 in. to 0.045 in. This is not an unusual experience when mills are equipped in installments. A mathematical analysis of the unbalanced horizontal force applied to the floor by a 72-in. Knowles worsted loom running at 120 picks per min. showed an average value of 154 lb., with a maximum of 262 lb. This gives some conception of the magnitude of the total force acting when a number of looms are in synchronism.

In all cases any movement estimated by the senses was far greater than actually recorded. This bears out the fact that even small and harmless vibrations are often responsible for apprehension on the part of the operatives.

EFFECTS OF VIBRATION

In presenting information covering the effects of vibration, the writer wishes to acknowledge the assistance rendered him by the Aberthaw Construction Company, of Boston, Mass., who deserve much credit for undertaking an extensive investigation of this unpromising subject. They have placed at the writer's disposal all of the interesting material accumulated by them to date, covering a wide range of industries.

Objectionable effects of vibration in textile mills have been noted by various observers as follows:

a Settling of foundations and footings on poor soils, with resultant cracking of walls and unleveling of floors, due to a "shaking-down" process of buildings subject to excessive vibration.

b Effect on operatives. This is usually manifested by apprehension of the failure of the building, loss of efficiency due to fatigue, and the serious effect of continued vibration on the nervous system.

c Effect on production of textile machinery.

Carding Wider card settings are found necessary on vibrating floors, causing uneven and poor work.

Spinning Vibration of ring rails on frames spinning either fine numbers or coarse waste yarns, causing breaking down of ends.

Turning of roving bobbins on skewers of spinning-frame creels, causing roving to unwind and kink.

"Chatter" of rolls on long frames.

Weaving Vibration of tension weights on narrow fabric looms, causing dropping of weights when loom is at rest.

Shaking of similar tension weights on elastic-webbing looms, permitting rubber warp to slacken and causing defective work by allowing excess elastic to enter fabric.

Increased sensitiveness of "feeler" mechanisms in filling changing looms.

Finishing Chattering of "doctor" blades on "backfilling" mangle, due to passing trucks, causing uneven distribution of starch on goods and imperfectly cleaned roll.

Wave movement of water in pan of "damping" machine, causing uneven distribution of moisture on goods by spraying brush.

Miscellaneous Breaking of electric-lamp filaments, making spring suspensions necessary. Difficulties in use of sensitive instruments, such as balances, scales, testing apparatus, etc.

Many consider that the matter of increased power consumption of shafting due to vibrating floors is important, but no authentic tests covering this point are available.

ELIMINATION OF VIBRATION

The elimination of vibration of an existing building of mill construction is usually attempted by:

a Stiffening and strengthening of floors by additional columns or trusses and making more secure connections to walls; also by stiffening outside walls with additional pilasters, or in the case of wooden-frame buildings even by braces or guys.

b Balancing of all machines possible and cushioning or absorption of the shocks of machines in which an unbalanced component seems unavoidable. More attention could advantageously be given to the matter of balance in certain classes of textile machines by their builders. Incidentally, the attendant reduction of noise would be beneficial.

The well-known advantages of reinforced-concrete buildings with particular reference to rigidity will not be discussed here, but such construction undoubtedly would obviate a large portion of the difficulties outlined above. There are certain conditions, however, where too great rigidity has been found to be most undesirable for certain classes of textile machinery as at present constructed. Such a large proportion of our textile plants occupy buildings of "slow-burning" mill construction that it is the present purpose to show existing conditions rather than emphasize the advantages of any one type of construction.

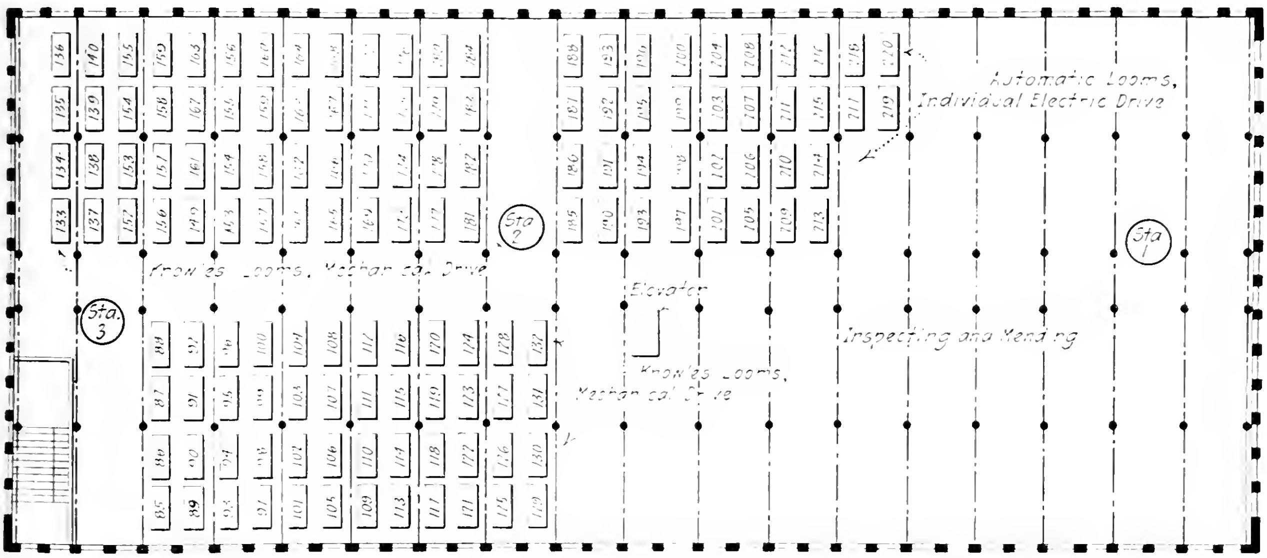

Fig. 2 Second-Floor Plan

EFFECT OF RIGID FLOORS ON TEXTILE MACHINERY

The data available covering the comparative operation of textile machinery under similar conditions on rigid and flexible floors are extremely limited, but experience seems to emphasize the following:

a In weaving heavy fabrics, the breakage of loom parts has been excessive when looms are mounted on concrete floors with no provision for absorbing the shocks produced. Cushioning the loom feet with absorbents such as wood, cork or rubber, has been found absolutely necessary under these conditions.

b Transmission of the noise of machinery to offices, laboratories, etc., has been found exceedingly annoying in some concrete buildings.

NEED FOR FURTHER STUDY

The problem of mill vibration, while not new, has yet to receive either full recognition or sufficient serious attention. The resulting economic losses are unquestionably large, if analyzed from all standpoints, and the elimination of vibration is consequently an important factor in the efficiency of the plant.

All information at present available would seem to point to a general agreement as to the desirability of avoiding excessive vibration in manufacturing buildings. There is evidence of a growing interest in the subject, but the scarcity of authentic results from experimental work along this line, carried on under actual manufacturing conditions, makes exhaustive tests and observations necessary before any general conclusions can be reached.

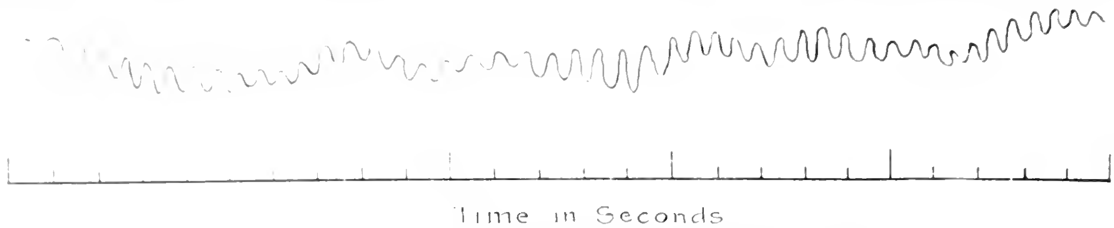

Fig. 3 Record No. 1, Taken at Station 3 on Second Floor

Shows High Average Amplitude. Period, 108 to 120 per Min. Average Loom Speed, from 110 to 120 Picks per Min. Maximum Double Amplitude, 0.03 In.

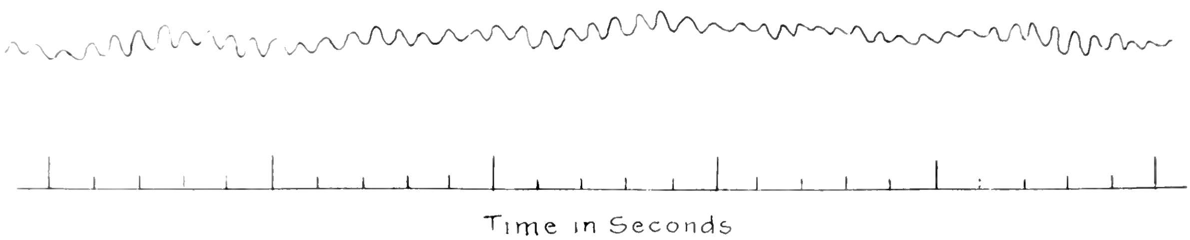

Fig. 4 Record No. 2, Taken at Station 3 on Second Floor

Shows Low Average Amplitude under Same Conditions. Records Taken at Station 2 Showed Same Characteristics as Those at Station 3

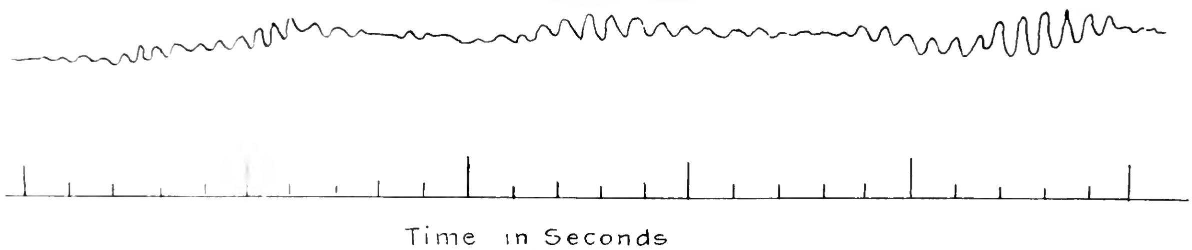

Fig. 5 Record No. 3, Taken at Station 3 on Second Floor

Shows Evidence of Cyclic Disturbances about Every 8 to 10 Sec.

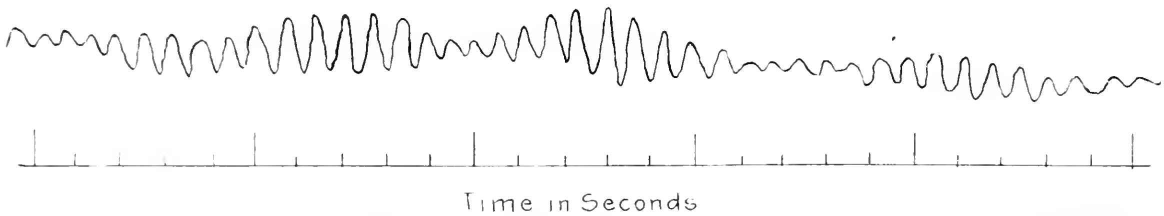

Fig. 6 Record No. 4, Taken at Station 1 on Second Floor, About 50 Ft. Away from Nearest Machine

Indicates How Readily Vibrations are Transmitted through Floor Undiminished in Amplitude. It may be Noted that the Group of 36 Looms Nearest to Station 1 are Individually Electrically Driven. Maximum Double Amplitude 0.045 In.

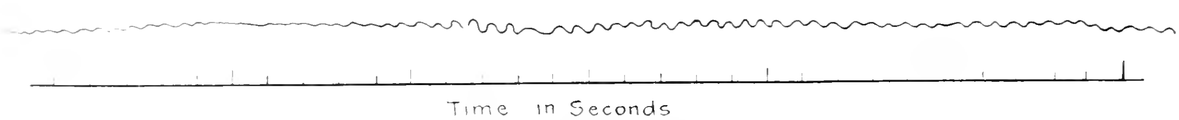

Fig. 7 Record No. 5, Taken at Station 5 on First Floor

Shows Typical Record at this Point with Vibrations of Slightly Less Frequency and Small Amplitude. The Average Speed of the 104-in. Looms on This Floor was 90 Picks per Min., and the Speed of the 84-in. Looms was 98 Picks per Min.

HOW DOES INDUSTRIAL VALUATION DIFFER FROM PUBLIC-UTILITY VALUATION?

By JOHN H. GRAY,[1] MINNEAPOLIS, MINN.

IT IS my object in this paper to show that value logically and necessarily means exchange value based on capitalized earnings, real and estimated. It depends on strategic advantages, and involves speculative elements, which are destroyed when an industry is declared a public utility and its earnings are limited to a fair return. This fair return has no relation to value, but is a matter determined in the supposed interests of the public welfare. The basic purpose of regulation is to limit profits to a just amount, and thus to take that part of the property for the public which would inure to the private owners under non-regulation. For the value of such an unregulated private monopoly is limited only by the willingness and ability of the people to pay rather than do without the services of the monopoly.

This paper deals chiefly with valuation of public utilities for purposes of fixing rates. As the courts ruled in 1898 that utilities are entitled to a fair return on a fair value of property in use at the time of valuation, valuation is necessary if regulation is to be attempted.

The most significant tendency of the last two decades the world over, and more particularly in America, has been toward the socialization of wealth; or, to express it in another form, toward the limitation of the rights of private property. Many businesses formerly considered private—gas, electricity, common carriers, insurance, banking—have now been brought under public regulation.

For better or worse, public utilities have been taken out of the category of unrestricted private property. Technically, they remain private property, but the law has taken from them the chief attribute of private ownership, that of the chance of speculative gains. The doctrine of fair return forever separates such property economically from ordinary private property.

For instance, it is only a single generation since the courts of this country uniformly declared that the making and distribution of gas was a private industry. The most conservative would not undertake to maintain that view today. The placing of electricity within the class of public utilities is much more recent. But, perhaps, no other industry illustrates this point as well as the common carrier and the extent of regulation, which, in theory, is universally recognized as proper today, compared with that which we considered permissible a generation ago. A mere study of the phrases "reasonable rates" and "unjust discrimination" will show the progress we have made, for good or for ill, along this line.

The same social progress has brought urban land, and in some countries all kinds of land, under special public control in every civilized country except America. What is true of land is equally true of the whole range of insurance. The changed attitude of the public mind towards the rights of banking illustrates the same point. A century and a half ago banking and insurance were, both, under the common law, occupations freely open to anyone, without restraint.

REASONS FOR CLASSIFYING CERTAIN INDUSTRIES AS PUBLIC UTILITIES

We have found that social considerations make certain industries of more immediate and overwhelming interest to the public welfare than are ordinary private businesses, and have thrown them into a single category labeled "public utilities"; but what social, economic and political reasons justify us in so doing?

About 150 years ago there grew up the theory that under a system of free competition one's self-interest would prevent him from injuring the public. With an abundance of free land, large opportunity to expand, accompanied by a high degree of intellectual, social, and educational equality, this was measurably true. But with the creation of fixed capital on a large scale this doctrine became unsafe, and self-interest can no longer be depended upon to hold in check the recklessness, greed and extortion of the owners of even purely private property. Government regulation may then be ascribed to the breakdown in the application of competition.

If competition, as indicated, is not a real safeguard, what is the danger of leaving private parties unrestrained in those industries where competition no longer works smoothly or effectively? I think if we go thoroughly into this point, we shall realize as never before that with the limitations of human knowledge the more complex the machine became, the more extended the division of labor, and the larger the mass of fixed capital, practically the more dangerous to the public was any mistake of the owners. If we wished to turn this into a modern phrase, we should say that it was strictly the speculative element in private property, the buying and selling and holding for an increase in price, that furnished the point of greatest danger. One was allowed this freedom in the early days on the supposition that the natural resources and things out of which property rights could be carved were virtually unlimited, and that when one undertook to develop these resources and claimed them for his own, he was doing a public service. Since we have found that resources are not unlimited and that we must learn to live together, we have discovered that, in this particular, what one gets for himself is taken from another, or at least prevents the other from taking in like manner and to the same extent. In other words, we are face to face with monopoly.

The world has now become alarmed on the subject of non-regulated privately owned monopolies, and there is a growing tendency to declare more and more of these to be public utilities. We apparently have reached the conclusion that civilization cannot be maintained or advanced unless such utilities can be made to render adequate service at a reasonable charge and without unjust discrimination. But increasing emphasis must be put on the fact that stability, regularity and universality of service are of infinitely more importance to the public than the general level of charges or the amount of profits made by a company.

SPECULATIVE ELEMENT IN PUBLIC UTILITIES THE ULTIMATE REASON FOR REGULATION

In the past the reason for the purchase of property has

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[1] Professor of Economics, University of Minnesota.

Presented at the Annual Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York, December 1916. The paper is here printed in abstract form. Pamphlet copies of complete paper without discussion may be obtained; price 15 cents to members, 30 cents to non-members.

often not been merely for the sake of income, but for the sake of possible gains in selling. Whatever we may finally consider is justice in regard to the reckless, unsavory and speculative past in this field, we may safely say that the world has now come to the view that for all future investments the amount contributed by the owners shall be the basis of calculations for rates, and that variable risks shall be met by varying rates of charge and income rather than by fluctuations in the value; for so long as we have the latter, owing to false valuations, we shall have manipulation and speculation to bring about increased gains. Our present problem is how are we going to take conditions growing out of competitive circumstances and adapt them to an age of monopoly with as little friction and injury as possible, and, in working it out, we must never forget that speculation and regulation cannot simultaneously exist.

LIMITATIONS IMPOSED ON PUBLIC-UTILITY PROPERTY

We are here concerned with the meaning of the content of the term "property": what are, in fact, and what ought to be, the limitations, if any, on the absolute rights of property. Are the limitations on public utilities different from those on strictly private property, and are they more severe? There can be no doubt of the present tendency on this subject. It is all towards greater socialization of wealth and limitation of private rights. One evidence of this is the growing tendency towards public ownership and operation, and the public enjoyment of property shows this. The constant enlarging of the list of industries that are subject to more and more restrictions in the public interest clearly points in the same direction.

It is true that many such industries are comparatively new, but they existed for a relatively long time before they were classified as public utilities. For instance, the common carrier is old; and it took us a long time to realize that the parlor-car business, the pipe lines (gas and oil), gas companies, the telegraph, the telephone, fall into the same class because of performing similar functions, and, that, if left unregulated, they are capable of inflicting like monopoly injury and abuse. So we have progressed step by step from the common carrier through the utilities named to the street railway, the use of electricity in all its manifestations, to conduits, cold-storage warehouses and the like. Furthermore, we have recently entered upon a broad and wide field, with ill-defined limits, that comes neither within the realm of public utilities nor private property, as these terms have heretofore been used, but occupies what Mr. Bryan calls a "twilight zone."

Justice Brewer discusses such cases in the Kansas City Stock Yards case,[1] where he considers various industries requiring some special regulation, but not such as we impose upon public utilities. One cannot view the progress regulation has made, for good or for ill, without realizing that the emphasis on property rights has changed fundamentally in recent years. In the opinion of this generation, property either public, semi-public, or private is looked upon more and more as a public trust. The attitude of the public mind, and of the law, has not only changed toward the industries mentioned, but has changed towards the industrial trusts as well; hence our anti-trust laws. Recently we raised the question whether mere size is cause for added regulation. For an answer to this question we must wait for the Harvester case to be decided. The subject naturally shades off into pure-food laws, building ordinances, height of buildings, and so on.

[1] Cotting v. Kansas City Stock Yards, 22 Sup. Ct. Rep. 30 (1901).

THE FAIR VALUE OF PRIVATE INDUSTRIAL PROPERTY

The question of the fair value of a strictly private (industrial) property depends principally on what it will actually sell for. This is determined by the actual past earnings and an estimate of future earnings, the latter being based on a presupposed established rate of charge. If the property is not subject to effective competition, the only way of arriving at its value is to estimate what it would sell for under competitive conditions.

This argument rests upon the *laissez-faire* doctrine of competition. The idea of competition rests on the right of charging all the traffic will bear, and on the assumption that natural forces place a limit to charges and thus prevent extortion. In such cases no government regulation is necessary or desirable. Regulation is the very antithesis of competition. The necessity for regulation comes from the fact that competition is totally absent, or is ineffective to protect the public and keep charges within the bounds of reason and in harmony with the welfare of society.

I have gone into this long preliminary statement to furnish a proper background, or foundation for our discussion, and to show, also, that things are not as hard and fast as we have been wont to suppose, and that changes in our legal system, even without any changes in the constitution, are not so difficult as they have usually seemed to be. But let us now come back to the main issue.

HOW SHOULD A PUBLIC UTILITY BE VALUED?

Since the monopolies under question are not sold frequently enough under comparable circumstances to establish a market price, we estimate the value on the basis of capitalized earnings, and on the (legal) assumption that the existing rates are fair and just.

There is a legal assumption that the existing rates are just, because they have not been judicially called in question or proved to be unjust. Take, for example, the vexed and admittedly unsettled claim of the public to a share, at least, in the clear surplus of a company acquired out of earnings which have also yielded dividends at a fair rate. It is conceivable that the question might properly be decided one way in the case of a company going out of business, and in exactly the opposite way for a company compelled to continue to serve the public, or, one way in regard to a surplus acquired before the era of regulation, and quite another way in the case of a surplus accumulated under regulation. In the one case the rate from which the surplus came might be considered both legal and just, in the other as both illegal and unjust.

But all careful and disinterested students now recognize, notwithstanding great vacillation of the United States Supreme Court on the subject, that the necessity for this super-regulation arises solely from the fact that the industries now under review are monopolistic. It cannot be said too often that regulation is simply a substitute for competition.

Gains due to speculations, stock waterings, frauds, extortions, excessive charges, surplus and unearned increment ought not to be and cannot be allowed to go to owners of public utilities. Past claims ought to be compromised or adjusted in some way and a new start made on a sound basis. With a complete, amicable and final settlement of this question, all

would agree that all that owners of public utilities are entitled to in the future is a safeguarding of the money they contribute and an annual rate of income commensurate with the risk involved.

PUBLIC-UTILITY PROPERTY ENTITLED TO A FAIR RETURN

Public-utility property, being devoted to public use, must be content with a fair return, determined under our system of jurisprudence by public authority, with an ultimate appeal to the judiciary. It is liable for continuous service, additional investment may not be made without specific consent of the public, accounts must be kept and made public in reports, and the owner must serve all alike without discrimination. Ownership under such conditions of incumbrance is therefore but partial.

The novel theory has recently been put forth that public-utility property is not in fact dedicated to public use, but merely the service is so dedicated.[1] But this theory in view of all the facts seems scarcely tenable. Such a limitation amounts to the statement that the property as compared with private property is property affected with a genuine servitude or incumbrance. If one has incumbered his private property with a mortgage, he does not expect to enjoy as large a net income therefrom as if the property were wholly unincumbered. Just so, on investing in public-utility property one does so under the present law and practice of regulation, with full legal notice of this incumbrance of regulation. To this extent, and in this sense, he is not free to do as he pleases with his own if he professes the public service.

We must not lose sight of the fact that freedom of contract is at the very foundation of all property rights, and cannot in essence or in law be separated from property as protected by the fifth and fourteenth amendments and other constitutional provisions. Nor would I be understood to say, or even to imply, that these constitutional safeguards are of no significance in the case of public-utility property. The whole point of my argument, however, is, that, by declaring certain property affected with a public interest, we have thereby necessarily given such an interpretation to these constitutional provisions as seriously to incumber the property, and, therefore, have restricted the uses to which it can be put so long as it is dedicated to a public use.

VALUATION OF FRANCHISES

Under our system of law a secondary or local franchise is property, but it is not to be valued, in ordinary rate cases, unless there is some specific agreement or contract on this point that makes valuation necessary. Unless a franchise gives an exclusive right and carries an inviolable contract for a fixed charge, it is not to be valued in a rate case under the established principles of regulation. The general rule now is that in rate cases franchises are not to be valued above actual cost. This is plain from the mere fact that in a rate case the fairness of the present income is the point at issue.

Valuations are made today not because justice or economic policy require it, but because of the court ruling that property is entitled to a fair return on its fair value. What is a fair value? These industries are vitally necessary to us, and if left in private hands the estimated income from them must be at the normal rate in the community for investments accompanied by like risks, in order to attract the necessary capital.

In a rate case it is impossible to arrive at a valuation that has significance. Courts have tried in vain to qualify value by such words as "fair." If these words could be collated and disconnected from their speculative past, they would mean simply that a company is entitled, in view of the unregulated results of the past, to what the court, under all the circumstances, regards as an adequate reward for the services and capital the owners have wisely and efficiently contributed. This, however, has no fixed, permanent or measurable relation to value in an economic sense.

COST-OF-REPRODUCTION THEORY OF VALUATION

For a decade or more and until recently the so-called cost-of-reproduction theory of value actually dominated courts and commissions, but they now demand the facts of investment. Companies claim a value on the cost of reproduction as high as the public would be willing to give rather than forego the service and undergo all the inconveniences of doing without it until a duplicate plant could be built. They forget, however, that the public, in absence of specific contract, has a right to duplicate the facilities, and that this would greatly lessen, or even destroy, the value of the old plant.

The fact that in a majority of the older and stronger railroads and many other utilities the original water has been squeezed out by the investment of surplus earnings in the plant, does not simplify the problem of valuation but merely adds complications to it. It emphasizes all the more the speculative elements in the situation. In the earlier days, the companies claimed a return on all their watered stock, and opposed regulation that interfered with this claim. To this the court answered with its "fair value." The effort of the companies was to inflate the valuation so as to bring about the results that the court denied them in the case of Smythe *v.* Ames. Meantime, social growth was very rapid and regulation very lax. Therefore, when prosperity came, surplus was piled into the plants in addition to a fair dividend, and under the doctrine of valuation and freedom of contract the companies with such surpluses based their claim to these same old speculative gains—gains which may legally, if not wisely, be permitted to go to private property, but which the law of public utilities tried to prevent from coming into being, and, by its doctrine of reasonable rates, tries to claim a share in after they have been created. I am not, at this point, passing judgment on the question whether these speculative gains ought to be prohibited or not. I am simply trying to show that the idea of monopolies regulated by law, under the doctrine of public utilities, leaves no place for them. The main object of classifying any industry as a public utility is to prevent this very thing. But valuation under the cost-of-reproduction and similar methods now employed prevents the accomplishment of this object through regulation.

All our trouble with regulation comes from past speculation and not from an inability to agree about what is just and fair, so far as entirely new utilities and future investments in old ones are concerned.

RESULTS OF CURRENT VALUATIONS MISLEADING

The valuation of all the railroads now in progress, as well as current valuations in rate cases, are worth more than their cost as a means of educating the public, and may be highly profitable as a basis for compromising with the companies

[1] Jared How, Discussions of the Economic Club of San Francisco, vol. I, p. 44.

for their past efforts. But they do not arrive at value in the economic or market sense. They are misleading, for the public supposes that on the theory of the cost of reproduction the next time a rate case arises we must go all through the process again, and drag in all the speculative elements due to social growth, unearned increment, and the like.

It may not be out of place to call attention, at this point, to several relatively recent street car franchises[1] based on the so-called principle of cost of service. These franchises are all in my judgment not only defective but vitally defective. But they are worth all they have cost and all they will cost in the future because of their contribution to the particular point under discussion. They have banished, once and for all, from these systems the bugbear of valuation; for the future the amount on which the companies are entitled to a return is the actual investment, or what is accepted as such by agreement.

These franchises are meant to give a fair return, in the future, on public-utility investments, made on a monopolistic basis, under non-speculative conditions, and publicly controlled capitalization.

Unless an attempt at regulating capitalization by commissions should prove as futile as earlier attempts at preventing stock watering have heretofore proved, investments made from now on will need no valuation whatever in these cities or elsewhere in rate cases. Furthermore, it seems plain that all commission laws will, in the future, provide for controlling investments and capitalization. It is not too much to hope and expect that the Interstate Commerce Commission will, at an early date, be given power over these matters.

This is what the new model franchises call for. It is what sound regulation means. It still leaves the vexed question of pioneering past wrongs and extravagant ventures to be settled by compromise, not by determining value in any proper or economic sense of the word. As previously stated, this is a matter of public policy, to be determined not by experts but ultimately by public opinion.

Any other method of trying to determine what is fair to the owners by valuation, or otherwise, plunges us at once into the question of how to deal with the results of past speculation, good, bad, and indifferent. How ought the punishments and the rewards of these past reckless, unregulated conditions of the competitive era to be apportioned between the owners and the public? What is a reasonable notice of a profound change of policy on the part of the government? There can be no doubt of the legal right of a government to change its policy and as little doubt of the fact that by creating the class of public utilities and making them subject to such regulation as the law calls for, we meant to change the relation of this property to government and to take away the chance of speculative gains. Is it fair then to enforce these laws strictly, or should we give more time for adjusting the old conditions to the changed ideas of public welfare? In other words, when ought we really to begin to enforce the theories underlying regulation? I cannot undertake to answer these questions at this time, but content myself with remarking that we have allowed the owners in their attempts to safeguard their supposed interests through valuations, to make control of future investment practically impossible, while contributing almost nothing to the settlement, under a compromise agreement, for the chaos of the past.

[1] I refer more particularly to the so-called street car settlements in Chicago, Cleveland, and Kansas City.

THE SURPLUS PROBLEM

If we could imagine all public-utility property now existing wiped out by a miracle, and all other things to remain as they are, namely, knowledge and needs, does anybody imagine that any question of valuation or "fair value" would or could arise? Under the present form of commission control, the commissions would simply see that the money with which to rebuild was properly capitalized, and the owners would agree that their returns ought to be based on this amount, and no other. Sound regulation aims at stable and equal rates much more than at low rates or low profits.

As for the claims of the public to a share of the surplus, the commissions would take charge of that at its source, and, under their control over investments, see to it that only such future surplus ever came into being as was really needed to protect the credit of the company and to carry on the business effectively. We should have no such a condition as presents itself today in the Union Pacific Railroad, which as a result of successful speculation now holds securities of other roads to the amount of \$175,819,947; and in addition, a surplus in cash, and cash items, of \$35,000,000. If the road never did any more transportation business or utilized any of its transportation property for any purpose, it could, from its other investments, pay a good dividend on its common stock in perpetuity. What relation has all this property to a fair rate? What is a fair valuation? What property ought to be included in a valuation of the property of this system?

Probably any system of effective regulation calls logically for a guarantee by the public against all losses necessarily incurred. It might be more advantageous to do this directly and openly instead of as at present inflating valuations under the heads of "going concern," "cost of developing business," etc.

CONCLUSION

To summarize: The welfare of the public has made it necessary to class certain industries as public utilities and to limit their profits. In the absence of regulation there would be no limit to the profits except the ability of the public to pay. Value, in the ordinary sense of the word, would therefore increase. The chief motive for regulation is to prevent such possible extortion by confining utilities to a fair and steady rate. This, however, destroys those attributes of private property out of which value grows. For value is measured by earning power, and this under regulation is fixed by law and not by the economic forces and bargaining power that fix value in the only proper meaning of the term. Therefore, to attempt to discover value as a means of fixing a rate of such a monopoly is to reason in a circle.

We have been led into this slough of despair in the wrangle over who ought to have the gains and who ought to bear the losses of the era of competition. With these questions settled once for all, there would remain no controversy over the fact that the amount so agreed upon plus any future additions is the investment upon which a fair return should be allowed. The present commission system of regulation, with its power over investments, capitalization and accounts, provides for such determination of the investment, and there is now no possible chance or occasion for valuation for rate making under such an arrangement, except as the controversy over the disposition of the speculative gains of the unregulated past and the uncertainty of the records of that period make it necessary as a basis for compromise.

REPORT OF COMMITTEE ON RECOMMENDED PRACTICE FOR STANDARDIZATION OF FILTERS

On January 28, 1913, P. N. Engel, Mem.Am.Soc.M.E., suggested in a communication that the Society appoint a committee to take up the question of rating of mechanical filters. Mr. Engel's suggestions were substantially as follows:

"Mechanical sand filters of the pressure type are coming into more general use every year, and yet the engineer or architect under whose specification they are bought and installed has no way of ascertaining just what size filters are needed to perform a certain amount of work, other than he can secure from the various filter manufacturers' catalogues, or from the claims of the filter salesman, which we regret to say in many cases vary greatly.

"Practically all of the standard filter manufacturers are agreed that a square foot of filter surface will not perform more in one filter than it will in another, with equal efficiency.

"I believe that the members of your Society will be greatly benefited by having an approved specification to which they could refer when buying filters, and therefore respectfully suggest that your Council appoint a committee to investigate the matter and to recommend the adoption of a standard specification.

"The points established are that the capacity of a filter is governed by the filtering area—that the filtering area is governed by the internal horizontal diameter of the filter; that all filters of a given diameter have the same capacity; that the capacities of filters of a given diameter vary according to the efficiency desired; that the more slowly the water passes through a filter, the more perfectly will the water be filtered, the minimum rate of flow being 2 gal. per sq. ft. of filter area.

"A standard specification will mean that the buyer of a filter of a given capacity will get a filter of the proper size—no matter from which manufacturer he buys it, and this is not the case at the present time, as the mechanical engineer has no text-book or standard specification to tell him what size filter is needed."

Mr. Engel's letter was referred to the Council, who in turn consulted a number of experts in this field on the desirability of the Society taking action in this matter. The consensus of opinion being favorable, the Council, on May 12, 1913, appointed the following committee to investigate and report on how to rate the capacity of mechanical filters: George W. Fuller, Consulting Engineer, *Chairman;* P. N. Engel, Vice-President, International Filter Co.; J. C. W. Greth, Manager, Water Purifying Department, Wm. B. Scaife & Sons Co.; James C. Boyd, Managing Engineer, Westinghouse, Church, Kerr & Co.; Wm. Schwanhausser, Chief Engineer, International Steam Pump Co.

For some time the work of the committee served to emphasize somewhat the importance of the conditions that led to its appointment, while at the same time developing difficulties in the way of making an adequate report.

The committee found, upon investigation, many points which undoubtedly needed remedying, it being doubtful whether pressure filters as used in the mill business or in the office-building business could be further standardized to approach the basis used in the best offices for municipal standards. The small pressure filters did not seem capable of having attached to them the various safeguarding devices used in the larger city plants.

On August 7, 1915, the committee lost by death one of its members, Mr. J. C. W. Greth, who rendered much aid in the collection of data on the practical side of the art. The chairman called in two new members, Arthur M. Crane, of the New York Continental Jewell Filtration Co., and Martin F. Newman, Assistant Manager of the Water Purifying Department, Wm. B. Scaife & Sons Co.

The committee presented its report to the Council on November 10, 1916, and it was received and ordered printed. The report was presented to the membership at the annual meeting in New York, December 5, 1916, and it was discussed at this meeting. The report and discussion are reported in full below.

The Report

To the Council of The American Society of Mechanical Engineers:

Your committee, appointed to make recommendations as to how to *rate the capacity of mechanical filters,* desires to submit the following report:

MUNICIPAL VS. INDUSTRIAL FIELD

2 The field of mechanical filtration may be arbitrarily yet definitely divided into two parts: One, the purification of drinking water or water for domestic supply, and the other the purification of water for other purposes, such as industrial uses.

MUNICIPAL PRACTICE SUBSTANTIALLY UNIFORM

3 On account of its importance and the large expenditure involved, especially in connection with municipal plants, much time and study have been given to all features of the filtration of water for domestic use. A large amount of data gathered through laboratory tests, and experience covering long periods in the practical operation of municipal plants, have brought into quite uniform adoption by all engineers engaged in such work the use of a rate of filtration of 2 gal. per min. per sq. ft. of filtering area for domestic supply.

DEPARTURES FROM NORMAL MUNICIPAL RATE PERMISSIBLE

4 While stating as a matter of information that such a rate is applicable in the great majority of such cases, your committee does not feel warranted in setting forth this rate as one to be adopted for all cases. As a matter of fact, the installation of a municipal filtration plant usually is done, and always should be done, under the advice and supervision of a competent filtration engineer engaged for the purpose, and the rate of filtration as well as other points of construction and operation should be left to his judgment, based upon the local conditions that may exist. For this reason, your

Received by the Council, November 10, 1916, and ordered printed. For presentation at the Annual Meeting, December 1916, of The American Society of Mechanical Engineers, 29 West 39th Street, New York.

committee feels that it is advisable and in accordance with the spirit and intent of your instructions to refer herein chiefly to the filtration of water for other than municipal purposes.

VARIOUS VIEWS CANVASSED

5 Your committee in considering this subject has sought information and assistance from many sources, and we desire herewith to express our appreciation of the many courtesies extended to us by those thus called upon for data or comment.

GRAVITY VS. PRESSURE FILTERS

6 It may be well here, in view of the misunderstanding that seems to exist to some extent, to make some reference to the two different types of mechanical filters known as the gravity type and the pressure type. With both types, purification is accomplished by passing the water through a filtering bed, which in practically all cases is sand, and the purification is dependent upon the property or power of the bed of sand to remove suspended impurities from the water passing through. This property is one inherent in the filter bed itself, and, while it will be affected by the rate at which the water passes, it is not altered by the incidental fact of the water being or not being under more than atmospheric pressure. While, with additional pressure available, more water can be forced through a pressure filter than a gravity filter of given size, there is no difference in the principles or methods employed that warrants a higher rate of filtration with such filters than is acceptable for open or gravity filters when similar results are to be obtained.

EXPERIENCE LEADING TO STANDARDIZATION

7 From the information gathered it was made apparent that experience has already brought about a substantial unanimity of opinion and practice on the part of all those who, as engineers, chemists or manufacturers, are brought into close contact with the field of mechanical filtration as to the limits within which permissible rates of filtration must fall. A very definite rate has become established in connection with municipal work, and indeed if there had been anything like the publicity in connection with filtration of water for other purposes that has obtained in connection with gravity filters such as are installed for municipal work, it is probable that there would have been no occasion for such investigation and report as this committee has been called upon to make.

TENDENCY TO OVER-RATING

8 While our investigation has made the above situation apparent, it has also developed the fact that there have been many filters installed in which the rate of filtration per unit of area is beyond, and sometimes far beyond, that at which good results can be expected or required. In some cases this has been due to the specifications under which the filters were installed, and in others, to what must be called an over-rating of the capacity of filters on the part of manufacturers. It is easily possible to force or pass through a filter of given dimensions much more water than it will properly filter, and in view of this it must be expected that there will be more or less yielding on the part of manufacturers placed under competitive conditions to the temptation to over-rate their filters.

NEED FOR DEFINITE, REASONABLE SPECIFICATIONS ON CAPACITY

9 This condition emphasizes the need and value of a pronouncement on this subject by some such body as The American Society of Mechanical Engineers which will serve for the information and guidance of those who, while having occasional need to specify or use mechanical filters, do not have opportunity to keep fully informed of conditions in that field. It is, therefore, hoped that this report and its recommendations will be of real value to engineers by placing before them information as to what is now the best opinion and practice, and thus enabling them to protect their own work and their clients' interests. To this end your committee most heartily and urgently recommends that when specifying filters there be included not merely the amount of water to be filtered per unit of time, but also specifications as to the rate of filtration per unit of area, or else the area or dimensions of the filter bed. Specifications thus written will insure fair competition and more satisfactory results.

IDENTITY IN GENERAL DESIGN

10 The same general design and the same principle of operation are followed by all the leading manufacturers of mechanical filters, the filtration being downward through a bed of sand superimposed upon layers of gravel, the filters being washed by a reverse flow of water. Competition in construction is, therefore, limited to the excellence of materials and workmanship, to the perfecting of details and to adaptations for convenience in accordance with good filtration engineering practice. While this affords abundant opportunity for conscientious care and requires familiarity with the history of filtration and thorough knowledge and observance of the results of experiments and tests, it does not allow any application of ingenuity to change fundamental requirements that are dependent upon natural laws.

UNNECESSARY TO STANDARDIZE CONSTRUCTION DETAILS

11 Your committee feels that it would be unwise, at least at this time, to attempt to standardize details of construction, there being a wide range in this field for individual preference or convenience, but there may well be established a standard in regard to the rate of filtration, since the object thereby sought is not mere uniformity but compliance with the limitations imposed by the laws of nature, so that the possible benefits of filtration will be actually and fully realized. It would thus seem to be self-evident, even if it were not fully established by experiment and experience, that the capacity of any filter is dependent upon and determined by two factors:

a The permissible rate per unit of area at which the water can be passed to insure the desired results.

b The effective area of the filter bed.

AGREEMENT AMONG LEADING FILTER MANUFACTURERS

12 It was made evident by the data gathered that there is a unity of opinion on the part of those best qualified to judge at what rate water may be passed per square foot of filter area to secure desired purification, and that there is a close agreement in the practice of all the leading filter manufacturers in rating the capacity of a filter.

FORM OF EXPRESSING CAPACITY

13 For convenience, we have expressed the rate of filtration in terms of gallons per square foot of superficial filter bed area per minute, thus combining units of quantity, area and time in a way to make easy the calculation of the amount of water any given filtering unit will properly handle or to estimate the area of filter bed surface that will be required for a given supply. The filtering area should be computed on the upper surface of the filter bed, as the latter lies during normal filtering operation, and no attention should be paid to a greater cross-sectional area such as is sometimes found in horizontal cylindrical filters.

CARE AS TO MAXIMUM DEMAND

14 In deciding upon the size of filters to be installed in any instance, very careful consideration should be given to the maximum flow that will be required at any time, and ample capacity provided. Where the demand is irregular, the maximum requirement is much greater than the average or minimum consumption, and either adequate storage for filtered water should be provided or the rated capacity of the filter made equal to the maximum demand. All filters are capable of passing more than their rated capacity, but beyond certain fairly narrow limits this is always at the expense of the quality of the filtered water, unless more than ordinary care is taken in efficiently coagulating the unfiltered water. As already intimated, the persistent use of moderately high rates above the normal and the occasional use of excessively high rates should be discouraged, if not prohibited.

DEPTH OF FILTER BED

15 While in a sense consideration of the filter bed may not be included within the instructions given your committee, we feel that some remarks in this connection will be of value, especially as there seems to be an opinion in some quarters that the use of a thicker filter bed or special methods or appliances for washing, or similar features, make higher rates of filtration permissible. In regard to such points, we would say, that while of course there is a minimum thickness of filter bed that must always be maintained for safety, better results do not follow increased depth. In fact, an excessive depth of sand bed is in some instances objectionable, as it may interfere with proper washing. We find that the minimum thickness of filter bed should be 27 in., of which at least 18 in. should be sand or similar fine material. A filter-bed thickness of 33 in., of which at least 24 in. is sand or similar fine material of suitable size and grade, is recommended.

INFLUENCE OF FILTER WASHING

16 While efficient washing of the filter bed must be provided for and while the use of special means or appliances, such as stirrers, air agitation or other means of breaking up the filter bed, may be of value in some cases as means of securing economy in time or of water consumed in washing the filter bed, the direct effect of such means is limited to that secured during the washing process and such effect has no influence one way or the other on the permissible rate of filtration, which is dependent upon and limited by properties inherent in the filter bed itself.

NORMAL FILTERING MATERIAL

17 The most desirable filter medium is a granular substance of a hard, non-porous, insoluble character, with grains substantially uniform in size and shape, the exact size and uniformity of the particles being open to some variation depending upon local conditions. If properly washed, such a filter bed will remain in efficient working condition for several years.

SPECIAL FILTERING MATERIAL

18 Bone charcoal or other porous material is sometimes of aid in the removal of iron, color, tastes or odors. But if they are used it must be recognized that growths of bacteria in the effluent are very likely to occur, although there is no evidence to indicate that such growths include disease-producing germs. These porous media may be used in single or double filtration, as noted in Pars. 20 to 23, inclusive.

RECOMMENDED RATE OF FILTRATION

19 The permissible rate of filtration in any instance depends upon the character of the water to be filtered and the purpose for which the water is used. If the water is for domestic purposes, whether the filters are installed in a municipal plant or otherwise, the rate of filtration should not exceed that which has been adopted for such service by universal consent of filtration engineers. We therefore recommend that:

a Whenever the water is to be used for domestic purposes or to secure full bacterial purification, the capacity shall be based upon a rate of filtration not to exceed 2 gal. per min. per sq. ft. of filtering area and a coagulant must be used.

b Where a lesser degree of purification is required, either because the water is not to be used for domestic consumption or because the water to be filtered is already sufficiently free from bacteria, or where the filtered water is to be effectively sterilized, a higher rate of filtration may be used, but not to exceed 3 gal. per sq. ft. per min.

DOUBLE FILTRATION IN SPECIAL CASES

20 Your committee finds that there is a limited use made of double filtration; that is, the water is passed through two filters placed in tandem. The consensus of opinion of those consulted and the recommendation of your committee is that when both filters are filled with the same medium this is not the best practice, but that better results will be obtained from the same filters operated in parallel, if they are properly constructed, owing to the slower rate of filtration.

21 Double or tandem filtration may, however, be used to advantage under some special circumstances, as, for instance, where the filter medium in the second filter is of a very close texture, so as to secure the very highest quality of filtered water by removing fine suspended matters that may pass through an ordinary filter bed.

22 Double filtration may also be of advantage where the use of a coagulant is not desired or where it is intended to remove iron, color, odor or taste. In such cases sand can be used in the first filter and bone charcoal or similar porous medium in the second. Such practice, however, should be limited to cases where an increase in the numbers of harmless water bacteria, such as frequently occurs in the effluent of a porous filter medium, is not objectionable.

23 If double filtration is employed, the rate of filtration should not exceed the rate of single filtration, unless warranted

by the result of experiments or upon the advice of a competent filtration engineer.

STERILIZATION

24 In earlier years it was frequently the custom to sterilize filter beds with steam, but it was found that the benefit of this treatment was temporary, and it frequently resulted in the growth of water bacteria within the filter. At present, sterilization is normally and preferably secured in the filtered water through the aid of liquid chlorine, hypochlorite of lime, or ultra-violet rays. When properly applied, such treatment will destroy all objectionable bacteria.

PREPARATORY TREATMENT

25 While this report deals essentially with filters themselves, it is proper to point out that mechanical filters, with the rapid rate of filtration employed, cannot be expected to accomplish the best obtainable results without the securing of proper coagulation; and if the raw water is very turbid, then preliminary sedimentation also must be considered.

26 In closing this report the committee desires to express its deep loss in the death on August 7, 1915, of J. C. W. Greth, Mem.Am.Soc.M.E., one of the original members, and also its appreciation of his aid in collecting data on the practical state of the art and of his judicially expressed opinion as to the basis of this report.

Respectfully submitted,

George W. Fuller, *Chairman*,
James C. Boyd,
Arthur M. Crane,
Philip N. Engel,
Martin F. Newman,
William Schwanhausser,
Committee on Filter Standardization.

DISCUSSION

Jos. W. Ellms.[1] The recommendations of the committee making this report are in agreement with the best modern practice in the design of mechanical filters. They have quite clearly indicated the maximum limits for safe rates of filtration and the minimum depths for the filtering medium. Their conclusions on these points are in accord with the writer's own experience.

In declining to commit themselves in regard to construction details, they are probably justified; yet it might have been well to have enunciated some of the general principles which experience has shown to be essential to the best design. The writer has reference more particularly to underdrain, strainer and waste-trough design. Probably no portions of a mechanical filter are more directly dependent upon proper coördination than are those whose principal functions relate to the cleansing of the filter bed. So far as these portions of the filter act as distributors of the influent water to the filter bed, and as outlets for the effluent from the bed, their importance is only of a secondary character.

It is of the utmost importance that the underdrain system of a filter bed shall effect as uniform a distribution of wash water as possible. Whether this is done largely through strainers of various types or through perforated pipes, or in conjunction with the coarse filtering material forming the bottom of the filter bed, is of small consequence, so long as it is actually accomplished. Moreover, a uniform and speedy withdrawal of the dirty wash water by means of properly disposed waste troughs is as essential as uniform distribution of the wash water when entering the filter bed. In other words, a mechanical filter which cannot be quickly and effectively cleansed is defective.

It is to be hoped that the indorsement of the committee's report by the Society will establish certain definite principles of filter design to which manufacturers will conform, and by which purchasers of filters may be guided in judging of the merits of any particular design that may be submitted to them.

George A. Johnson.—The report of the committee recommending certain standard procedures in filter practice shows clear evidence that the general proposition has been viewed from the numerous necessary angles and the tentative conclusions drawn from approved practice in filter design and operation. At best the preparation of such a report was a difficult task, for the reason that in water-filtration problems local conditions govern so very largely, and their individual peculiarities are so numerous and varied. This report will serve a valuable purpose in the development of standard practices where possible of application, and the committee is to be congratulated for the skill and conservatism displayed in its preparation.

Frederick Schreibman, in the first of a series of articles in *The Iron Age* on improving operating conditions in machine shops without buying new machines or erecting new buildings, proposes to adopt the following plan whenever an expansion of a plant is attempted: *a*, to adopt a new location of machines at present used; *b*, to change the location or enlarge certain doors, windows, stairways and elevators; *c*, to strengthen certain parts of the first floor, etc.

In the construction and insulation of refrigerators "built in" on board ship, difficulty has been encountered with the use of cork that had not been sufficiently pressed previous to baking. This cork was not as dense as it should have been, and was lacking in mechanical strength.

As to refrigerator doors, the idea seems to prevail that they should have beveled edges and that such edges make a very tight door. However, as soon as the moisture begins to have its effect, such a door cannot be tight any more. Further, if the hinges yield at all, as they are likely to do with such a heavy door, it will never be tight.

The way to make a tight refrigerator door is to have a plain surface come up against a plain surface with a flexible gasket between them, or two pairs of such surfaces with gaskets between them, making an air pocket between the two sills. If this arrangement is used the door can sag considerably without causing any serious binding or failure in tightness.

As regards estimating the capacity of the refrigerator machine required to take care of the given refrigerator, it is not sufficient to calculate on heat loss through the insulation of the refrigerator, as it is only a part of the total loss. The other losses are due to heat entering in warm goods, by the interchange of air through the opening of doors, and by leaks through defective insulation or defective doors; to lights, or to the heat of the bodies of workers; to any change of state occurring in the goods, such as freezing, fermenting, etc.—R. F. Massa in paper at the Annual Meeting of the Society of Naval Architects and Marine Engineers, November 1916.

[1] Filtration Plant, California, Cincinnati, Ohio.

ANNUAL MEETING DISCUSSIONS

Written Discussions of the Papers Presented at the Thirty-Seventh Annual Meeting of The American Society of Mechanical Engineers, New York, December 5 to 8, 1916

IN the preceding issue was given an outline of the Thirty-Seventh Annual Meeting of The American Society of Mechanical Engineers, held in New York, December 5 to 8, 1916, in which it was aimed to give a comprehensive and yet not over-long account of the whole meeting. It was only possible to include in this outline the briefest abstract of the written discussions, which were exceptionally full.

It was hoped to give full publication to these written discussions in this issue of The Journal, but here again space precludes giving more than one-half the discussions and the remainder will be given next month.

The discussions are printed substantially in full, and will be found to contain a large amount of valuable material supplementing the subject-matter of the papers. Following the discussions are given, in each case, the authors' closures, which refer also to the oral discussion abstracted last month.

THE TESTING OF HOUSE-HEATING BOILERS. L. P. BRECKENRIDGE AND D. B. PRENTICE

William Kent. The method of rating a house-heating boiler proposed by the authors seems to leave out a most important factor of such a rating, viz., the grate surface, or the amount of coal that should be burned per square foot of grate surface.

The authors say, "The capacity or commercial rating of a heating boiler has always been given in terms of the direct radiating surface which it would serve." The capacity of such a boiler thus defined, that is, the amount of radiating surface which it will serve, is an exceedingly variable quantity, depending chiefly upon the amount of coal that is burned under it per hour, which in turn depends on the size of the grate and the rate of combustion. A certain boiler with 1 sq. ft. of grate and say 20 sq. ft. of heating surface may supply 150, 300 or 450 sq. ft. of heating surface, depending on whether the coal is burned at the rate of 4, 8, or 12 lb. per sq. ft. per hour. It is evident then that no satisfactory rating of a house-heating boiler can be made that does not take into consideration the rate at which the coal is burned. I therefore would amend the authors' definition of a unit for stating the capacity of a heating boiler so as to make it read as follows:

The *foot of radiation* shall be $\frac{1}{4}$ lb. of steam per hour condensed at 212 deg. fahr. and discharged as water at 182 deg. (equivalent to 250 B.t.u. per hour) when the coal is burned at the rate of 4 lb. per sq. ft. of grate surface per hour.

I use the figure 250 instead of the authors' 242.6 because it has long been used by heating and ventilating engineers as a standard equivalent for an average square foot of radiation. A radiator generally discharges its return water at a temperature somewhat below the temperature of the steam, and the figure 250 is therefore more nearly equivalent to the actual conditions of condensing $\frac{1}{4}$ lb. of steam than is 242.6.

In 1909 the writer presented a paper on The Testing and Rating of House-Heating Boilers to the American Society of Heating and Ventilating Engineers, which is published in the Transactions of that society. Some of the points in that paper are pertinent to the discussion of the present paper.

S. B. Flagg and R. L. Beers. The writers have been engaged during the past two years in planning and carrying on an extended series of tests which the Bureau of Mines is conducting for one of the Government departments. The principal purpose of these tests has been to obtain information as to the relative value for domestic heating purposes of a large number of fuels used by this department, including a number of Canadian and foreign coals. At the same time a comparison is being made of steam and hot-water boilers.

The reasons given in the paper why it is important to have a satisfactory method of testing house-heating boilers are heartily indorsed. The writers would add to these reasons by pointing out that in many localities anthracite coal is practically unobtainable or can be used only at a much greater heating cost than for some other fuel. Consequently methods of firing and testing such boilers and the ratings established for them should take account of these other fuels, especially bituminous coal.

It is agreed that the lack of clearness as to the meaning of *a foot of radiation* is undesirable and should be corrected. In reporting results of tests of boilers of the hot-water type, the employment of a unit such as the paper describes would be especially desirable for comparison with steam-boiler tests.

In the development of plans for the tests which the Bureau is now conducting the following considerations governed:

The average residence-heating boiler operates during the most of the heating season at a load less than 40 per cent of its rating. Results were desired showing the comparative values of the fuels under average load conditions, and the tests were therefore run at approximately this load.

Conditions of attention were to be comparable to those in actual service so far as possible. For this reason with most fuels charges of relatively large size were fired so as to give a firing period ranging from 6 to 12 hours.

In the case of the steam boiler installed in a residence, neither the rate of delivery of steam nor that at which the condensation returns is uniform. The boiler output was therefore allowed to vary, but the valve controlling the delivery was so set that with automatic damper regulation an average load of approximately 40 per cent of rating was maintained. This corresponds with the authors' requirement in Par. 12*a*.

So far as possible the test data were mechanically recorded and some of the data so recorded by a second piece of equipment.

In order to reduce errors of starting and stopping the duration of the tests was made approximately 48 hours.

The authors concede that when the load is allowed to vary the conditions of house operation are reproduced, but they feel that under such circumstances it would be difficult to duplicate results. Tests conducted at the Bureau's experiment station do not justify such a conclusion, and the writers' opinion is that the real purpose of the test should be to learn what the boiler will do under operating conditions. If it be agreed that such is the purpose the effort should be to approximate the operating load. Observations taken at the time the Bureau's plans were being developed showed that the actual delivery of steam by a residence-heating boiler varies

through a considerable range, even in moderate winter weather, and is affected principally by the times and conditions of firing, and the character of the fuel.

It was the effort when the Bureau's tests were first started to employ a method of starting and closing tests similar to that proposed in Par. 17 of the paper. The duration of the full test was then and still is made approximately 48 hours, and at the end of the first 24 hours the fires were brought to a closing condition and readings taken. Experience with this method, particularly with anthracite coals, showed so great variations between the two 24-hour periods and also between different tests that it was abandoned for what was formerly known as the "standard" method of starting and closing. With the latter method of test the overall efficiencies are usually lower, but results can be more easily checked with 24-hour tests by this method than by 48-hour tests by the former method. The following results illustrate the variation:

Test	Coal	Method of Starting	Duration (hours)	Total Coal per sq. ft. Grate	Overall Efficiency %
761......	Anth. Egg.	First.	47.07	89.6	77.6
761 (a)...	"	"	24.28	51.8	80.0
761 (b)...	"	"	22.78	37.8	74.5
868......	"	Second	24.25	80.3	62.8
853	"	"	49.37	128.3	62.9

The proposed method of starting and stopping can probably be used with a fair degree of success with anthracite coal of stove or chestnut size, but the writers' experience with other sizes was anything but encouraging. The evaporative performances quoted by different manufacturers, nearly all of which are believed to be for anthracite coal, appear high, and it may be due to the effort to get results with a short test or to the use of a method of starting and stopping which does not give correctly the quantity of fuel actually consumed.

It is obvious that the proposed method of starting involves less work in both the conduct of the test and the analysis of fuel and refuse samples than does the other method wherein the test is started with a new fire and analysis is made of the material remaining on the grate at the close of the test. It was because of this difference that the effort was first made to start with a fire which has been burning for 3 or 4 hours, but the writers were not able to carry out the method successfully with anthracite, lignite and some of the sub-bituminous coals, and they are of the opinion that others would experience similar difficulty. A duration of test sufficient to show a total fuel consumption of 40 pounds per square foot of grate is, however, believed to be adequate if the so-called "standard" method is used.

The feeding of water to the boilers may be done as described in the paper or it may be done in another way if the output rather than input is measured. The latter course is followed in the Bureau's tests.

Connection may be made by a small line from a source of water under pressure to the return outlet of the boiler. In this line a small orifice may be placed and the pressure drop through the orifice read off of a manometer graduated to read in rate of flow or simply in pressure difference. The manometer shows at any time at what rate the water is being fed, and this feed can be adjusted to keep the boiler water level practically constant.

Measurement of output can readily be made in either of two ways. One way is to send the steam delivered by the boiler through a closed-type feedwater heater, the condensing water circulating in the coil, and measure the condensate. The other way, which would obviate the use of calorimeter readings in computing results, is to measure the quantity and rise in temperature of the condensing water, the condensate returning to the boiler. Selection of equipment for either method may be made from a wide variety, and nearly any desired degree of accuracy obtained in measuring the output.

ROY E. LYND. There are two points in this paper which I would like to discuss. The first is that the titles of the paper and of the proposed testing code both confine themselves to house-heating boilers, and the paper states that the class of boilers indicated by the authors under this heading includes only boilers designed to serve 2000 ft. of radiation or less. It seems that we make a mistake in thus limiting this code. The same boilers which we use in our houses are used very extensively to heat schools, churches, and other large buildings, and several makes of low-pressure cast-iron sectional boilers are designed to serve as much as 10,000 ft. of radiation. We would do well to eliminate the term *house-heating boilers* from the title, the paper and the code, and substitute therefor *low-pressure heating boilers;* and include all low-pressure heating boilers instead of those only which are designed to serve 2000 ft. of radiation or less. The larger boilers of this class are covered by section (9) of the code, which states that the test conditions should be as nearly as possible like the ordinary operating conditions for the boiler to be tested.

In the A.S.M.E. Boiler Code of 1914, boilers are divided into two classes.—Power Boilers, Section 1, and Boilers used exclusively for Low-Pressure Steam and Hot-Water Heating and Hot-Water Supply, Section 2. This division should be borne in mind in any new testing code. As the proposed testing code is essentially a code for evaporative tests, we are not concerned with boilers for hot-water heating and hot-water supply. It would seem therefore that the new code should cover all boilers used exclusively for low-pressure steam heating, and should be so entitled. The A.S.M.E. Boiler Code, in Section 2, does not limit low-pressure heating boilers to 2000 ft. or less, and we should not so restrict the testing code.

The second point is in regard to the definition given for a *foot of radiation.* The authors seem to think that the amount of steam condensed per foot of radiation enters more largely into ordinary heating calculations than the B.t.u. They have assumed a convenient average amount of steam per foot of radiation, and have then converted this into an awkward B.t.u. value. This, to my mind, is wrong. We figure practically everything in connection with heating installations in B.t.u.'s, and it is very rare that the question of the amount of steam involved is raised. I would suggest that the *foot of radiation* be defined as a transfer of heat equal to 250 B.t.u.'s per hour. This figure, and its reciprocal, 0.004, are both very convenient, and would be far preferable to the figures given by the authors.

It has been the writer's practice to test low-pressure boilers at atmospheric pressure, keeping a record of the steam temperature as indicated by a mercury thermometer placed in an oil well directly in the steam chamber in the top of the boiler. The pressures at which these boilers are operated are as a rule so nearly atmospheric, if the heating system is conservatively designed, that a test made at atmospheric pressure comes about as close to actual operating conditions as it can be got. The great advantage of the atmospheric pressure test is, of course, its simplicity, it being unnecessary to use the reducing valve, receiver, and bank of valves spoken of by the authors.

One of the functions performed by this system of pressure control suggested by the authors is in the determination of the time of starting and stopping the test. The test is started

by establishing normal running conditions with a pressure of, say, 5 lb. on the boiler. Then the fire is cleaned and thinned until the pressure drops to say, 3 lb., when the test is assumed to start. The same conditions are reproduced at the end of the test, the test being over when the pressure drops to the same 3 lb. This would all be out of the question with a test made at atmospheric pressure. The writer has used for some time a system which is very similar, and which gives practically the same accuracy, and which is applicable to tests made at atmospheric or any higher pressure. Normal running conditions are established before the test, and then the fire is cleaned and thinned just as outlined in the paper, but instead of depending on the pressure dropping to a certain starting pressure, the temperature of the flue gases is used as an index. When the temperature of the flue gases falls to a predetermined point, the test is assumed to be started, and at the close of the test the starting conditions are reproduced until the flue-gas temperature taken at the same point in the flue falls to the starting temperature. This method seems preferable, as the flue-gas temperature is more intimately connected with the condition of the fire than the steam pressure is, and at the same time it enables us to use the very much simpler atmospheric pressure conditions.

It has also been the writer's practice, for some time past, to keep accurate records of the draft in the flue, in the firebox, and in the ashpit, by means of differential draft gages. These data sometimes indicate differences in the draft conditions which may explain differences in test results.

Max Friedlander. Below is a description of a new method for the *continuous* determination of the heat balance of house-heating boilers. The principle of the method was suggested by Prof. H. Junkers, the originator of the Junkers calorimeter, and the method was tried out and applied by the writer in a series of actual tests on a steam-heating boiler in 1911 when he was his assistant at the Technical College of Aix-la-Chapelle, Germany.

The idea was to measure all items of a complete heat balance in a continuous way during operation, and for this purpose the boiler was suspended upon a sensitive balance, so the smallest amount of fuel burned off in the boiler could be weighed very exactly at shortest intervals, thus giving a continuous determination of the fuel consumption and the incoming heat. The arrangement is shown in Fig. 1.

The entire steam generated was condensed in a condenser and the condensed water carried back to the boiler. In this way the useful heat could be determined continuously by continuously measuring with a Poncelet vessel the quantity of cooling water used in the condenser and, with the thermometers, the increase in its temperature.

The flue gases were drawn out by a ventilator and carried through a flue-gas calorimeter, in which their entire *sensible heat* was determined by cooling them down to the room temperature by a water jacket, the quantity of cooling water being measured continuously with a Poncelet vessel, and its rise in temperature also being measured. The volume of the flue gases was recorded with a gas meter of 1500 liters capacity per revolution.

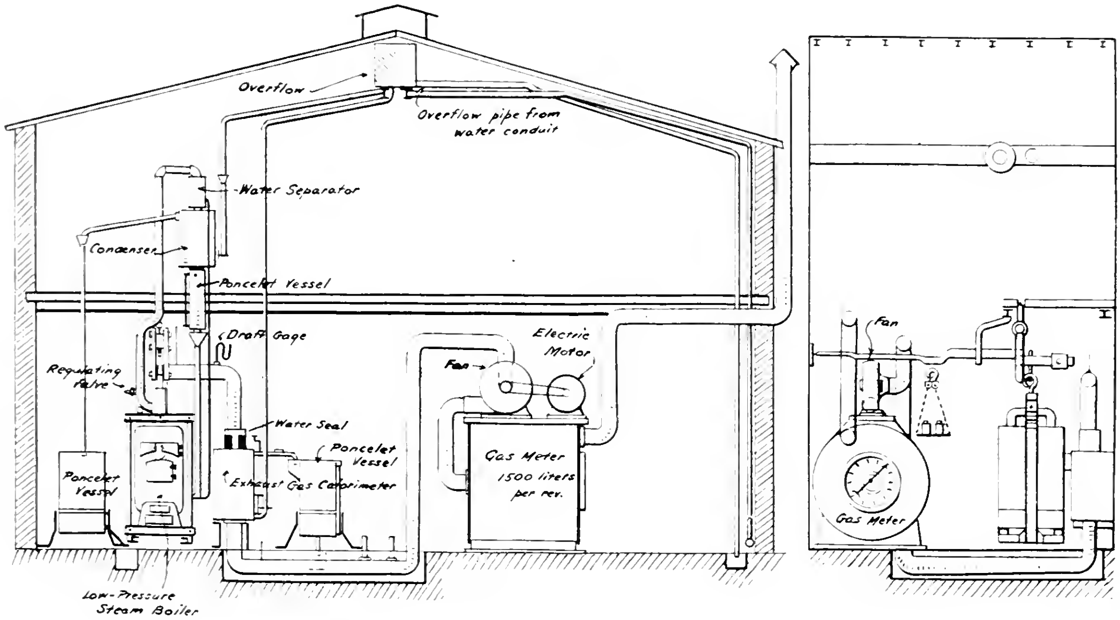


Fig. 1 Testing Low-Pressure Boilers at the Royal Technical High School, Aix-la-Chapelle, Germany

A quite novel feature was the continuous determination of the loss of heat due to incomplete combustion by a new calorimetric method in which the heat value of the flue gases was measured in a calorimeter fitted with a specially designed burner for which a patent is pending. This method for the calorimetry of flue gases has been developed by the writer in separate experiments and tried out in a great number of actual tests and applications on boilers and combustion engines, and it has been described in detail in a dissertation (not yet published), where all these experiments and tests are also reported. The arrangement for this is also shown in the illustration.

The heat loss due to incomplete combustion was very variable and, with the boiler mentioned, wavered between 8 per cent and 23 per cent of the incoming heat when the operation and combustion was normal, and increased to over 45 per cent when the boiler was operated with insufficient excess of air or otherwise in bad condition. In all cases, however, the heat value of the flue gases decreased continuously, or, in other words, the combustion improved steadily in the proportion

as the layer of coal was burning off, thus indicating that the boiler was working in the beginning like a gas producer.

Heat radiation and conduction was determined by temperature measurements of the outer surface of the boiler and its surroundings, and by use of individual coefficients of heat transfer.

CLOSURE BY PROFESSOR BRECKENRIDGE

L. P. Breckenridge. The authors appreciate the discussion and suggestions presented by the different members. It is evident that the time has arrived for adopting a plan for testing house-heating boilers. It is probable that the Power Test Committee will be able to use the suggestions made in the discussion when they come to give consideration to this paper.

At no place in the paper do the authors discuss a method of rating boilers. That is a matter for future consideration. We still believe that in spite of the convenience of 250 B.t.u., the reason already given in the paper is of sufficient weight to justify asking that the most careful consideration be given to the authors' proposed definition of a foot of radiation.

THE UTILIZATION OF WASTE HEAT FOR STEAM-GENERATING PURPOSES, ARTHUR D. PRATT

Warren B. Lewis. The extraction of waste heat from furnace gases has not always been successful, and the unfortunate examples have been heralded fully as much as the successful ones. Boiler economizers are the most widely known waste-heat extractors; and their success has been due, in no small measure, to a thorough understanding of the characteristics of the gases to be handled. The conditions surrounding steel furnaces have not been so thoroughly understood, nor the requirements of the furnace so well appreciated, so that the apparatus for recovering waste heat has not been standardized.

The following description of a plant using waste-heat boilers in which the transfer rate is low is cited to show what has been accomplished from a different reasoning point to that employed in the paper.

Admitting at the start that mechanical draft is practically a necessity, the regulation of draft takes place in the flue between the furnace and the boiler, or, to put it another way, a certain definite draft must be maintained at the end of the checkers. What happens beyond that point is of comparatively small importance.

The furnaces were fired with producer gas made from bituminous coal. The amount of coal consumed in a year was 8400 tons. The gases between the producers and the furnaces were analyzed, as were also the gases between the checkers and the stack; and a determination made of the weight of gas issuing from the stack. The temperature of the gases averaged 1050 deg. fahr., and the boilers were designed to abstract 550 deg. fahr.

The boilers chosen were of the Manning type, with tubes 20 ft. long; and draft was produced by means of a motor-driven steel-plate fan mounted on a platform at the top of the boilers. A rotatable steam-jet tube blower was installed, by means of which the tubes could be blown out as often as desired with a minimum of labor. The ground space occupied was small, and the protection necessary from the weather inexpensive. The boilers were equipped with automatic feed-water regulators.

The early calculations in connection with this installation showed that there should be an average output of 212 boiler hp. One year after the investigation was made the boilers were in operation, and the actual boiler horsepower developed was 227; the temperature of the flue gases was 418 deg. fahr. The total square feet of heating surface was 6600, and the transfer rate less than 2. The actual power required to drive the fan was about $2\frac{1}{2}$ per cent of the net return from the boilers.

The tests showed a comparatively high percentage of recovery, as indicated by the low temperature of the flue gases issuing from the fan.

In order to recover a high percentage of heat with a low transfer rate, a large amount of surface must be used; and it is simply a question of what that additional surface costs as compared with the cost of a high-pressure drop.

L. D. Ricketts[1]. The Cananea plant is the oldest one installed with the header type of flues for the distribution of the waste-heat gases to the boilers. In more modern smelters in the Southwest, Stirling boilers or ones of similar type but of much larger capacity are used. They are equipped with superheaters. Economizers have not been installed recently on account of their tending to become foul and to cut down the draft in the furnaces.

The new plant of the International Smelting Co., near Globe, Arizona, has three reverberatory furnaces, each 21 ft. wide by 120 ft. long, and seven waste-heat boilers of a capacity of 713 boiler hp. each, and they are supplied with superheaters which furnish 50 deg. of superheat to the steam, which is generated at a pressure of 195 lb.

We find it advantageous, however, to use three boilers to a furnace, and now that we have to increase the size of the plant and add an additional furnace, we contemplate installing three more boilers of this size so that we can do this in operating three furnaces and have one boiler as a spare.

It may be of interest in this connection to give some idea of the amount of power recovered at a plant like the one in question.

Each of the furnaces treat about 500 tons of solid charge per day, and with two furnaces running continuously the plant smelts about 30,000 tons of solid charge per month. The evaporation from and at 212 deg. in the oil-fired boilers in the power house is 16.46 lb. of water per pound of oil. The evaporation in the reverberatory furnaces is 7.32 lb. of water per lb. of oil. In other words, a pound of oil burned for smelting purposes in the reverberatory furnaces yielded on an average (for the first ten months of 1916 at the International Company's plant) 44.77 per cent. of the power such oil would yield if burned under its boilers. The gross oil consumed in smelting was 0.856 barrel per ton of solid charge, and of this 0.475 barrel was charged to smelting and the balance to steam generated.

B. N. Broido[2]. Waste heat is also very often used in Germany to superheat steam. In cases where for some reason superheaters cannot be installed in boilers, or in which circumstances require the superheater to be near the engine, independent superheaters are recommended. In such cases superheaters heated by waste gases are the ideal installation.

The writer has designed and installed a number of superheaters both large and small for waste heat. Fig. 2 shows such a superheater for 40,000 lb. of steam per hour, installed at the plant of the Coal Mining Co., Gelsenkirchener Berg-

[1] 42 Broadway, New York.

[2] 228a Rector Street, Perth Amboy, N. J.

werks Gesellschaft. The gases had an average temperature of about 1382 deg. fahr.

The moist steam enters the superheater at *A* in order to prevent rapid burning of the tubes at the point where the gases first come in contact with them. The steam flows through this portion of the superheater in the same direction as the gases, passes over to *B* and flows in the opposite direction, taking full advantage of counter-flow principle.

With a velocity of the flue gases of about 900 ft. per min., and a velocity of steam inside of the pipes of about 5000 ft. per min., the average heat transfer was 4.3 B.t.u. per sq. ft. per deg. fahr. temperature difference. The steam for this superheater was supplied by five waste-heat water-tube boilers, 300 hp. each, four of which were always in operation.

On account of its smaller heating surface the cost of this independent superheater was considerably smaller than it would be with each boiler provided with its own superheater.

Most of the superheaters have been installed for waste heat from coke ovens and open-hearth steel furnaces. Also copper furnaces and cement kilns often furnished waste heat for superheaters.

have been in accordance with early rather than modern waste-heat practice; that is, gas velocities comparable to those now used in open-hearth, cement-kiln and beehive coke-oven work have not been used. In view of the success of the application of this principle in these industries, and from a comparison of exit-gas temperatures from boilers set with smelting furnaces and temperatures from the modern design of waste-heat boiler, it would certainly appear that a trial installation at least of the modern design is warranted on the part of one of the copper campanies.

Mr. Lewis in his discussion gives some interesting figures on the performance of a boiler with low-temperature gases where, based on the transfer rate, the velocity must have been very low as compared to modern waste-heat-boiler velocity. He points out that for such low transfer rates the amount of surface to be furnished for a given capacity must be high. The boiler in question, presumably of 660 nominal rated horsepower, cooled approximately 48,000 lb. of gas per hour from 1050 to 418 deg. and developed 227 hp., or some 34 per cent of its normal rating. It is interesting to compare the heating surface of a modern waste-heat boiler to develop the same

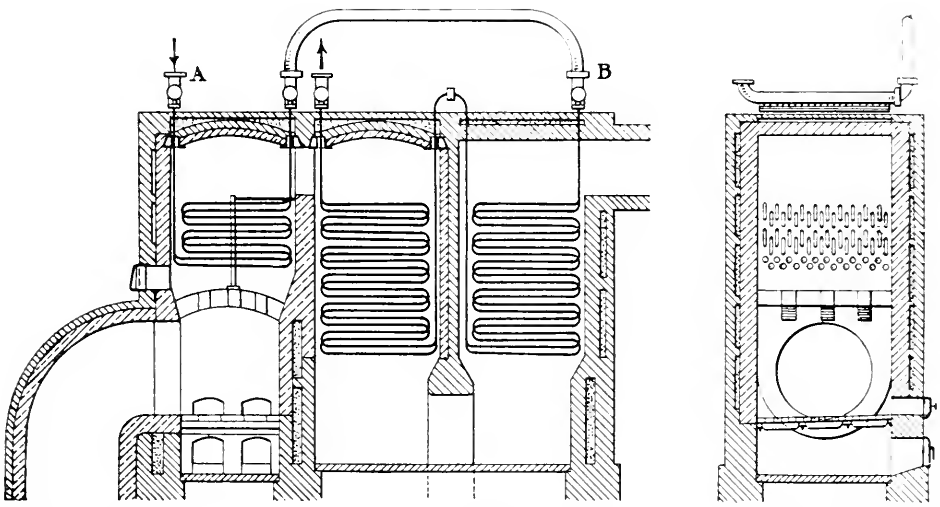


Fig. 2 Independent Superheater Utilizing Heat of Waste Gases. Capacity, 40,000 Lb. Steam per Hour

Mr. Pratt's Closure

Arthur D. Pratt. Mr. Christie raises the question as to whether the principles of high gas velocity could not be successfully applied in direct-fired work. This has been tried a number of times, and the absence of unqualified success has come rather from improper boiler design than from faulty principle.

It is of interest to note that there have recently been sold a number of direct-fired boilers in which the principle of high gas velocity along the lines of modern waste-heat practice is followed. These units are not as yet in operation, but in view of the knowledge gained in waste-heat work there is no reason why the installation should not be wholly successful. That this view is warranted is best indicated by the boilers described in the section of the paper on Utilizing Beehive Coke Oven Gases. Here with entering gas temperatures of 2100 to 2300 deg. fahr., temperatures which at least closely approach the direct-fired practice at ratings of 200 per cent and upward, exit temperatures of about 475 deg. are secured.

The operating figures of the International Smelting Co. given by Dr. Ricketts are of interest. With one exception, all of the boilers furnished with copper reverberatory furnaces

capacity with that described by Mr. Lewis. With such a boiler it is entirely possible to cool this weight of gas from 1050 to 418 deg. and thus develop 227 hp. (It is to be remembered that the temperature to which it is possible to cool a gas is to an extent governed by the pressure carried in the boiler.) The amount of heating surface necessary for such capacity, however, would be approximately 3500 sq. ft. as compared with 6600, and this heating surface would be operating at some 65 per cent of its normal rated capacity.

Mr. Lewis states that the power required to drive the fan was approximately $2\frac{1}{2}$ per cent of the net capacity of the boiler. With the gas velocity through the boiler corresponding to the transfer rate obtained, the draft loss through the boiler proper must have been very low, and it is possible that the duty of the fan consisted largely in furnishing draft at the checkers. If the ordinary draft of 1.4 in. was required at the checkers, with the furnace directly connected to a natural-draft stack, the height necessary for a gas temperature of 1050 deg. would be approximately 150 ft. With the boiler installed and the gases cooled to 418 deg., this height of stack will give at the boiler outlet about 0.75 in., which would not be sufficient for proper furnace operation.

As compared with $2\frac{1}{2}$ per cent of net power required for the fan with the boiler described, a motor-driven fan for the modern design of waste-heat boiler would require approximately 4.4 per cent of the gross output. A turbine-driven fan for the modern unit would require approximately 6.4 per cent of the gross output, but if the exhaust from the turbine could be used in a heater, a large part of this power could be returned to the system.

While, as Mr. Lewis states, the question involved is the cost of additional surface as compared with the cost of a high-pressure drop (for a net capacity), the foregoing comparison seems to be decidedly in favor of the modern design.

Mr. Broido's discussion, in which he refers to the utilizing of waste heat for superheating steam, brings out a point that was perhaps not sufficiently emphasized in the paper, namely, that by far the greater portion of modern waste-heat boilers installed have been equipped with integral superheaters. The high gas velocity has the same effect in increasing transfer rates in superheaters as in boilers, and the amount of superheat being obtained even with low-temperature gases is comparable to what would be secured from the same amount of superheating surface in direct-fired boilers.

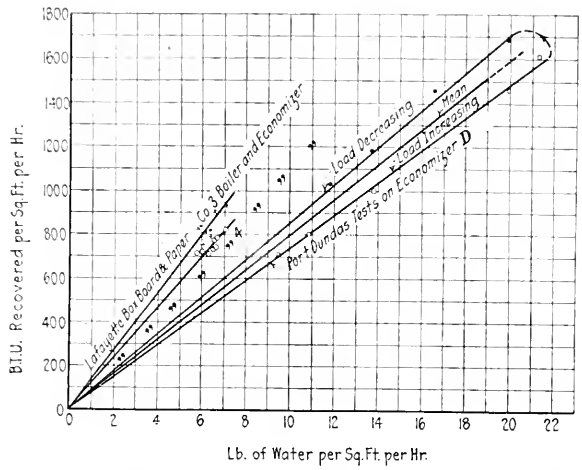


Fig. 3 Relation of Heat Recovery of an Economizer to Rate of Water Flow

Several installations have also been made of superheaters outside the boiler proper after the manner of separately fired superheaters. In one plant with which the writer is familiar such superheaters were set in the flue connecting open-hearth furnaces to waste-heat boilers. In these superheaters a transfer rate of approximately 6 B.t.u. was obtained.

In one or two other installations superheaters have been placed outside of the setting in the exit boiler flue. Such a location, however, would only be practicable with boilers where the gas velocities were such as would result in high exit-gas temperatures.

GRAPHIC METHODS OF ANALYSIS IN THE DESIGN AND OPERATION OF STEAM POWER PLANTS, R. J. S. PIGOTT

C. F. Dixon. We are building in Buffalo a station which will be equipped with three 20,000-kw. Curtis turbine generators and five 11,500-sq. ft. B. & W. boilers and Green economizers. We placed in operation on November 26 one turbo-generator and two boilers. Our operation is in conjunction with Niagara power, so that the steam plant is in operation now only about twelve to fourteen hours a day, and we are confronted with the problem of starting and stopping these large units from no load to full and reverse on very short notice. The starting is quite simple, as the underfeed stoker responds very rapidly to load demands. Our chief difficulty is in the loss of auxiliary steam during the starting period before the main unit is started. This is the only period I have ever found where electric-driven auxiliaries would show any value, and this period does not extend over 20 to 30 min., and would never occur in a 24-hour plant.

Stopping these large boiler units is the most difficult problem we have, especially with the high volatile coal used. We have found that banking with green coal is out of the question. We are able, however, to take our boilers out without loss of steam if we have 20 min. to burn down fires before load is withdrawn.

I cannot agree with Mr. Pigott's statement that the economizer has grown undesirable through the use of higher boiler pressures. With higher boiler pressures have also come higher boiler ratings, with their consequential higher flue temperatures, and the economizer can be made to pay for itself under these conditions. The construction, however, must be materially changed for the higher pressures.

F. A. Wardenburg. In this paper Willans input-output lines are ingeniously applied to the design of the power plant. In the paper two examples are worked out, where most exact information on each unit is plotted. It is not possible to secure such accurate data except from actual test on an operating plant, and in very few cases are these data available in making a design. There is no advantage in working out a design so minutely when the figures ordinarily obtainable are speculative. A great many things vital to the design of a power plant are not subject to exact analysis and must be left to the judgment of the designer; this being the case, it is straining a point to apply such exact analysis to the parts of the design for which figures of more-or-less doubtful value are available. Further, the proposed method does not take into account return on investment, which is one of the most important considerations in the design of a power plant. The designer can, by direct figuring, determine the necessary features of design more easily than by the use of the Willans input-output curves.

MR. PIGOTT'S CLOSURE

R. J. S. Pigott. Several who have discussed this paper seem to have mistaken entirely the source of the data on these curves. The method is practically without use if the data must be plotted from tests; in neither case were any test data available at the time the graphic curves were made up. They are made entirely from guarantees, and the data are no more exact than is usually the case in obtaining guarantees, except in that they are complete; but the use of the input-output line allows one to get the complete characteristics of a unit from two or three guaranteed points. This is especially true of such apparatus as boiler-feed pumps and fans.

The criticism that this method cannot be made to take care of financial features is not true; in one case in the paper I have done it, and it is just as easy to treat the investment costs in the same manner by the use of the double panel curve used by Mr. Stott when figuring total cost of power. If Mr. Wardenburg's statement about direct figuring being easier than the graphic method were true, there would be no necessity even for such things as load curves, because they can

always be figured from the log sheets. I do not believe that anybody who has made extensive use of graphics would agree with this.

With regard to Mr. Dixon's and Professor Greene's questions raised relative to the economizers, I would say that if the use of the steel-tube unit were adopted, most of my objections to the economizer in its present form would disappear; but in this paper I have been considering constructions as they are standard on the market at the present time. Certainly the reliability of the economizer would approach that of the boiler, if put into steel-tube form.

Mr. Reinicker's method is simply a short cut permitted in an operating station, by the presence of venturi meters. Naturally, advantage should be taken of the opportunity to elide some of the steps. I must repeat again that the paper is a mere indication of the application of the method. The variations in detail and in general are endless. To sum up, the use of input-output lines, both of individual apparatus and combinations of apparatus, is the easiest and safest way of getting information for all loads. Individual calculations for a single point at a time do not show the important changes taking place around cut-in points, and are not as likely to be accurate.

POWER-PLANT EFFICIENCY, VICTOR J. AZBE

Geo. H. Gibson. The author states that "it is difficult to reason out just what effect load variations have upon an economizer as a heat absorber." However, in a given installation, if the heat absorption at any one load be known, the heat recovery at other loads will be approximately in a direct proportion to the rate of water flow, as indicated by the chart of Fig. 3, which gives the results of three different tests with variable loads. From the Port Dundas test, it would appear that the heat recovery while the load is increasing is somewhat less than while the load is decreasing. This is due to heat storage in the large mass of water in the economizer. If the heat recovery of the economizer for a given steady load is known, however, it is only necessary to draw a straight line through this point and the point for zero load, in order to determine the heat recovery at every other load.

One of the graphs in the paper purports to show the relation between velocity of gas through the economizer and heat absorption per square foot per hour per degree difference of temperature. However, the coefficient of heat absorption varies with the temperature of the gases as well as with the velocity. The relations between rate of gas flow, temperature of gases and average coefficient of transmission are shown in the accompanying chart, Fig. 4, which I have compiled from tests upon a large number of commercial economizers in various conditions of actual service. The temperatures marked upon the graphs are the mean temperatures of the gases, that is, the temperature of the gases entering the economizer plus the temperature of the gases leaving the economizer, divided by two. The rate of gas flow is stated in pounds of gases per foot of pipe in a section per second, that is, if there are ten pipes in a section of the economizer and each pipe is 10 ft. long, there will be 100 ft. of pipe per section, and the total gas flow per second would be divided by 100 to obtain the quantity set off on the horizontal axis.

Ed. A. Uehling. Mr. Azbe's paper covers the whole steam-power plant, and he makes many valuable suggestions as to how the heat now wasted could be saved. I shall confine my specific remarks to the operation of the steam generators, in which at least 50 per cent of the preventable heat losses occur, especially in the type of plants to which Mr. Azbe most particularly refers.

To obtain highest efficiency from a boiler three things are necessary, these in the order of their importance being (1) efficient combustion of the fuel, (2) efficient absorption of the heat generated by combustion, and (3) efficient rate of driving.

The difficulty in maintaining boiler efficiency is that so many continually changing variables are involved in its operation that fixed adjustments are out of the question. To maintain maximum boiler efficiency the fireman must have before him the information necessary to enable him to make the required adjustments intelligently, as well as the facilities necessary to make them. The draft must be varied to burn the coal necessary to produce the steam required. The steam gage tells him when to increase or decrease his draft. The thickness of the fire must be adjusted to the draft, so that complete combustion takes place with the minimum excess of air. Unless some means are provided by which the fireman can tell whether the relation between the draft and thickness of fire is right, he cannot know with any degree of certainty

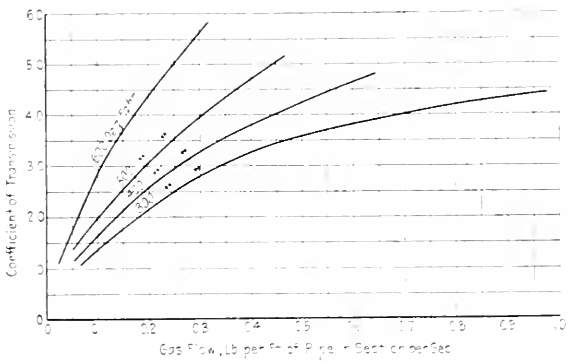


Fig. 4 Relations Between Rate of Gas Flow Through Economizers, Temperature of Gases, and Coefficient of Heat Transmission

whether his fire is too thick or too thin for economic combustion at the changed rate of driving. A CO_2 indicator at the boiler front tells him at a glance whether this adjustment is right, and what to do to make it so. Although the necessary draft adjustment to the steam demand and the fire adjustment to the combustion-efficiency demand can and must be made regardless of what the draft gage may indicate, it is none the less of great value to the fireman in making adjustments. He should have before him not only the boiler draft but also the furnace draft, the latter to indicate the condition of his fire bed and the former to indicate the rate of driving. Where positive information is required regarding the rate of driving, steam meters also must be installed.

The temperature of the escaping gas depends on four variables: (*a*) the condition of the boiler setting, including the baffling; (*b*) the condition of the heating surface; (*c*) the rate of driving, and (*d*) the percentage of CO_2 in the escaping gas. It is an index to absorption efficiency provided condition (*a*) is perfect and (*c*) and (*d*) are known. It is of no value to the fireman as a guide to combustion efficiency, because it depends on conditions beyond his control. A record of the temperature of the escaping gas considered by itself is also of questionable value to the operating engineer and may be entirely misleading, inasmuch as a low gas temperature may result from air infiltration as well as efficient absorption of heat by

the boiler, and high temperature may be due to a high rate of driving, dirty heating surface, or broken down baffling. To discriminate in the former case, we must know the percentage of CO_2, and to locate the cause of the latter we must know the boiler draft.

Although the flue gas temperature by itself is of no value to the operating engineer as a control, it becomes of some value when considered in combination with the boiler draft, and is of the utmost value in connection with the percentage of CO_2, because these two factors determine the heat loss up the chimney.

Boiler efficiency can be correctly ascertained only by accurately measuring the heat input and heat output. This, however, is neither feasible nor desirable under operating conditions. A system of efficiency control on the heat input-output basis was organized by Mr. Polakov for the Penn Central Heat & Power Co. in their Warrior Ridge plant, and described by him in a paper read before the Society in December 1913. This system of control approached scientific accuracy and gave excellent results, at least while under Mr. Polakov's able management, but it is too elaborate and cumbersome for general application, and to my knowledge has not been duplicated at any other plant.

Automatic coal weighers alone are of no value as a control for boiler operation, though they may be of some value as a check on the shippers' weights. Water meters are of more value because a more-or-less approximate estimate of the coal burned can be made at convenient intervals, perhaps monthly, and knowing the weight of water evaporated, a calculation of steam produced per pound of coal burned can be made and a rough idea of the combined efficiency of all the boilers obtained.

Diagnosis must precede the selection and application of the remedy, or a cure cannot be effected with any likelihood of success. Every boiler must be treated individually. The gas must be analyzed, temperatures must be measured and draft conditions observed continuously. To do this the necessary instruments must be supplied by the manager and intelligently used by the operating personnel, and if so used the highest efficiency which the conditions of the plant permit can be attained, and in no other way is it attainable. It has been accomplished many times by thorough combustion experts with the aid of an Orsat apparatus and a portable draft gage and pyrometer. This is very well and good. The trouble is the high efficiency established by the expert will not stay put. He has scarcely left the plant when it will begin to drop off, and in the course of a few weeks or months at most it will be down nearly, if not quite, to where he found it. High efficiency cannot be continuously maintained without instruments that will guide the fireman as to what to do, and will indicate properly the effect of what he did, and will autographically record the performance of both fireman and boiler as a control for the operating engineer.

Autographic records to be of the greatest benefit must be regularly and thoughtfully scrutinized and co-related, and the information they contain must be promptly acted upon, whether to bestow a praise, administer a rebuke, or correct a shortcoming in the operator or plant. The moral effect of the autographic record is very great if wisely used. Scientific apparatus cannot serve their purpose unless they are kept in continuous operating condition. They will not prove a paying investment if they are operated perfunctorily. They should receive the same regular and conscientious attention that must be given to the machines and apparatus which are vital to the operation of the plant.

MR. AZBE'S CLOSURE

Victor J. Azbe. In connection with Mr. Pigott's opinion in regard to maximum CO_2 desired, I wish to say that this is altogether a matter of type installation. With many installations it is not desired to go over 10 per cent; with others again 16 per cent and 17 per cent can be obtained without serious losses due to incomplete combustion. The most important factors in this problem are proper facilities for gas mixing and proper air distribution over the grate. We also must not forget that on one hand at high CO_2 percentages, CO might not be the only combustible gas escaping, and on the other hand that a given percentage of CO at high CO_2 percentages represents a great deal smaller loss than with the low CO_2.

Supplementing Messrs. Harrington and Polakov's excellent statements, I wish to say that while the manager is the one who is mostly responsible for the present condition, nevertheless the operating engineer shares also the blame to a very great extent, and the chief reason for the bad condition is that efficiency in power plants is taken, generally, too lightly, and this even by a great many professional men who really should be the leaders in agitation for better conditions.

I do not agree with Mr. Hunter's statement on CO_2 recorders, for the reason that I have had five CO_2 recorders of three different types in operation for two years, obtaining with them the most satisfactory results in our two St. Louis Anheuser-Busch plants. One man—not a college graduate—takes care of, changes charts and keeps in constant proper operation eighty different instruments, such as CO_2 recorders, recording pyrometers, steam-flow meters, venturi and other water-flow meters, etc., and in addition finds time to help with testing work. Where CO_2 recorders or similar instruments are not successful, it is generally due to not taking time to learn their principles of operation, and to improper installation.

Fig. 6 of my paper was not drawn to show exactly the economizer heat transmission, but rather the approximate relation between heat flow and draft loss, and represents conditions in the economizer at about 300 deg. fahr. mean temperature difference. Mr. Gibson mentions that the rate of heat transmission varies with the temperature. I wish to say that it varies rather with the mass of the gas and the velocity, both of which are, of course, dependent upon the temperature. Heat transmission in economizers with a given gas velocity will also vary, due to the influence of such factors as cleanliness of outside and inside heating surface, water velocity, and distribution of gas over the heating surface.

With Mr. Gould's opinion that I overlooked the most important point, "the character and quantity of fuel used," I do not agree, for the reason that while the quality and cost of coal are prime factors in planning efficiency methods and efficient equipment, they are not necessarily essential factors, so far as my paper is concerned. Preventable power plant losses are general over the whole country and where high as well as low-grade coal is burned, and if it pays to prevent the losses in small plants burning low-grade and at the same time cheap coal, it certainly should pay in larger plants or with higher-grade and more costly coal.

THE FLOW OF AIR AND STEAM THROUGH ORIFICES, HERBERT B. REYNOLDS

Sanford A. Moss. The author has executed some difficult experimental work in a very creditable manner. The coefficients for venturi meters at high densities are valuable pieces of contributory evidence to the general principle that an orifice or venturi coefficient is nearly unity.

The coefficient which Mr. Reynolds gives for the Taylor pitot tube is the product of the ratio of average to central velocity and of the static-hole constant of the Taylor tube, which is not unity.

Some remarks may be made regarding the formulæ used. The venturi formula given is the correct general formula both for the venturi and the plate orifice. It should never be used for computation work, however, as simplified formulæ give equal accuracy with vastly less computation.

For the case of Mr. Reynolds' venturis the differentials are exceedingly small, and the proper formula for cubic feet of standard air at 32 deg. is

$$\frac{491.5 \times 677.5\, d^2 \sqrt{P_2 (P_1 - P_2) / T_1}}{519.5 \times \sqrt{[1 - (A_2 / A_1)^2]}}$$

For the case of the table given on Page 29, this becomes

$$286.1 \sqrt{[P_2 (P_1 - P_2) / T_1]}$$

The following table gives a comparison. There is a constant difference of a fraction of a per cent. due to difference of fundamental constants.

From table on P. 29	From above formula
8.4	8.69
10.9	11.09
13.9	14.05
17.7	17.95
21.6	21.82
25.5	25.66
29.2	29.44
33.0	33.38
38.0	38.19
42.6	42.91
46.6	46.95

The formula used by Mr. Reynolds for the thin-plate orifice is theoretically correct only for pressure ratios greater than 0.52. For less pressure ratios, the flow is dependent on the initial pressure only. I understand that Mr. Reynolds has made his computations on this basis. However, Mr. Reynolds' actual results for small pressure ratios show that the flow does vary with the final pressure. This means that the coefficient of a thin-plate orifice varies with the pressures. The exact variation is given for the first time by Mr. Reynolds and he gives a very interesting empirical law, taking account of both the theoretical and the coefficient variation and giving the net flow.

The conclusion which I think should be drawn from the data presented is that the venturi meter is much preferable to the thin-plate orifice for the following reasons:

The venturi coefficient is well established by much previous data and by Mr. Reynolds himself, as nearly unity, while the coefficient of the thin-plate orifice is variable and the net flow is a complication of this factor and the theoretical flow. Mr. Reynolds' empirical formula is very ingenious, but it would have to be established for many other cases before it would be proper to use in general.

The corner of the thin-plate orifice has an important influence and even Mr. Reynolds used two different forms,—square and with 1/16-in. radius. I believe a venturi with a well-rounded approach and some length of parallel portion can be more easily made and duplicated than a true thin-plate orifice.

Mr. Reynolds also mentions, in the steam case, an uncertainty regarding point of measurement of pressure.

He complicates the venturi case by use of the full theoretical formula, whereas much simpler and equally accurate formulæ are available. He uses a rather large venturi throat, giving small differentials which are comparatively hard to measure. One of the great advantages of the venturi is the fact that large differentials can be used by proper selection of the throat diameter.

Hence I feel that Mr. Reynolds' paper gives valuable evidence showing that the venturi meter should not be displaced by the thin-plate orifice for the case of large pressures.

MR. REYNOLDS' CLOSURE

Herbert B. Reynolds. In regard to the relative merits of the venturi tube and the thin-plate orifice for measuring compressed air and steam, I wish to say that the venturi tube considered from the theoretical point of view is a more desirable instrument. However, when the cost and other practical considerations are taken into account, the thin-plate orifice has a great many advantages over the venturi tube, as is pointed out by Mr. Pigott.

In reply to Mr. Thurston's question as to the use of venturi tubes in parallel, I have no doubt that the apparent difference of pressure noticed by him when some of the tubes are shut off is due to the pulsating pressure, as explained by Mr. Connet.

The method of measuring the air described by Mr. Connet is probably as accurate as the method used in these tests. However, I think that the gasometer method is freer from uncertainties than any other method, as it is a direct measure of the actual volume of air.

Referring to Mr. Christie's interesting remarks about the close agreement of the coefficient of the Taylor pitot tube when used in a 10-in. pipe with the coefficient which I found for a 2-in. pipe, I find that, by referring to my original curves—which are easier to interpolate—the coefficients are about 0.78 for both the 2-in. and the $1\frac{1}{2}$-in. pipes.

I think that everyone will agree with me that the pinhole type of pitot tube is much to be preferred to the Taylor tube, as the coefficient of the pinhole type can be considered unity for all practical purposes if a traverse is made in the pipe or duct. The data for the Taylor tube were obtained in this case because it was desirable to calibrate this form of tube in connection with some other work.

I do not agree with Dr. Moss when he says that the formulæ which I have used should never be used for computations. One object of these experiments was to compare the actual performance with the theoretical performance, and thus I do not think that short-cut methods should be used on the theoretical side in order to save work any more than they should be used in determining the actual performance, namely, in the actual measurement of the air. A great deal of work and expense could have been saved if some simpler method had been used in measuring the air. However, the uncertainties would have been increased. On the other hand, a simpler formula might have been used in computing the theoretical flow, and giving the same degree of accuracy as pointed out by Dr. Moss, but at the same time involving uncertainties. Therefore I think in this case, with the object of the computations in view, the unquestionable correct theoretical formula should be used in comparing the theoretical flow with the actual flow.

I have made the above remarks about the approximate formula granting that it gives practically the same results as the theoretical formula. However, in investigating the formula as given by Dr. Moss, which becomes

$$Q = 286.1 \sqrt{P_2 (P_1 - P_2) / T_1}$$

for the 2×0.666-in. venturi tube, I find that for the lower pressure ratios it gives results which are quite far from the correct results. For example, the percentage of error varies from 0.64 per cent when the pressure ratio is 0.99892, to 34.62 per cent when the pressure ratio is 0.5821.

Dr. Moss states that the equation which I have used for the

orifice is theoretically correct only when the ratio of pressures is greater than 0.527. If used correctly this equation is theoretically correct for any ratio of pressure. However, when the ratio of pressures is less than 0.527, the value $0.527P_1$ should be substituted for P_2 in the formula. This was done whenever the ratio of pressures was less than 0.527.

Dr. Moss says that the size of the venturi throats which I have used resulted in very small differentials which are very hard to measure. Expressed in pounds per square inch, these differentials appear to be very small. However, it should be kept in mind that these pressure differences were measured in inches of water, which resulted in readings of considerable magnitude in most of the tests. In fact, in some of the tests the differentials were so large that it was necessary to use mercury in the manometer in place of water.

SPONTANEOUS IGNITION STUDIED BY MEANS OF PHOTOGRAPHIC PLATES, FREDERICK J. HOXIE

Milton F. Jones[1]. The subject of the early stages of oxidation of inflammable substances which, should the reaction continue, may terminate in spontaneous ignition, is a matter of importance regarding which very little is known.

If the author's assumption that the effect upon the photographic plate is due entirely to liberated hydrogen peroxide, is correct, then we have perhaps the first tangible evidence of the beginning of the oxidation process, in a form which would allow comparisons to be made.

That the density of the photographic image does not harmonize with the iodine number of the oil, is not remarkable. The iodine number of an oil is usually employed as a means of identification. It is based upon the capacity of the oil in question to combine with one of the halogens, that is, iodine. It is doubtful, however, whether we have the right to assume that the oil will combine with an equivalent amount of oxygen. Chlorine unites directly with some elements with which it is difficult for oxygen to unite.

Because the drying oils have as a rule the higher iodine numbers, and are prone to spontaneous ignitionn, it has been suggested that the iodine number might prove a guide in determining the tendency of an oil in this direction. Boiled linseed oil possesses greater drying properties than raw oil, and is usually considered more hazardous, yet it seems to have been conclusively demonstrated that it has the lower iodine number. The ordinary red oil which is a crude oleic acid obtained from tallow, an animal oil, is probably as hazardous as regards spontaneous ignition as linseed oil. Cottonseed oil is not considered a drying oil.

The statement of the author that all charcoal is not alike will hardly be questioned; it is one of the most perplexing factors in the investigation of charcoal fires. He finds that the density of the photographic image corresponds with the activity of the sample of charcoal, which is interesting. The conditions as to charcoal are different from those of oil. In the latter case, having determined that an oil is hazardous, it can be safeguarded more or less. With the charcoal, however, although many samples may show an inactive condition, one active piece favorably located in a pile may under certain conditions determine the destruction of the mass.

As the author states, the results are only a beginning, and subsequent research will determine the value of the process, whether of scientific interest only, or whether applicable to industrial or fire-prevention uses.

[1] National Fire Protection Association, Boston, Mass.

STANDARDIZATION OF MACHINE TOOLS, CARL G. BARTH

Fred A. Parsons. Regarding standardized progressions for speeds and feeds and standardized power, the paper presents what is without doubt the ideal condition, but in application the following points should be borne in mind:

1 At present a very small percentage of machine tools goes to factories where the management would appreciate the refinements in feed and speed ratios suggested. Indeed, the jobbing shop could never get together with the manufacturing plant on the question, since the former requires a wide range of speeds with large ratios and the latter a small range of speeds and feeds with small ratios.

2 Present machine-tool feeds and speeds are very largely the outgrowth of the above conditions, though there are no doubt many instances, as the author mentions, where no particular attention has been paid to anything except getting the high and low speeds required.

3 Present milling practice seems to require of general-purpose machines, such as the plain knee-and-column type, about the same number of feeds as of speeds, but a total ratio of about 24 to 1 for the speeds as against about 48 to 1 for the feeds. Unless present practice is wrong, this would require two different progression ratios.

4 Some designs permit considerable economies to be effected in space and parts required by attempting only a fairly close approximation of the perfect geometrical progression. An instance may be considered of obtaining nine speed variations with nine gears on three shafts, the gears on first and last shafts being sliding gears and on the intermediate being laterally stationary. In this case it is not possible to reach any perfect geometrical progression exactly, if the high and low speeds are even fairly far apart, but a close approximation can be obtained.

5 Considering that by practically any method of drive the variation from normal speed at no load and at full load will be up to 5 per cent, is it warrantable to add cost to a machine tool to come closer than a few per cent above or below a given geometrical progression?

6 Mr. Barth has stated in his paper, that the standardization of speed ratios should be accompanied by a standardization of power for machines of a given type and size. Such a standardization must be considered from the standpoint of the user. At present the users seem to demand two power capacities of any given range, one light and one heavy, and it is hard to see how this could be avoided, as otherwise some will be purchasing power capacity they do not need, though they require the range, and in the other extreme the reverse would be true.

7 It seems unquestionable that a few years more will see the development and general application of a machine-tool drive for both feed and speed in which the speed variations can be represented by a smooth curve from minimum to maximum. Such a drive is typified at the present time by the variable-speed motor; the objections are that it is expensive to install and cumbersome. Such a drive will not of course apply to lathe feeds for screw cutting, or milling-machine feeds for spirals.

Regarding the standardization of details such as T-slots, taper shanks, etc., which Mr. Barth mentions, there are not the difficulties which enter into standardization of speeds and power. The cases are quite different, inasmuch as if a T-bolt, for instance ¾ in. in diameter, is being used in an appropriate place, there must certainly be only one correct depth

of slot, considering strength for any given material, the same as there is one best size for the square and thickness of bolt head.

H. M. Norris. That some machine-tool builders are learning to appreciate the value of a smaller speed variation is attested by the fact that fifteen years ago no radial drill was provided with more than eight changes, while now they may be obtained with 20, 24 and 30. The speeds of most of these later tools are intended to be in geometrical progression, but I am of the opinion that a geometrical series is not the best for a drilling machine.

The ratio of progression most favored by Mr. Barth appears in the first column of Table 1. The second column gives the corresponding number of revolutions per minute, and the third the diameters of drills which this series would drive at a cutting speed of 80 feet per minute. To my mind this is not as efficacious a series as that obtained from a ratio giving both desired extremes, columns 4, 5 and 6. Here we have fifteen speeds for drills from 5/8 to 4½ inches in diameter, while under the former gradation there are but twelve.

But why use either? Instead of deciding upon a series and then seeing what drills it will drive at a certain cutting speed, is it not better to decide first upon the drill diameters and then try to obtain the exact speed for each, regardless of the ratio of advance? Suppose, for example, we set down, as in column 7, the diameters of drills we would like a machine to drive at a cutting speed of 80 feet per minute. It is an easy matter to ascertain at what number of revolutions per minute each should run, column 8. Here each *harmonic* group of speeds may be obtained from a five-change speed box or a 2-to-1 motor, while back gears made in the ratio of 1 to 1, 1 to 2, 1 to 4, 1 to 8, etc., will give as many successive *geometric* groups as desired.

Mr. Barth states in his paper that "It is by this time universally accepted by those who have a right to an opinion in this matter that the available speeds of a machine should be in a geometrical progression," and that "a discussion of this will not be undertaken by him unless provoked by some one else." It is not my purpose to provoke an argument, but I would like to learn if I am in error in thinking that my series is the best of the three.

TABLE I COMPARISON OF BARTH, NORRIS, AND USUAL METHODS OF CALCULATING DRILL RATIOS

Barth			Usual Method			Norris		
Ratio	R.P.M.	Diam. In.	Ratio	R.P.M.	Diam. In.	Diam. In.	R.P.M.	Ratio
1.000	43.3	7.09	1.000	67.9	4.50	4½	67.9	1.000
1.189	51.5	5.93	1.152	78.2	3.91	4	76 4	1 125
1.414	61.2	4.99	1.326	90.1	3.39	3½	87.4	1.285
1.682	72.8	4.20	1.527	103.7	2.94	3	101.9	1.500
2.000	86.6	3.53	1.759	119.4	2.56	2½	122.2	1.800
2.378	102.8	2.97	2.025	137.5	2.22	2¼	135.8	2.000
2.828	122.3	2.49	2.332	158.3	1.93	2	152.8	2.250
3.364	145.6	2.10	2.686	182.2	1.68	1¾	174.5	2.570
4.000	173.2	1.77	3.093	210.0	1.46	1½	203.8	3.000
4.757	205.8	1.48	3.552	241.0	1.27	1¼	244.4	3.600
5.657	244.8	1.25	4.103	278.6	1.098	1⅛	271.6	4.000
6.727	291.0	1.05	4.725	321.0	0.952	1	305.6	4.500
8.000	346.0	0.883	5.441	369.0	0.838	⅞	349.2	5.140
9.514	411.6	0.742	6.266	425.0	0.720	¾	407.5	6.000
11.314	488 9	0.625	7.215	488.9	0.625	⅝	488.9	7.200

MR. BARTH'S CLOSURE

Carl G. Barth. While I am rather disappointed at the fewness of the discussions of my paper, the, on the whole, very favorable discussion by an engineer who has given so much independent attention to the subject as Mr. De Leeuw, is compensation enough for my having taken the trouble to prepare it. Regarding Mr. De Leeuw's comment that certain machines, as, for instance, large boring mills, would be better provided with two *bunches* of speeds, I agree with him fully; but will insist that each bunch should conform to the principles advocated by me. I also agree with him that more experiments with cutting tools should be made, and am pleased to inform him that more is known about the art of cutting metals with planer tools, milling cutters and drills than has as yet been published. For fully ten years I have thus had a set of slide rules covering certain milling cutters on the one hand, and gear cutters on the other hand, which have been of substantial assistance to me in my efforts to improve shop practices; and if I live long enough, I shall fully disclose their theory, construction, and application, together with much else relating to the art of cutting metals. Regarding Mr. Norris' discussion, it discloses such a fundamental lack of grasp of the whole matter considered, that I would be inclined not to waste any words upon it, beyond stating that it proves that he belongs to the other class I had in mind when I referred to "those who have a right to an opinion in this matter." However, being a great admirer of the many excellent features of the line of radial drill presses he has developed during a term of years, I am glad to point out that his mistake consists in neglecting to take account of the fact that the proper cutting speed of a drill—just as much as of a lathe tool and a milling cutter, etc.—varies with the diameter of the drill, the feed used, and the hardness of the material drilled; and that there is an exceedingly small increment between all the drills used in nearly every shop. Hence, theoretically, to meet every combination of these variables between a maximum and a minimum, infinitesimal increments would be required, in the absence of the possibility of obtaining which, *equal-percentage* increments become our only rational practical approximation; and that is, in a nutshell, all the reason and argument there is behind a geometrical progression of speeds, and it is all that is needed. Regarding Mr. Parsons' discussion, I fully agree with him that at present but a small percentage of machine tools goes to the factories where the management would appreciate the refinements of the feed and speed ratios suggested by me. However, it has been my business for a number of years to help managements to such appreciation, and I think the machine-tool builders should again help *me* do it. The field I can personally cover is exceedingly limited, whereas, theirs is unlimited. What he says about the relation of feeds and speeds of general-purpose milling machines is not clear to me, so I cannot comment upon it. I never expected all attempts at a geometrical progression of speeds to turn out even a practical perfection, but, I have fully demonstrated in my paper that there is no inherent difficulty in doing better in numerous instances than what has been done. I have said nothing in my paper that excludes any number of sub-standards of machine tools, as regards power. Thus, I fully believe that there might to advantage be both a heavy and a light standard of any work capacity (as opposed to chip-producing capacity) of several of the more common types of machine tools. For reasons that I prefer not to reduce to writing at the present time, while much misunderstanding still exists regarding my work as a scientific-management expert, I do not favor any kind

of continuous speed or feed variator for the mere sake of getting the closest possible speed adjustment (which nobody can hope to know closer than a rather uncertain percentage anyway, for any set of practical conditions), though under certain conditions I strongly advocate adjustable-speed motor drives, because of the quickness with which they enable speed changes to be effected.

ACCURATE APPRAISALS BY SHORT METHODS, J. G. MORSE

CHAS. W. MCKAY[1]. The reproduction cost of the property, tangible and intangible, the present or depreciated value of the property, the cost of producing and marketing the plant output, and the capacity of the plant, are all factors which should be carefully considered in attempting to evaluate an industrial property. Of these elements reproduction cost and present value, if not the most important, are at least worthy of careful consideration, and in the following paragraphs is briefly outlined a method of manufacturing-plant appraisement patterned after current practice in public-utility valuation work. The grand summary of such an appraisal would take somewhat the following form:

GRAND SUMMARY OF MANUFACTURING-PLANT APPRAISAL

	Reproduction Cost.	Present Value.
Direct Construction Costs:		
Land	....	(Same)
Buildings	....	....
Machine Tools (lathes, boring mills, etc.)	....	....
Auxiliary Equipment (chucks, etc.)	....	....
Electrical Equipment (motors, rheostats, etc.)	....	....
Belting	....	....
Shafting	....	....
Small Tools and Dies	....	....
Patterns and Drawings	....	....
Stock and Supplies	....	(Same)
Furniture and Fixtures	....	....
Total Inventoriable Property	....	....
Omissions and Contingencies	....	....
Purchasing Expense During Construction	....	....
Tools and Tool Expense During Construction	....	....
TOTAL DIRECT CONSTRUCTION COSTS	....	....
Collateral Construction Costs:		
General and Legal Expense During Construction	....	....
Engineering and General Supervision During Construction	....	....
Taxes and Insurance During Construction	....	....
Interest on Investment During Construction	....	....
TOTAL COLLATERAL CONSTRUCTION COSTS	....	....
Non-Physical (or Intangible) Assets:		
Value of Patent Rights	....	....
Value of Trade Marks	....	(Same)
Value of Going Concern	....	(Same)
Value of Goodwill	....	(Same)
TOTAL NON-PHYSICAL ASSETS	....	....
GRAND TOTAL	....	....

Inventoriable Property. As to the inventory and appraisement of the strictly physical property, an appraisal made by a consulting engineer should be equally well adapted to serve for tax adjustment, insurance or accounting purposes or as a basis for the determination of fair value in the event of the sale or reorganization of the property under consideration. The inventory should be accurate, within reason, and should be based upon sound engineering and economic principles, so that it can successfully withstand the scrutiny to which it is almost certain to be subjected if presented before the courts.

Mr. Morse's plan is a little too broad to meet the requirements just outlined. He is merely satisfying his clients, or his employers, as to the physical value of the risks they are undertaking. They have sufficient confidence in him to warrant their acceptance of such short-cut methods as he may see fit to employ, knowing full well that he will be able to substantiate his valuation in the event of a call for claim adjustments. Nevertheless, it is very probable that the Factory Mutual Companies, or any other insurance organization, would be somewhat loth to accept valuations made by outside engineers based upon these rather broad-gage methods. In any event, it is probable that an engineer in submitting such an appraisal would experience considerable difficulty in "getting by" with the courts, in the event of a lawsuit over the value of a manufacturing property, or in using it as a basis for capitalization.

In a manufacturing-plant appraisement, the inventory should be made in sufficient detail to facilitate its ready analysis by opposing experts, in the event of legal action, and should be so arranged as to render the various elements of plant segregable for accounting or insurance purposes.

The attitude of the courts has been unfavorable toward real-estate appraisements made by consulting engineers, and, to be on the safe side, it is usually best in the long run to have land appraised by a real-estate broker of unquestionable standing and the buildings preferably by the architect under whose supervision they were erected. The auxiliary building equipment, however, such as elevators, piping and wiring, should, so far as possible, be considered as a part of the building rather than as a part of the machine equipment, as suggested by the author. Of course, exceptions may have to be made, as in the case of special wiring for motor-driven machinery.

As to the preparation of the unit costs of the inventoriable property, it is better for all purposes, with the possible exception of insurance appraisals, to carefully investigate them for a period of a year or two preceding the appraisal, and if those prevalent at the appraisal date seem to be abnormal, to use average prices.

Omissions and Contingencies. No matter how carefully an inventory may be made, there is always the probability that items, perhaps individually of small value, but which when taken collectively may amount to an appreciable sum, will be entirely omitted. In public-utility work, the usual allowance to compensate for such omissions, and one which has had the sanction of the courts, is two per cent of the reproduction cost of the inventoriable property.

The word "contingencies" as used in appraisal work may be defined as the monetary allowance which may be added to the appraisal of the inventoriable property to compensate for such unforeseeable contingencies as may arise in the construction of the property and which cannot be taken account of in the preparation of the unit costs. In public-utility appraisal practice it is usual to add an allowance of about two per cent of the reproduction cost of the inventoriable property. Similar conditions are encountered in manufacturing-plant appraisal work, and there is no reason why a specific allowance should not be made for omissions and contingencies.

Purchasing Expense During Construction is a very appreciable item, involving, as it does, the securing of competitive bids and possibly visits to the manufacturers' plants to inspect machinery. This may be cared for on a percentage basis, the allowance depending largely upon the nature of the equipment involved.

Tools and Tool Expense During Construction. This item includes not only the original cost of the tools, but also the cost of maintaining them during the construction period. In public-utility work, an allowance of 2 per cent of the repro-

[1] McMeen & Miller, 1454 Monadnock Block, Chicago, Ill.

duction cost of the inventoriable property is not unusual for this item.

General and Legal Expense During Construction. This item includes the general expense of the executive organization during the construction period, the cost of temporary offices for the bookkeepers, timekeepers, paymasters, etc., and the cost of legal counsel for incorporating the company. In manufacturing-plant-appraisal work a suitable allowance for this item, based on the reproduction cost of the inventoriable property and depending upon the nature of the property involved, will probably not exceed two per cent.

Engineering and General Supervision During Construction. Plans have to be prepared for the general layout of the buildings and transportation facilities, as well as for the distribution of the machinery in the buildings themselves, and in many plants it is customary to retain an engineer throughout the entire construction period to supervise the erection of the plant and the installation of the equipment. The usual allowance for this item varies from 5 to 9 per cent of the reproduction cost, depending upon the nature of the property involved.

Taxes and Insurance During Construction are unquestionably capital expenses, and should be included in the determination of the total reproduction cost of a manufacturing property. An adequate estimate may be made by ascertaining the insurance and tax rates prevalent at the time of the appraisal.

Interest During Construction. Up to the time the plant starts production, this item is just as real a part of the total investment in the property as is the cost of the inventoriable plant. For all practical purposes, interest may be computed with sufficient accuracy by ascertaining the interest rate prevalent at the date of appraisal and applying one-half of this rate to the total physical costs, including General and Engineering Expense, Taxes and Insurance.

Intangible Assets, or, more properly, non-physical assets, include Value of Patent Rights, Going Value, Value of Trade Marks and Goodwill, and constitute the major portion of the total value of an industrial property. The method of determining their value is so dependent upon the exigencies of individual cases that it is useless to attempt to outline a general plan for their determination.

Depreciated or Present Value of the inventoriable portion of the plant. This may be determined along the lines suggested by Mr. Morse. The items Omissions and Contingencies, Purchasing Expense, Tools and Tool Expense During Construction, and all of the Collateral Costs, should be depreciated at the same rate as the inventoriable property, i. e., the present value of the inventoriable property divided by its reproduction cost will give a condition per cent which may be applied to the reproduction cost of the items Omissions and Contingencies, Purchasing Expense, etc., to obtain their respective present values.

It is undoubtedly true that some of the appraisals prepared by the so-called appraisal companies contain needless detail, and, furthermore, that the accuracy of inventory is ofttimes more than offset by erroneous assumptions as to depreciation and by too close adherence to standard unit costs. This raises the point that the problems involved in manufacturing-plant-appraisement work are strictly engineering problems, requiring the experience and judgment of trained engineers.

The short-cut methods prescribed by the author, on the other hand, while admirably adapted for his own purposes, are, it would seem, a little too approximate in their nature to warrant their general adoption for engineering valuations. Is it not true that there is a happy medium between these two plans, and that this medium can be best reached by observing, and to a certain extent copying, the methods adopted in the public-utility appraisement field?

Then again, when preparing a reproduction-cost appraisal, why appraise the inventoriable property with great care and accuracy and then omit entirely elements which are just as inevitably a part of the cost of reproducing a property as the cost of the machinery or tools? It is true that the collateral and intangible elements may not be necessary for some of the uses to which manufacturing appraisements are put, but, on the other hand, they are most essential for the determination of fair value in the event of sale or reorganization of properties.

PRODUCTIVE CAPACITY A MEASURE OF VALUE OF AN INDUSTRIAL PROPERTY, H. L. GANTT

R. S. Hale. Many of the questions about cost and value would become simpler if we would give up the idea that there is any abstract "cost" or "value," and instead should work on the basis that the business of the accountant and engineer is to provide data which will make it easier for the executive to answer certain questions, or rather to enable the executive to take action.

The first of the two theories of costs given by Mr. Gantt, by which all the expenses are included in the cost, gives a figure that helps the executive decide whether he can afford to declare a dividend, but is not of very much use for deciding what the expenses will be next year.

The second theory, by which only the expenses actually needed for the production of an article are charged to its cost, gives a figure which is useful in determining what the expenses may be next year, but is not particularly useful in deciding what profit the concern has made the past year.

There is no such thing as an abstract "cost," or if there is it is of no use to any one. Sometimes we want to know whether we have made or lost money during a given period. In other cases we want to know how much our expenses will be increased if we put some by-product on the market. In that case we want to know *only* the real extra cost of the by-product. In still other cases a factory owner may want to know whether he had better shut down his factory for a period, or run it until the market for the product improves. To answer this question he needs an entirely different set of figures than when he is deciding whether or no to build a new factory.

Mr. Gantt's charts are exceedingly valuable, because they help the executive to decide what he could have done if he had had more material, or if he had had more orders, or had had more help. Likewise they help show what could be done if certain idle machinery were disposed of, etc. The cost figures they show are, however, more than useless in some cases; but the same is true of all cost figures.

Practically every theory of cost or theory of valuation helps to answer some particular question, and it is only a matter of logic to say that we shall continue to have new cost theories and new value theories so long as new questions are coming up to be answered.

The point it is desired to emphasize is that abstract "cost" and abstract "value" are of slight or no importance. What the accountant and engineer should give the executive are the figures that will help solve the *particular* questions that are asked in a particular case, and they should not put these figures in any form that would cause them to be used improperly, nor should they give them any abstract name that

would have the same result of misleading the user of the figures.

A. C. JEWETT. The expense of idle equipment shown by Mr. Gantt's chart must be combated, so far as idleness due to lack of orders is concerned, by an intense study of the sales problem. The engineer must direct the sales policies. He must direct the distribution of the products of industry. The consuming power of mankind is not limited. It is the distributing mechanism that is at fault when machinery in the mills and factories is idle and many people lack sufficient food and clothing. When the problem of the proper distribution of the products of industry is solved there need be no idle labor, the cost of living will not be an acute problem, and there need be no complaint about the length of the working day.

This is not new, but it is new for the engineer to give serious attention to matters such as these as a part of his work of industrial management. The solution of these problems and all that they involve is not an easy task, but it is one that no engineer can afford to neglect and that all ought to study earnestly.

J. B. MILLIKEN.[1] To make our position clear, we define the valuation of industrial property to mean the value at which the physical manufacturing property of a corporation is carried on its books. We mention this because Mr. Gantt's paper evidently contemplates a different definition, viz., one including the efficiency of the plant, which involves the value of the organization operating it, which latter he states "is an integral factor in the valuation of an industrial property." We agree with Mr. Gantt, if by industrial property he means all the values which are represented by the capital stock of a corporation, in which case the value of the management is reflected in the profit and loss account and in the market value of the corporation's shares; but the value of an organization cannot properly be reflected in the physical assets of the corporation as shown by its books.

Our view is that the valuation of land, buildings and equipment should be shown on the books of a corporation at their original cost, less a depreciation for use or obsolescence. As a check on our valuations and on our depreciation ratios, we have appraisals made by professional appraisers at intervals of approximately ten years and compare results carefully with our valuations.

In contrast with the *accounting method,* which should be based on actual cost, we believe that *appraisals* should be made on the basis of present cost to replace, less proper allowance for age or for obsolescence, rather than on the basis of original cost, as the latter may be difficult to determine at the time of the appraisal and in some cases may represent more or less than real value, even at the time of purchase. A careful appraisal may disclose excessive original costs, for example, in which case a question arises as to whether the valuation of a given item should be reduced to agree approximately with the appraisal. Great care should be exercised in comparing appraisal values made on the basis of replacement values to avoid taking advantage of an abnormal present cost, such, for instance, as would occur in the case of appraisals made at the present time, due to the very high prices of practically all materials and labor.

We believe that actual cost, whether higher or lower than normal, should be the basis of all values on a corporation's books. It is conceivable that two factories might be exact duplicates and yet show original cost of construction and equipment widely variant. The proper course in such a case is not for the higher-cost company to reduce its valuation, which was its actual cost, but to justify its cost through its profit-and-loss account by increased earnings, if it can do so, so that a comparison of its ratio of net earnings to capital invested in plant may compare favorably with that of its competitor. This method discloses the facts, both of the actual cost of the property and the actual earnings, whereas reducing the cost on the books by a charge against earnings (in excess of reasonable annual depreciation) distorts the facts as to both earnings and assets.

[1] Treasurer, The Yale & Towne Mfg. Co., Stamford, Conn.

J. H. WILLIAMS.[1] Mr. Gantt recommends the use of "constant" cost rates in cost accounting as a means of increasing efficiency of production. The writer would go further and recommend the use of *standard* as well as "constant" cost rates.

By cost *rates* is meant the *percentage* to be added to direct wage and the hour *rates* for the different machines; by *standard* cost rates, rates representing what the cost *should be* as distinguished from what *it is.* The determining of *standard* cost rates is to the same end as time study and the determining of standard methods and time.

Overhead costs and volume of work which are the only factors affecting cost *rates* as here defined are not subject to the same kind of study as operations, but they are equally susceptible of scientific study.

The use of standard cost rates makes possible a daily comparison of the aggregate of the amount charged on the cost records (at standard rates) with the aggregate of the actual cost. Any difference is shown in dollars and cents in the aggregate instead of in the rate. The occasion of the difference, if any, is ascertainable through subdivision of the actual cost into the items used in determining the standard rates.

Through the use of standard rates we are able, as above explained, to determine our profit or loss due to *volume* daily; and by analysis of actual cost and comparison with standard cost, to determine their source.

On the other hand, through using the same *standard rates* in keeping production-cost records, we are also able to determine our profit or loss due to *efficiency* daily by jobs as they are completed. By comparing the actual with the estimated cost of production we are able to determine the operations in which the profit or loss occurred.

In this wise we have a daily statement not only of profit and loss but also a statement as to the several exact sources of profit and loss, and one wherein the difference between the aggregate daily profits and aggregate daily losses will agree with the increase and decrease in assets and liabilities, as shown in the monthly, quarterly, or yearly closing. In no other way can profits and losses be accurately determined daily, or in such a vast number of items. The timeliness and detail of these statements is of the utmost importance in their effectiveness.

R. B. SHEPARD, JR.[2] I am particularly impressed with the paper by Mr. Gantt and heartily subscribe to his dictum that the productive capacity is a measure of the value of an industrial property. Indeed, I will go even farther and assert that productive capacity, taken in conjunction with the desir-

[1] 772 Park Avenue, New York, N. Y.

[2] Office Engineer, Atlantic Coast Line R. R. Co., Wilmington, N. C.

ability of the product from the consumers' point of view, in other words the *earning capacity*, is *the* measure of value, and the only measure unless natural economic conditions have been artificially disturbed. It is remarkably significant that most of the valuations heretofore made have had as their object not the determination of absolute value, but rather the ascertainment of a limit below which public bodies could not arbitrarily depress value through interference with charges for the commodities produced. Granted the power of the public to regulate charges for service rendered by so-called public utilities, subject only to constitutional restraint against confiscation, the only unassailable position open to public utilities in the protection of their interests seems to be that confiscation results when earnings are so reduced by arbitrary action of regulating agencies that fair returns on the capital employed are denied, and the cost of reproduction seems to afford the readiest measure of the sum of capital, or capital equivalent, engaged in the service; hence the disproportionate importance to which the estimated cost of reproduction seems to have attained in current schemes of valuation. To the owner the cost of reproduction does not signify value but is definitely related to the cost of the output of his plant. For his business to be profitable, it must yield a sum sufficient to meet all costs of operation and leave a balance from which to pay interest on the confined capital and a profit. The value is commensurate with the size of this balance, not with cost, or capital equivalent.

The term "cost of reproduction" should, in the writer's opinion, be interpreted to mean the total investment which would be required to replace the object under consideration, including working capital, development costs, etc., etc.; that is, the absolute sacrifice, expressed in terms of money, which would be required for present production, in its entirety, of the completed and operating utility. This is a somewhat more comprehensive definition than is generally attached to the term, but it is justified by the economic functions of the estimated cost of replacement.

For the ascertainment of absolute value recourse must be had to the balance sheet, the past history and the future prospects of the business. The balance sheet does not disclose the value in stated terms, but it furnishes the data as to results of operation and the present financial condition of the business on which the calculation of value must be founded. The value has no fixed relation to the investment. It is, of course, affected by the judgment used in making the investment, the efficiency of the organization, the confidence of the purchasing public, the general condition of prosperity and enlightenment of the community, etc., but these are matters more for the consideration and activity of the managers than of the appraisers, especially as their practical effects are reflected in the balance sheet and enter, along with all other influential facts, into calculations based on data taken therefrom. No definite conclusion as to value could be drawn from the study of operations for one or two years, but the examinations should extend over at least a decade in order that periods both of depression and of prosperity could influence the findings.

This method of valuation is applicable to those industries only which are more or less free to respond to economic influences. For others, subject to regulation and price fixing by external agencies, purely arbitrary methods must be evolved if the valuations are to enter into the contest or construction of rates of charge. To meet such a situation, the industries must claim the right to profitable operation and contend that profitability ceases when the earnings are not sufficient to pay all costs, including interest at reasonable commercial rates on total capital equivalent and, in addition, yield a profit in proportion to the size of the business handled. This is the rock bottom of permissible depression. The criterion should, in equity, be the relative extent to which the regulated, as compared with unregulated, industries are permitted to participate in the general prosperity and welfare.

F. J. Cole. Mr. Gantt does not state whether the items in his idleness expense chart are a copy from an actual day's run at some mill or typical. It is significant, however, that out of \$1969 total cost of idleness, \$1630, or 83 per cent, is chargeable to lack of material or to poor material.

One of the principal sources of expense in the production of any manufactured article is the loss due to an insufficient supply of material, either in not having it at the machines when needed in sufficient quantities, or it being of improper quality.

Where many kinds of materials are used and their quality is more difficult and complex, more systematic work is required in the purchasing, inspection, tracing and delivery of such materials in order to avoid serious delays.

Proper scheduling of events or processes in the making of manufactured articles is most necessary in order to determine the correct anticipation of dates when things must be *done*. This scheduling includes the dates for ordering and delivering of material, inspection, tracing shipments and manufacturing operations of various parts and processes so that the doing of the necessary events is maintained in their proper sequence.

Using all the machines all the time is most economical, but whether it can be done always depends upon many conditions. A surplus of machines is sometimes required to take care of variations in product, where the character of the work varies considerably with different articles of the same general class which are being manufactured.

A daily statement of the losses in dollars and cents incurred through idle machines, idle processes, caused by the percentage of time they are idle, must be a great object lesson to a management in calling prompt attention to the monetary loss caused by idleness in operating below maximum capacity. The idleness expense chart proposed by the author shows at a glance the loss in values, in percentages of idleness, and their cause.

A GAS PRODUCER FOR BITUMINOUS FUEL. O. C. BERRY

Godfrey M. S. Tait. The methods used by the author for the determination of the tar content are all highly practical as applied to the experimental apparatus used, but would, of course, have to be modified in connection with a test of a plant in regular service.

The author's theory as to the volume of recirculated gas is not original, having been tried with more or less success in Europe, the main difficulty experienced being the power consumed by the blower and the excessive quantity of steam thus introduced—unless some arrangement were provided for connecting the governor on the gas engine to the by-pass blower so as to control same. With low load and the by-pass blower running full capacity, it was possible to lower the temperature of the fuel bed to such a point as to shut down the engine, hence the need of some form of automatic control.

Also the findings, as to clinkers, are apt to be misleading, due to the very small size of the producer in question.

The ideal conditions of draft current in a gas producer consist of a perfectly balanced draft at all loads. Any arrangement to get away from this balanced condition greatly

increases the tendency to clinker in all kinds of fuels, for be it understood that the clinker is first formed by a fissure forming in the fuel bed, and by the concentration of draft through such a channel, with a blowpipe effect that fuses the ash and fuel, and that the only way to prevent clinkers is to so arrange the fuel bed that the tendency to form such fissures or "pipes" is reduced to a minimum. This is best accomplished by using fuel beds of generous dimensions and grates that insure equal distribution of the draft current to all parts of the fuel bed at all loads.

In practice it will be found that the resultant increase in efficiency due to the fixation of the tarry vapors of the gas, rather than to wash them out and waste them, is much less than would be expected. If such figures have been worked out by Mr. Berry, the results would be of interest.

Personally I rather lean to the construction of bituminous producers along the line of simple single-zone up-draft, with attached tar washers, as being more adapted to the hard usage of practice, and have in mind a single 400-hp. up-draft, balanced-draft producer, operating on Illinois slack, costing 85 cents a ton delivered, said coal having 4 per cent sulphur content, 22 per cent ash, and 38 per cent volatile matter (10,300 B.t.u.). This producer was installed without any spare unit to help out, and has operated 24 hours per day since August, 1910, using 1¼ lb. of coal per hp-hour. I mention this plant as a case in point on the clinker question, as this fuel had a bad reputation in that respect (as well as others).

Also as to the reduction of CO_2 to 2CO, my own experience indicates that perfect reduction occurs at 1800 deg. fahr., provided that the draft velocity is sufficiently low to allow the time necessary for the reaction. The faster the flow of draft through the fuel bed, the higher must the temperature be for this reason.

Mr. Berry should continue his investigation under conditions entailing more commercial conditions, variable load, without special attention, and noting the possibility of keeping the gas tar-free during such variations without undue attention and the effect of large grate areas; for example, in producers 10 ft. inside diameter, for all producer builders have had the sad experience of discovering that the design that was most successful at 36 in. diameter was far from such on twice that diameter, etc.

C. M. Garland. The studies recorded in Mr. Berry's paper are very interesting and the methods of investigation, together with the design of the producer, are both novel and ingenious. There are several points brought up in the paper, however, which the writer feels have not been sufficiently described and on which further information would be very desirable.

Regarding the removal of ash and clinker from the producer: from the drawing it would seem that the burner for the recirculating gas takes up a large portion of the grate area. It would also seem that this burner would be in danger of clogging through an accumulation of ash. Regarding the formation of clinker: the combustion of the recirculating gases, while it would undoubtedly destroy the tar, would, however, produce a high temperature in the ash zone which would greatly facilitate the formation of clinker, even with fuels which would not clinker in the ordinary producer. Due to the recirculating of the gases and the high temperature, which are apparently maintained even in the coking chamber of the producer, the clinker formation might begin very high in the producer. In this connection temperatures through the fuel bed and of the gases leaving the producer would be very interesting. The removal of the gases from the side of the producer is another element that would tend to cause the formation of clinker, particularly around the side walls.

Data on the calorific value and the composition of the gas from the producer would also be very desirable. The design would unquestionably eliminate tar and produce a gas of low calorific value. While the gas of low calorific value, in so far as power is concerned, is not objectionable, the power end of gas-producer work today is a comparatively small end of the work and is more than likely to decrease rather than increase.

The ideal to be approached in the elimination of tar is a producer in which the tarry products are converted into fixed hydrocarbon gases which would raise the calorific value of the gas instead of lowering it. The demand today is for a producer gas to replace fuel oil. This gas must have a high calorific value in order that high furnace temperatures may be produced.

MR. BERRY'S CLOSURE

O. C. Berry. Mr. Tait calls attention to the methods used in testing for tar. It is very important to know that the gas leaving this producer is entirely free from tar at all times. The method used in making this test is a very searching one and can be applied continuously and without difficulty in any power plant where either live steam or compressed air is available. It consists in maintaining a vacuum of about 20 in. of water inside of a large glass bottle by means of a steam or an aspirator. The bottle should have a wide mouth closed by a stopper. To this stopper is attached the support for a slip of white cardboard. The gas to be tested for tar is led into the bottle through a glass tube. This tube is drawn down to a small opening at its lower end and bent so as to cause the gas to impinge against the paper at right angles and at a high velocity. The presence of the slightest trace of tar in the gas will cause a brown spot to form on the cardboard immediately. This method is very easy to apply, and has the advantage of being very searching and at the same time very quick to react.

I feel that if Mr. Tait will make a closer study of the European producers he will find that they have not been worked out along the lines here presented, though some of them have been very similar. In some cases I have had a hard time to see for myself why the older producer should fail and my own be worthy of success. There has been a reason in each case, however, even though the search for it has caused some anxiety on my part in the early stages.

The work of O. Boudouard, published in the Comptes Rendus de l'Académie des Sciences in 1899 and 1900, has been widely referred to. It would seem to indicate that a temperature of 1800 deg. fahr. is sufficient to decompose the CO_2. The element of time has been left out in this work, however, as is shown by the later work done by J. K. Clement, L. H. Adams, and C. N. Haskins for the Department of the Interior, U. S. Bureau of Mines, and published in their Bulletin 7. Here it is shown that at a temperature of 1832 deg. fahr. the gas must be in contact with coke for 123.2 sec. in order to decompose 78.4 per cent of the CO_2. This is entirely prohibitive, as Mr. Tait will see.

I am sorry to be unable to present a detailed sketch showing Mr. Garland just how the gas burner avoids clogging up with ash. The removal of the ash and clinker is as easy to accomplish in this plant as it is in the standard anthracite plant, and the burner is so designed as to avoid any possibility of clogging up, and never has to be cleaned.

The burning of the recirculated gas tends to lower rather than raise the temperatures met with in the combustion zone of the producer, and has never been the cause of the formation of clinkers. The formation of clinker in the coking zones of the producer is unthinkable, as the temperatures there are below 1200 deg. fahr., while it is a poor coal having an ash with a fusing temperature as low as 2350 deg. fahr., while good coals will not clinker below 2750 deg. fahr.

The heat value of the gas from this plant seems to vary between 125 and 150 B.t.u. per cu. ft., the same as anthracite gas. The high heat values reported in connection with producer gas from bituminous fuel are due quite largely to the presence of tar vapors in this gas, and would be impossible without these vapors. Such a gas is ideal for some types of furnace work, but cannot be used in an engine.

Mr. Rathbun takes exception to the cleanliness of this gas. He knows that the gas from an anthracite plant is the cleanest gas that can be gotten from any type of gas producer, and is also the easiest to separate from what little dirt it does contain. The gas as it leaves this producer is in a class with anthracite gas. It is not clean enough to use in an engine in the condition in which it leaves the producer, but it is the easiest gas to clean that there is.

Mr. Smith is correct in his statement that it will take considerable fixed carbon in the coal to reduce all of the CO_2 and H_2O formed by the combustion of a large amount of volatile matter. It is probable that not all of these gases are completely burned. The tars can be completely destroyed by passing them through an incandescent zone, and some of them are probably eliminated in this way. As a matter of fact, nearly all of the tests on this producer have been made with Indiana and Illinois coals, having about 8 per cent moisture, 35 per cent volatile matter, 49 per cent fixed carbon, and 8 per cent ash. No trouble was experienced in keeping a sufficient bed of coke with any of these fuels.

Whether Mr. Chapman's objection on the score of a deep fuel bed would hold in the case of a larger plant, is problematical. In the case of the plant here shown it is 4 ft. deep, which is not too deep to poke with ease.

Reliability in a producer of this character cannot be established by a series of laboratory tests. It requires years of use in many power plants. I hope that the future may establish the predictions which the laboratory tests have lead us to make for the future of this type of producer.

THE RATIO OF THE SPECIFIC HEATS AND THE COEFFICIENT OF VISCOSITY OF NATURAL GAS FROM TYPICAL FIELDS, ROBERT F. EARHART

H. B. BERNARD. Due to the many features encountered in piping natural gas, such as condition of pipe, type of joints, bends, temperature changes, etc., it is doubtful whether Professor Earhart's determinations are of any value outside of the laboratory. For practical conditions, the formulæ derived by T. R. Weymouth from numerous observations and published in Vol. 34 of the Transactions of the Society are unquestionably of sufficient accuracy in problems involving the flow of natural gas.

Referring to Table 1, it appears that the coefficients of viscosity are computed from the coefficient of viscosity for air and the relative coefficients of viscosity as determined on the following page. It is unfortunate that the author has neglected to give sufficient data to permit the checking of these values by the formula preceding the table.

In determining the relative densities by an effluxometer, the densities are in the ratio of the squares of the times of efflux. In view of the fact that the coefficients of viscosity are in the ratio of the times of efflux, the densities should be as the squares of the relative coefficients of viscosity. Using the latter values as given in Table 1, the computed densities as compared to those in the tables are as follows:

Computed.......	1.000	0.593	0.533	0.563	0.540	0.563
From Table 1...	1.000	0.682	0.660	0.660	0.690	0.666
Computed.......	0.504	0.578	0.563	0.672	0.689	.....
From Table 1...	0.585	0.755	0.678	0.755	0.770	.....

P. F. WALKER. The author uses in his title the words "ratio of specific heats," and throughout his discussion shows that he is assuming that this ratio and the value of the adiabatic exponent are identities.

The statement is made at the outset that this paper and the experimental work on which it is based constitute an extension of an earlier paper dealing with the question of the variation of natural gas from Boyle's law. In that paper the joint authors indicate a very marked deviation of the gas from the laws of perfect gases. While the numerical values shown in that paper are excessive, being made to appear large because of some unexplained fluctuations at low pressures which other experiments do not corroborate, it is true that the substance differs materially from a perfect gas.

It is not necessary to go through the steps of the mathematical proof of the principle that for a perfect gas the adiabatic exponent is the ratio of specific heats. It has been my observation on several occasions, however, when questions on this matter were up for discussion, that it is necessary to remind engineers of the fact that the statement applies only to perfect gases. It seems to be an ingrained notion in the minds of technical and scientific men that the adiabatic exponent must be the ratio of specific heats. This is far from being the truth, however, when the gas is of such a character that it fails to follow the laws of perfect gas to such an extent that the variation is worthy of notice. The point brought out in the previous paper by the author, and in substance fully attested to by all who took part in the discussion, is that this gas in its behavior does vary materially from the laws of perfect gases, and hence it must follow that the value of the exponent found for an adiabatic cannot be taken as the ratio of specific heats.

This point is of significance, provided the purpose of the investigator is to discover facts with reference to specific heat. We need not enter at this time into a discussion as to which is the important thing to be determined. Every contribution to our knowledge of matters in this connection is valuable, and we should be grateful to Professor Earhart for having brought this interesting and instructive investigation to our attention.

SANFORD A. MOSS. While natural gas may depart considerably from the perfect-gas laws, at high pressure, the departure at pressures close to atmospheric cannot be very serious. Hence the computation of density and of specific-heat ratio from gas analysis will give reasonably accurate results.

I have made such computations for the various samples given by Professor Earhart in his Table 1, using the volumetric analysis there given. I obtained values for the density and specific-heat ratio which differ greatly from experimental values tabulated by Professor Earhart.

The method of computing density or specific gravity of a mixed gas from the volumetric analysis is well known. It consists in multiplying the percentage of each component by

density of said component at standard conditions, and adding the results. A sample computation of density is given in Columns *C* and *D* in Table 2. The values of specific heat at constant pressure and specific heat at constant volume can be found in a similar way, using, however, analysis by weight instead of analysis by volume. The ratio of the specific heats of the mixture as thus computed gives a value which can be used to compute velocity of sound, etc., and which should agree with the experimental values of Professor Earhart's n.

In other words, if we have a gas mixture containing various components whose individual specific heats at constant pressure are c_p', c_p'', etc., and whose specific heats at constant volume are c_v', c_v'', etc., and if the percentages by weight of each of the components are x', x'', etc., then it can be shown that the specific heat ratio for the mixture is

$$n = \frac{x' c_p' + x'' c_p'' + \quad . \quad . \quad .}{x' c_v' + x'' c_v'' + \quad . \quad . \quad .}$$

This formula is almost self-evident. However, I have given a deduction in *Sibley Journal*, May, 1905, page 311. A sample computation of specific-heat ratio by this method is given in Table 2, Columns *E*, *F*, *G*, *H* and *I*.

In making computations I have used the values of c_p and c_v listed in Columns *F* and *H*, Table 2. All of these values are fairly well agreed upon by various authorities except the value for ethane, which I was not able to find. However, it is well known that for a perfect gas the molecular specific heat or product of specific heat and molecular weight m, is given by

$$c_p m = \frac{1.97}{1 - 1/n}$$

I have used the value of n for ethane given on the first page of Professor Earhart's paper, and obtained c_p by this formula. The value is of course in error due to the imperfection of ethane, but the discrepancy cannot be very large.

I have made computations similar to those in Table 2 for each of the gas samples given in Professor Earhart's Table 1. A comparison with the experimental results of Professor Earhart is given in Table 3. As will be seen, there is an appreciable discrepancy. I do not believe this can be explained by the fact that the gases in question do not obey the perfect-gas laws.

MR. EARHART'S CLOSURE

R. F. Earhart. A confusion of terms seems to have arisen involving the flow of gases through a pipe. The resistance offered to the passage of a stream of gas through a pipe is a complex problem and, as Mr. Bernard has pointed out, is influenced by the physical condition of the pipes, the joints and several other factors. The coefficient of viscosity, strictly speaking, is a measure of the internal friction of the gas and is but a single factor in the problem. In many cases, no doubt, it is less important than others; it is, however, a factor peculiar to the gas itself.

It appears that in some cases the viscosity effect (or computations for "viscosity" by engineers) is taken to represent the summation of a considerable number of factors. Some of these have been taken into consideration by Mr. Weymouth in the article to which reference has been made.

The experiments on the coefficient of viscosity were made with the idea of comparing the single factor of internal friction or viscosity for gases obtained from widely different sources under similar conditions of pressure and temperature and in the same apparatus. The values obtained cannot, of course, replace those found serviceable in practice and which include several other factors, even though in a very loose way they go by the same name; nor can they be expected to give satisfactory density values.

The rate of escape of a confined gas through an orifice is a function of the pressure, temperature, density and coefficient of viscosity. In the effluxometer we compare the densities of two gases under similar pressure and temperature conditions by the rate of escape through an orifice which must be an opening in a thin diaphragm. To obtain density comparisons, the diaphragm must be vanishingly thin in comparison with the size of the orifice. This is approximated by making a small hole in a piece of thin foil, usually of platinum. The necessity for making the diaphragm thin is to reduce the effect due to viscosity.

TABLE 2 SAMPLE COMPUTATION OF DENSITY, WEIGHT ANALYSIS AND SPECIFIC HEATS OF A GASEOUS MIXTURE, FROM VOLUMETRIC ANALYSIS

Natural Gas from Vinton County, Ohio, Line 6, Table 1

Component *A*	Volumetric Analysis % *B*	Density of Components, lb. cu. ft. 14.7 lb. Abs. 60° F. *C*	Weight of Components, lb., cu. ft. $= B \times C$ *D*	Analysis by Weight $= D$, 0.05174 *E*	c_p of Components *F*	c_p of Mixture $= E \times F$ *G*	c_v of Components *H*	c_v of Mixture $= E \times H$ *I*
CO_2...	0.1	0.11683	0.00012	0.23	0.2020	0.0005	0.1554	0.0004
O_2....	0.8	0.08442	0.00068	1.31	0.2175	0.0028	0.1556	0.0020
CH_4...	73.0	0.04261	0.03111	60.13	0.5920	0.3560	0.4490	0.2700
C_2H_6...	5.8	0.08212	0.00476	9.20	0.4260	0.0392	0.3600	0.0331
N_2...	20.3	0.07424	0.01507	29.13	0.2419	0.0705	0.1835	0.0535
	100.0		0.05174	100.00		0.4690		0.3590

Density of air, 0.07638 lb./cu. ft. at 14.7 lb. abs. and 60 deg. fahr.
Specific gravity of gas, 0.05174/0.07638 = 0.6775
n or c_p/c_v for mixture, 0.4690/0.3590 = 1.306

TABLE 3 COMPARISON OF VALUES OF SPECIFIC GRAVITY AND SPECIFIC-HEAT RATIO OF NATURAL GAS BY COMPUTATION AND EXPERIMENT

Line in Earhart's Table 1	Specific Gravity (Density, with Air = 1.00)		Specific-Heat Ratio n or c_p/c_v	
	Earhart's Experimental Value	Computed Value	Earhart's Experimental Value	Computed Value
2	0.682	0.6503	1.238	1.285
3	0.660	0.6278	1.214	1.294
4	0.660	0.6370	1.209	1.305
5	0.690	0.6622	1.210	1.290
6	0.666	0.6775	1.259	1.306
7	0.585	0.5795	1.285	1.318
8	0.755	0.7320	1.293	1.259
9	0.678	0.6870	1.220	1.278
10	0.755	0.7521	1.290	1.300
11	0.770	0.7760	1.224	1.297

Thus, by suitably dimensioning the apparatus, the viscosity effect becomes small and is assumed to be negligible. When, however, we make the diaphragm very thick or for convenience cause the gas to escape through a tube whose length is great compared with the diameter of the opening, the rate of escape is determined largely by the viscosity factor. Practically, when the length of the tube is 200 times the diameter, the viscosity term becomes so large in comparison with the density factor that the density factor is neglected. The conditions which prevail in the two cases are so different that the data

obtained under one set of conditions cannot be treated by the formula applying to the other.

A comparison of density determinations made by different effluxometers indicates that those made in the usual way are not accurate; the discrepancies are sometimes several per cent. The writer is therefore brought to the conclusion that the accuracy of this method is greatly overestimated.

The point raised by Professor Walker concerning the application of the law of perfect gases to the theory of velocity determinations is well taken. The degree of accuracy obtained in the experiment will determine whether the correction factor should be applied or omitted. The value of n is obtained by taking the product of three quantities, one of which is the density of the gas. The density of the gas was determined to one part in five hundred in the laboratory. This is a higher degree of accuracy than conditions really warrant, for gas from any field will show variations from day to day of perhaps one per cent. However, it was easy to determine. This, however, places a limit on the accuracy of the result, and it is not desirable to introduce a correction factor of less magnitude in the other quantities.

The experiment by Mr. Wyer and myself showed that the departures from Boyle's Law were appreciable for several atmospheres' change and were large when the pressure variations were thirty or forty atmospheres. However, when sound waves pass through a gas the pressure changes are from one atmosphere to possibly one and one millionth atmospheres. Even for such a pressure change there should strictly be a correction for deviation from Boyles' Law, which is assumed to hold between the limits of pressure employed.

The application of this correction factor is not justified when compared with the density determinations. The correction applicable in such cases is treated in a very able way by Capstick in a paper presented to the Royal Society of London (Phil. Trans. Roy. Soc. of London, 1894, Part I, Page 1.) Dr. Capstick was determining the ratio n for a series of vapors some of which were but slightly removed from saturation. Under such circumstances the deviations from Boyles' Law are considerable. He made a careful study of the case and found a small correction necessary. The natural-gas products, however, are so far removed from this condition that any modification of the value obtained from direct experiment is not justified.

PULVERIZED FUEL FOR LOCOMOTIVES, J. E. MUHLFELD

C. W. Corning.[1] I am familiar with many of the results from the use of pulverized fuel as stated in Mr. Muhlfeld's paper, having for several months had charge of an Atlantic-type locomotive in first-class passenger service, burning this form of fuel.

Of the many things which contribute toward the lightening of the enginemen's cares in the discharge of their duties, probably the two most essential are the properly working of injectors and the free steaming of the engine.

In all of the runs made by the engine mentioned, it never failed to deliver all the steam pressure required (in the language of the fireman, it is "two o'clock" all the time by the steam gage). In the event of the failure of the injectors it is a simple matter to shut off the supply of fuel until such time as the matter can be remedied and the fire relighted.

A very prominent feature of the pulverized-fuel engine is the fact that the draft appliances need not be changed for different grades of fuel, or climatic conditions of the various seasons of the year. The locomotive has been operated in all kinds of weather, in very heavy rain storms, snow storms, extremely hot and dry weather, and when the temperature was several degrees below zero, and there never was any noticeable change in the steaming qualities of the engine.

Last, but not least, of the many good qualities stated in Mr. Muhlfeld's paper is that of the possibility of enlarging exhaust-nozzle openings. The area of the exhaust-nozzle opening on the C. & N. W. engine has been increased about 40 per cent. In summing up, what is nearest the heart of an engineman is a free-working engine, and this is obtained by burning pulverized coal.

[1] Chief Smoke Inspector C. & N. W. R. R., Chicago, Ill.

W. A. Evans. Only two of those discussing the proposition suggested what has always been the one difficulty in obtaining powdered-fuel combustion under boilers, viz., the difficulty of maintaining the brickwork with its necessity of large combustion space for this form of burning. One of the men stated frankly that his company had experimented with powdered coal, and found when forcing the boiler, as is necessary in locomotive practice, that the brickwork was difficult to maintain. It is hoped that Mr. Muhlfeld will give full account of brickwork difficulties and means by which he would overcome them.

To those who have watched powdered-coal development there was much satisfaction in the apparent success of burning it under a Franklin boiler at the American Locomotive Works in Schenectady, N. Y. That installation seemed to indicate the necessity of large combustion space and slow velocity of fuel and air entering the furnace. These demands are quite contrary to the limited possibilities on the illustrations shown in Mr. Muhlfeld's paper on the application to locomotive boilers. After operating for over two years, to the writer's knowledge there is no evidence that results have been so desirable as to have the other boilers in the same plant equipped with the same fuel apparatus, and two years of experience ought to attract more attention than is evidenced by the lack of further development in the stationary line in this time.

There is further cause for caution on the part of those considering the use of powdered coal in the fact that of the many concerns claiming to produce powdered-fuel equipment and soliciting opportunities to undertake the entire installation, none, to the writer's knowledge, will give a definite guarantee of results.

Lawford H. Fry. Mr. Muhlfeld has shown the economy and advantage of applying pulverized fuel to locomotives designed with a grate for burning lump fuel. It would be interesting if he could tell us what further advantages could be obtained if the locomotive were to be designed from the outset without the restrictions imposed by the necessity of a grate. To see what changes would be involved, consider the difference in the two processes of combustion. In firing lump coal, the fuel is introduced intermittently, being thrown on to a bed of incandescent fuel. The volatile matter is distilled off and burnt in the volume of the firebox. The fixed carbon, or at least the greater part of it, remains on the grate. In order to burn this, a strong current of air through the grate is necessary since, owing to the comparatively small surface of the lumps, it is necessary that they be scrubbed vigorously by the air, using an amount in excess of that which combines

with the carbon during combustion. This process of combustion gives two requirements in locomotive design: sufficient volume for the combustion of the volatile matter, and sufficient grate area for the combustion of the fixed carbon. It is well known that the higher the percentage of fixed carbon, the larger must be the grate, hence the large grate areas necessary for anthracite burning locomotives.

With pulverized fuel the conditions are, as Mr. Muhlfeld has pointed out, entirely different. The fuel is introduced continuously as it is burnt, not intermittently. Owing to the very large surface which each particle of fuel has in the pulverized form, the scrubbing action of the air is not required, and complete combustion can be obtained with the theoretically necessary amount of air, provided the fuel floats with the air for a sufficient time at the temperature necessary for combustion. It is obvious that with the pulverized fuel no grate area is necessary, but there must be sufficient firebox volume and a sufficiently long travel for the flame to allow complete combustion to take place before the gases enter the flues and are cooled below the combustion temperature. It would be very interest if Mr. Muhlfeld could give us some information as to the volume and length of firebox required for a given rate of combustion.

Now coming to the effect which this novel process of combustion may have on locomotive design: So far as the lump-fuel locomotive is concerned, Mr. C. D. Young in discussing locomotive proportions before the Master Mechanics' Association last June, pointed out that the basic steps in designing a locomotive are, first to determine the grate area necessary to give power, and then to settle on the depth of throat sheet which will give sufficient firebox volume for efficient combustion. The depth of throat sheet in conjunction with the diameter of the drivers fixes the diameter of the boiler which can be used with a given loading gage. This all means that the design for the whole lump-fuel locomotive is built up around, and is controlled by, the grate area and the depth of firebox.

Now with pulverized fuel it would seem to be possible to eliminate both grate and throat sheet, and to use a boiler of larger diameter and special design which would give even better results than can be obtained by adapting an existing lump-fuel boiler. I have not attempted to work this thought out in its practical details, but it would be interesting if Mr. Muhlfeld could tell us whether he has considered this phase of the question of pulverized fuel. Of course a special design of boiler along the lines indicated presupposes complete conversion of the road using it to pulverized fuel, but no doubt Mr. Muhlfeld has sufficient confidence to look thus far into the future.

E. H. Stroud. The results reported by Mr. Muhlfeld show a great advance upon the practice of burning lump coal upon locomotive grates, hand-fired, and an enormous saving to the railroads in many ways. Still better results can be had, however, and a greater saving of coal and money be made by abandoning the use of stack draft, and making all the air necessary for the most complete combustion possible carry into the firebox all the coal that has to be burned.

The statement has been made that it would be impossible to find space enough that could be spared upon the front end of a tender for such apparatus as would be required to do this. Such apparatus, however, is available from my firm, in size to fit that space, and it can be built to operate, at variable speed, by either steam or electricity. It is the result of 16 years of effort and I know of nothing but our method of operation which has been really successful under boilers of any kind. We tried the stack-draft method and abandoned it years ago for the very faults shown by Mr. Muhlfeld's locomotives. They save 15 per cent of coal. Our plan saves nearly 50 per cent in stationary boiler plants, where the usual losses are not so great as in locomotives. By our method we are able also to give furnace temperatures from 1800 deg. fahr. to 3000 deg. fahr. and over, and such a low temperature has not been achieved before.

It is evident from Mr. Muhlfeld's showing that the use of stack draft renders necessary for the control of the fire of a locomotive a much more complicated mechanism than is needed for firing by the method and device I have mentioned, which latter performs for powdered coal the same service as the device called a carburetor performs for gasoline: namely, it receives the entire quantity of the two fuel elements, coal and air, and mixes them thoroughly together in exactly the right proportions before they enter the combustion chamber.

It makes no material difference, therefore, whether the locomotive is standing or running, or what its speed may be, or whether there be wind or no wind, provided it be fired by such a stoker; whereas, when depending upon stack draft the circumstances mentioned must necessarily exert a considerable influence, and require the use of a constantly varying quantity of exhaust steam at all times to counteract those influences, thus putting a back pressure upon the cylinders and reducing the efficiency of the locomotive proportionately.

I think it is admitted by most railroad men that the use generally made of the exhaust steam to create stack draft reduces the total locomotive efficiency 25 per cent. Such being the case, the use of the apparatus referred to would give the locomotive one-third more power to use, besides effecting a greater saving of coal and water and the simplifying of the control of the firebox results, because the exhaust steam will not be used to create draft.

J. H. Manning.[1] Mr. Muhlfeld's paper accords with our practical experience with engine 1200, having a boiler the principal dimensions of which are as follows:

Diameter, first course..........................86 in.
Firebox, size.......:..........114 in. wide, 126 in. long
Equivalent heating surface.................5004 sq. ft.
326 2-in. tubes
46 superheater units

This boiler supplied steam to 27 x 32-in. cylinders, and developed through a medium of 63-in. wheels, 60,000 lb. tractive power at the drawbar, carrying 205 lb. of steam.

This company, the Delaware and Hudson, is closely connected with a territory that produces about 80,000,000 tons of anthracite per year. It is not hard to understand that a great deal of extremely fine coal and dust accumulates in the process of marketing. This cannot be burnt on the grates, but, if at all, in suspension in a refractory furnace. For this latter purpose we have available in our neighborhood 550,000 tons per month. This latter and the fact that there were located around us a number of industrial plants successfully burning bituminous coal in pulverized form, encouraged us to build an experimental locomotive of the dimensions stated above, producing approximately 2700 cylinder horsepower. To guard against the possibility of failure, the entire firebox, boiler and locomotive was so constructed that the application of the powdered-fuel mechanism could be readily removed and the firebox, etc., arranged for burning fuel on grates.

[1] Superintendent of Motive Power, Delaware and Hudson Company, Watervliet, N. Y.

We soon found out it would be impossible to burn clear anthracite coal in pulverized form. Due to the low volatile, it would promptly snuff out if the engine should happen to slip or worked extremely hard, and firebox temperature would not permit it to again flash. We therefore arranged a program and determined to start with 75 per cent bituminous and decrease until it was found that this objectionable feature was removed. This was continued until a mixture of 60 per cent anthracite and 40 per cent bituminous was obtained. We find this gives splendid results, the engine steams freely with very little smoke and is very nicely controlled by the fireman to the extent of keeping the engine within three pounds of the maximum pressure continuously without popping under the different operations necessarily obtaining in a day's work with an engine of this character, experiencing no firebox trouble whatever.

Such difficulty as we have had with the pulverized-fuel mechanism for the introduction of the fuel into the firebox has been satisfactorily eliminated and the successful burning of pulverized fuel in suspension in locomotive firebox, to my mind, has passed beyond the experimental stage. It is now a question of economy only and this depends upon the source of supply in a great measure.

MR. MUHLFELD'S CLOSURE

J. E. MUHLFELD. With respect to the points that Mr. Robinson brought out, I would say that he has looked at this matter from a strictly practical standpoint, and, in my opinion, the advantages that he names, through ability for the railway to pool the various grades and qualities of coal that they secure from the different mine operations along their line, reduction in fire building, ashpit and other terminal delays, and the elimination of arduous labor on the part of the fireman, are among the most important items with which the railways are contending today. The advantages of pulverized fuel with regard to all of these have already been demonstrated in road and terminal operation.

Mr. Katte took exception to paragraph *a* under the caption Facts and Conclusions. If, as he states, the electric locomotive and the complete electric installation behind it for the movement of heavy traffic over long distances can be maintained and operated cheaper than the equivalent steam unit, then we would like to have some figures to show it. As the steam locomotive carries its own self-contained power plant, its maintenance cannot be compared with an electric locomotive that does not generate its own power. A fair comparison must cover the combined fixed charge, maintenance and operating expense involved for drawbar horse power per hour.

Mr. Katte felt that the electric installations so far made have demonstrated greater reliability under all conditions than steam locomotives. In reply to this it might be interesting to make a comparison of steam-railway steam-locomotive operation for from 25 to 30-mile runs in the Chicago district with steam-railway electric-locomotive operation for similar distances in the New York district as regards schedule time and regularity and continuity of service, summer and winter. With respect to flexibility of service, a steam locomotive can be operated wherever the gage and strength of the track admit it, whereas an electric locomotive is confined to the electrified section that fulfills its electric-current characteristics and contract-line requirements. In the January 8, 1916, issue of the *Railway Review*, I covered this phase of the subject in considerable detail in a paper entitled The Future of the Steam Locomotive, the majority of the data presented having been obtained from about five years of actual experience with steam- and electric-locomotive operation on the Baltimore and Ohio Railroad.

The point that Mr. Fowler makes about more constant firebox temperature with pulverized fuel is certainly correct, as the firedoor is never opened during the time that combustion takes place, and the liability of a cold shaft of air passing through the firebox, as where coal is burned on grates, is entirely eliminated.

Mr. Young refers to work that the Pennsylvania has done and which, from results obtained with a locomotive in a stationary condition, must have been with entirely different means, methods and processes from what we have developed and make use of in both locomotive- and stationary-boiler practice. Their arrangement evidently concentrates or pockets the heat in connection with the refractory material, and too great a velocity pressure of the products of combustion must obtain in the firebox.

Mr. Young also brought out that the Chicago & North-Western locomotive water-rate performance was exceptionally high. He evidently considered this from a cylinder-horsepower, rather than from a drawbar-horsepower-per-hour standpoint.

With respect to his statement that from 40 to 60 per cent of the fuel consumed by steam locomotives, when coal was being burned on grates, takes place when the engine is not working steam: Our data in this regard, obtained from actual road results, are in accord with his figures. Of course, the more congested the operation on a right-of-way, as for example, during the past few months on various steam roads in the Eastern district in the United States, the greater this percentage becomes.

Mr. Randolph brought out the matter of liability of dust explosions. From the fact that about 8,000,000 tons of pulverized coal are now being burned in the United States per annum, it is thought that general practices with respect to the handling, drying, pulverizing, storing and disbursing of the same have been pretty well taken care of, and the general results with the various cement and industrial plants using this kind of fuel indicate this to be the case. Where we have had our designs of fuel-preparing, handling and burning equipment installed, up to the present time no trouble whatsoever has obtained.

Mr. Basford's idea of prolonging the life of existing locomotives by modernizing them through the application of pulverized fuel was well taken, and an enormous amount of work remains to be done along this line which will enable the reclaiming of motive power that in its present condition is ineffective and uneconomical.

Mr. Baker brought out the problem of smoke elimination, particularly in the larger city terminals where numerous switching and transfer locomotives are used.

The control of not only the smoke, but also of sparks, cinders and popping off, as well as the reduction in the exhaust-nozzle noise is entirely possible and practicable with the development that has already been demonstrated through the operation of the Chicago & North-Western pulverized-fuel-burning locomotive in the City of Chicago.

The items that Mr. Corning brought up were those which appealed to the practical railway operating official as well as to the engineer and firemen in charge of the locomotive, and the benefits to be derived from flexibility in the operation of the equipment and the maintenance of economical working steam pressure at all times and under all conditions, and further the increased tractive power by the enlargement of the exhaust-nozzle area are most essential in that regard.

Mr. Evans brought up the difficulty in maintaining brick-

work, with the necessity for large combustion space in the use of powdered fuel in boilers, and requested data on that subject. The answer is: Reduce the velocity pressure of the combustion gases to the minimum; eliminate restricted areas in the brickwork through which these gases must flow; and bring these gases into contact with heat absorbing surfaces as quickly as possible after the combustion process has been completed. We have found that owing to the rapidity of oxidation large combustion space and brick area are not necessarily essential to effective results.

Probably the reason for Mr. Evans not being able to secure a definite guarantee of results from the use of pulverized fuel from the concerns with whom he has had the matter up, is the fact that until recently very little practical knowledge has been available on which to base such assurances, and that essential means, methods and processes were not really developed along practical lines until the application of pulverized fuel to the most unfavorable condition, i. e., the steam-locomotive boiler, was undertaken.

Mr. Fry brought up the question of volume and length of service locomotive firebox necessary for a given rate of combustion. All of our development work has been done with existing standard designs of locomotive fireboxes and boilers ranging from 48 in. wide by 90 in. long, to 114 in. wide by 126 in. long, and in no instance has there been any difficulty experienced with burning the requisite amount of fuel to secure economical boiler horsepower under the most extreme working conditions. This applies to lignite as well as to bituminous coal and to a mixture of 60 per cent of anthracite slush and 40 per cent bituminous screenings.

The point that Mr. Fry brings up relative to being required, when coal is burned on grates, to build up a locomotive design around the grate-area and depth-of-firebox dimensions, is largely correct, and the burning of fuel in suspension will enable the use of special designs of locomotive boilers, for example, for longer flameway and return tubes, which will permit of utilizing a much greater percentage of the fuel value than will ever be found possible by the burning of fuel on grates.

Mr. Stroud points out the feasibility of securing still better results than what have been obtained by abandoning the use of stack draft. The practical work that we have done along this line has, to the present date, not demonstrated this. While stack draft is not needed to secure combustion results, it is required to produce boiler and superheater capacity and effectiveness, which all-important factors Mr. Stroud has apparently overlooked.

Mr. Manning brings up that on his road a mixture of 60 per cent of anthracite and 40 per cent of bituminous is now giving splendid results in locomotive service. I desire to elaborate on this and state that the 60 per cent consists of anthracite slush, or heretofore waste by-product of mining, and that the 40 per cent consists of bituminous unwashed screenings, all of which is mixed and pulverized.

This mixture gives a fuel of about 15 per cent volatile as compared with the heretofore generally recommended practice of not less than 30 per cent volatile. Furthermore, this result has been acquired with the second type of furnace refractory arrangement tried out, and we feel that the next change in the refractory arrangement will result in the utilization of a mixture of at least 80 per cent of anthracite slush and 20 per cent bituminous screenings, for the reason that no difficulty whatever is now experienced in burning the straight anthracite slush in stationary boiler practice and obtaining the requisite boiler capacity and maximum efficiency.

WATER FOR STEAM BOILERS, ITS SIGNIFICANCE AND TREATMENT, ARTHUR C. SCOTT AND J. R. BAILEY

S. B. Applebaum[1] This paper and discussion confine themselves to the old lime-soda system which has been in use about half a century and from which little that is new can be expected. No mention is made of the "Permutit" process which has so rapidly come to front in the last decade in Germany, France and England, and during the last few years in this country. This is an entirely new departure in water softening and it represents the only real progress made in a considerable period.

The essential characteristics of this process are that the water passes through a bed of insoluble exchange alumino-silicates or zeolites at a high rate, and that in the cold a chemical exchange automatically takes place between the water and this material, whereby all the calcium and magnesium are completely removed and replaced by sodium. It is a rapid chemical reaction between the insoluble powerful reagents and the water, which is a very dilute solution of calcium and magnesium salts. The insolubility of these exchange silicates in water is the essence of the process. Because of this property it is possible to remove all of the hardness from water and to obtain this result by automatic filtration. Why is this not possible with the older process? Every chemical reaction to be carried very near to completion needs a driving excess of the reagent. When we add lime and soda ash to water, they dissolve in the water. To remove all of the hardness we would have to add a large excess which would remain in the effluent. Such an excess would be out of the question from the point of view of operating costs, especially today with soda ash at 2½ to 3 cents per pound; and the high causticity in the treated water would make it unfit for boiler-feed use.

The exchange silicates are placed in the steel filter shells in amounts many times in excess of that required by the reaction. But they are insoluble, and as the water flows through the bed of silicates the excess of the latter drives the softening reaction to completion in a few minutes; the effluent comes out of zero hardness and no causticity is present.

The advantages of this process may be summed up as follows:

1 No chemist is needed to analyze the varying compositions of the raw water and proportion the chemicals accordingly. The water passes through the softening material automatically and can never be overtreated.

2 The reaction takes place in a few minutes. With soluble chemicals three to six hours are needed to allow the reactions to take place. Accordingly large settling tanks are needed. These occupy considerable floor space. The Permutit filters for the same service are small and compact.

3 No precipitates are formed and no sludge has to be removed. The liquors from the regeneration are all fluid and run into the sewer.

4 The only cost of operation is that of the salt used for regeneration of the exchange silicates. It is much more economical than the use of soda ash for the removal of permanent hardness.

5 Finally a water free from causticity and having zero hardness is obtained at all times which deposits absolutely no scale.

[The remainder of the discussion on this paper will appear in the March issue of The Journal.]

[1] 30 East 42nd Street, New York City.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

Strength of Boiler Furnaces

To the Editor:

In the October, 1916, issue of The Journal, I have read with considerable interest an article by Prof. John Airey, the purpose of which apparently was to expose the inadequacy of the flue formulæ, as regards safety, of the A. S. M. E. Boiler Code by comparing the results of these formulæ with some other flue formulæ promulgated by various authorities.

As the writer has had the advantage of figuring allowable pressures on a very large number of flues covering practically all varieties of sizes actually in use, and also knows from close personal touch with accident statistics in this country that flue failures due to structural weakness as known by theoretical determination contribute a microscopically small proportion of the total number of flues collapsed, he is quite certain that Professor Airey's criticism of the A. S. M. E. Boiler Code formulæ is not warranted. In fact, it seems entirely misplaced, since, judging from what still is actual practice in this country as regards allowing pressure on flues, the A. S. M. E. Boiler Code formulæ appear ultraconservative and their prime virtue is that they are consistent with the most up-to-date and thorough research on this phase of mechanics. Professor Airey's reference to *the danger* of the A. S. M. E. Boiler Code formulæ would therefore seem almost humorous, especially when it is considered that flue failures, aside from those cases of flues that come down due to overheating in connection with excessive amounts of oil entering boilers, are very rare.

It would further appear that Professor Airey's observations of the pressures allowed by other authorities are not correct in several instances, tending to reveal a lack of familiarity with the subject.

Taking up Professor Airey's comment on some of the various rules quoted, I would call attention to the fact that Fairbairn's rule is based on experiments with wrought-iron tubes that were lap-riveted and brazed, so that further allowance for the weakening effect due to a riveted joint is obviously not necessary, especially when making comparisons. This rule is, however, inconsistent in that it permits of pressure determination on flues of any length and produces pressures for long flues that are very low and for the shorter flues excessively high.

The fact has been quite definitely established that for lengths of flues over about six times the diameter, any increase in length for a given diameter does not materially decrease the collapsing pressure.

By a series of tests, conducted on a most exhaustive basis, Prof. R. T. Stewart found this formula for some conditions to err as much as 400 per cent. (Trans. Am.Soc.M.E., 1906, Vol. 27).

In the book written by Hutton no mention is made of the fact whether the flues tested, on which he based his formula, were riveted or welded, but judging from their size and the time this took place, it is fairly safe to assume that they were riveted flues, so that the weakening effect of a joint does not have to be separately taken into account, as it certainly never is in practice.

Hutton's formula has the same faulty characteristics as that of Fairbairn, which has led to the use of the length of riveted sections for L in the formula instead of the total length of flues that are made up in sections by means of lap-riveted girth seams. By doing this, an allowable working pressure that seems more reasonable and which sometimes may still be considered safe is obtained on long flues.

Plain furnace flues of the length given in the concrete case submitted by Professor Airey, namely, 94 in., were rarely made in one length, so that a large majority of the flues at present in use have pressures allowed on them as based on this practice of taking the length of sections for L. In some cases the pressure resulting appears unduly high.

This practice of using the length of sections for L is still followed more or less to this day in the manufacture of inferior grades of boilers and other pressure vessels.

Needless to say, the Code formula gives pressure results considerably lower than the values obtained in the manner just mentioned with Hutton's rule.

The German Government rule is not quoted by Professor Airey in its entirety. This rule reads as follows:

$$t = K \times \sqrt{(P \times L \times D)} + 0.1 \text{ cm.}$$

The constant 0.1 is for boilers in river steamers. For boilers in sea vessels this constant is 0.2. The extra thickness resulting from this augmented constant is required to offset the stronger corrosive action in boilers on board sea vessels due to the possibility of salt water entering them. Quite obviously, for the purpose of making a comparison with the requirements of the A. S. M. E. Boiler Code, which is intended for stationary practice, it would appear that 0.1 is the proper constant to use instead of 0.2, as was done by Professor Airey. On the flue mentioned in the concrete example (29 in. diameter, 94 in. long, ½ in. thick), by using the constant 0.1 the pressure becomes 90 lb. against 75 lb. as calculated by Professor Airey.

Lloyd's rule, $P = \dfrac{89{,}600 \times t^2}{L \times D}$, used to be quite generally employed in the United States for riveted flues, but is now more or less in the discard. Wherever it is still prescribed, as, for instance, in the boiler rules of the City of Philadelphia and other rules that were designed to cover the early practice of boiler construction, the length of the lap-riveted sections may be taken for L, which in some cases has led to absurdly high pressure allowances.

In the practice of applying Lloyd's rule it was never customary to make a special allowance for the character of the longitudinal seam, speaking with regard to American practice at least, and this certainly is not done now in localities where this rule is still used.

The U. S. Government rule (Steamboat Inspection Service) is not identical with Lloyd's rule as stated by Professor Airey,

the latter having been abandoned about 10 years ago. The present U. S. Government rule is

$$P = \frac{51.5}{D}\left((18.75 \times T) - (1.03 \times L)\right)$$

This is the same formula as given in the A. S. M. E. Boiler Code for flues of which the length is 120 times the thickness of the plate or less.

According to this formula the pressure on the flue of the concrete example would figure 94 lb. safe working pressure. There is no stipulation in connection with this formula regarding the weakening effect of longitudinal seams, and consequently the pressures on all boilers in steam vessels where this rule happens to be the deciding factor are never determined making such an allowance; and it may be said in this connection that (to quote the Government Rules) such "plain circular riveted flues, furnaces and cone tops" are quite generally lap-riveted.

The fact that the U. S. Government rule allows for L in the formula to be taken the length of lap-riveted sections causes pressures to be used that appear entirely out of proportion in some cases of very long, thin flues.

The British Board of Trade rule is not correctly quoted by Professor Airey. He quotes it as:

$$P = \frac{75{,}000\, t^2}{(L+1)D}$$

The constant in this formula may be taken at 77,000 for steel flues with single-riveted lap seams. This brings the pressure on the flue in the concrete example up to 75 lb.

There is no provision that the length of riveted sections may be taken for L in this formula, but there is a stipulation limiting the pressure on plain flues to $\dfrac{9900 \times t}{D}$ lb.

Since the British Board of Trade allow various constants in their flue formula relative to the type of joint, it is, of course, not necessary for Professor Airey to make further allowances for the weakening effect of a single-riveted lap seam as he did, as this is taken care of by the constant.

Summarizing the results of the various rules taken up here in the light of their practical application as stated, we get:

	Working pressure
Fairbairn Rule	155 lb. per sq. in.
Fairbairn Rule (modified)	125 lb. per sq. in.
Hutton's Rule	120 lb. per sq. in.
German Government Rule	90 lb. per sq. in.
Lloyd's Rule	99 lb. per sq. in.
U. S. Government Rule	94 lb. per sq. in.
Michael Longridge Rule	157 lb. per sq. in.
British Board of Trade Rule	75 lb. per sq. in.
Average	114 lb. per sq. in.
A. S. M. E. Boiler Code Rule	99.7 lb. per sq. in.

Of course, as pointed out in the foregoing, the fact that some of the above-mentioned rules allow the length of lap-riveted sections to be used for L, in the case of flues so constructed, changes the values of pressure as given considerably; if, for instance, the flue of the concrete case under discussion were made in three sections that were joined by single-riveted lap girth seams, we would get allowable working pressures as follows:

	Working pressure
Hutton's Rule	208 lb. per sq. in.
Lloyd's Rule	296 lb. per sq. in.
U. S. Government Rule	209 lb. per sq. in.
Average	238 lb. per sq. in.
A. S. M. E. Boiler Code Rule	99 lb. per sq. in.

It is particularly in this feature of taking for L in the various formulæ the length of riveted sections, that the A. S. M. E. Boiler Code rules are a marked improvement, as this is specifically prohibited for the Code formula. (See interpretation by the Boiler Code Committee in Case No. 22, The Journal, January 1916, Page 44.)

It is extremely doubtful whether in the majority of cases one is justified to consider the reinforcing effect of a single-riveted lap seam connecting the sections of a riveted flue, sufficient to disregard the total length of the flue and simply consider the greatest length as that of one section, the same as is done when the sections of a plain furnace flue are joined by the Adamson-ring construction or similar reinforcement, especially so when such flues built in lap-riveted sections are quite long, say 5 or 6 times the diameter.

A few examples of actual flues may serve to further show the conservative amount of pressure allowed by the A. S. M. E. Boiler Code formula and what it has heretofore been quite generally the practice to allow, by taking for L the length of sections, according to Hutton's, Lloyd's and the U. S. Government rules.

58½ In. Length. 2 Sections. 26 In. Diameter. ⅜-In. Plate

	Working pressure
Hutton's Rule	135 lb. per sq. in.
Lloyd's Rule	198 lb. per sq. in.
U. S. Government Rule	163 lb. per sq. in.
Average	165 lb. per sq. in.
A. S. M. E. Code Rule	103 lb. per sq. in.

88½ In. Length. 3 Sections. 24 In. Diameter. ⅜-In. Plate

	Working pressure
Hutton's Rule	146 lb. per sq. in.
Lloyd's Rule	213 lb. per sq. in.
U. S. Government Rule	176 lb. per sq. in.
Average	178 lb. per sq. in.
A. S. M. E. Code Rule	72 lb. per sq. in.

100½ In. Length. 3 Sections. 24 In. Diameter. ⅜-In. Plate

	Working pressure
Hutton's Rule	137 lb. per sq. in.
Lloyd's Rule	188 lb. per sq. in.
U. S. Government Rule	167 lb. per sq. in.
Average	164 lb. per sq. in.
A. S. M. E. Boiler Code Rule	63 lb. per sq. in.

H. J. Vander Eb.

Hartford, Conn.

Friction Screw Presses

To the Editor:

In the July, 1916, issue of The Journal attention is called to an article treating Pressure Developed by Friction Screw Presses, which appeared in one of the trade papers.

While my firm furnished the author at his request some photographs showing the presses it manufactures, I do not

wish the impression to prevail that the theory developed covers our conception of the subject, and that the value of our product be gaged thereby.

Practically every deduction of the author is wrong and the readers of The Journal may be misled by this article.

The formula for the coefficient of efficiency of the screw is unnecessarily complicated and moreover not correct as it assumes that the end-thrust friction acts on a lever r_2 while only $2r_2/3$ should be used.

The formula should have the following form:

$$N = \frac{t_g\ \alpha}{t_g\ (\ \alpha + \varsigma\ ) + \dfrac{2\ Fr_2}{3\ v_1}}$$

α = mean angle of thread.
ς = angle of friction.
F = coefficient of friction.
r_1 = radius of screw.
r_2 = radius of thrust pivot.

The other formulae, such as those of the energy of the flywheel and pressure developed, are also incorrect.

In the example the author accomplished the remarkable feat of calculating the pressure developed by a press by using a formula containing a constant based upon the dimensions and physical properties of the workpiece, and obtains this constant from the dimensions of the press.

Newark, N. J. E. W. Zeh.

Systematic Committee Work in Technical Societies

To the Editor:

The paper submitted by Mr. Hathaway on a Proposed Plan for the Activities of the Machine Shop Practice Sub-Committee of The American Society of Mechanical Engineers[1] contains certain suggestions that have a far wider scope than his title indicates. While, therefore, the discussion below has been brought out by his paper, I would prefer a more representative title, such as Systematic Committee Work in Technical Societies, with Special Reference to Research Work.

Mr. Hathaway says: "The proceedings of such (scientific and technical) societies should provide authoritative and usable data covering the entire range of activities in their respective fields."

Farther on Mr. Hathaway, in elaborating on his idea, says: "A second and even larger undertaking would be the prosecution along predetermined lines of research that would result in definite advancement of the art. At present this is almost entirely left to the enterprise of individuals or companies and there is no coördination of effort."

To a certain extent work of this sort is already being carried on by various societies, including our own. In order to write more by the card I shall confine myself at first to our own work.

We have within our Society:

The Committee on Technical Research. This is the logical agency to which investigation and experimentation for advancing the arts should be entrusted. Special work is naturally carried on by suitable sub-committees created from time to time and existing until their work is completed and gathered into a final report. The main Committee itself should be a permanent or "Standing" one.

We already have a *Research Committee.* As a research committee it is and can be little more than a name. Research and no funds make a poor combination. That is a joke and a rather *poor* joke at that, whether taken in the literal or punning sense. This is no doubt partly because the Committee is not active and does not ask for adequate funds, and it probably does not ask for funds because it is doubtful of those being granted. Inverting the old saw is also a truth: "Ask not and ye shall receive not." It is expecting too much of a Finance Committee to have to provide in its budget, already unable to comply with demands, for funds not asked for. Even so, the Finance Committee does recognize the Reseach Committee's needs by providing the munificent sum of $300.00. (See the report on page 1018 of the December Journal.)

The various *Standards Committees* provide another agency within our Society that does sometimes concern itself with certain phases involving research, but in too haphazard and uncorrelated a manner to secure the best work at the least cost. While standardization is necessarily based more or less on research, research *per se* is not a function of standardization.

Special Committees are occasionally appointed to deal with certain definite subjects, not standards. In much of their work they could be aided by an adequate Research Committee.

A Suggested Plan. We already have a Research Committee. This should be a general supervising committee, not one that actually carries on research. It should originate or pass on projects for research brought to its notice and advise the Council as to the creating of sub-committees, each to deal with one special line only. It would supervise the work of the sub-committees and the expenditure of funds allotted them. It would, on occasion, bring about coöperation with other bodies from other societies, and secure coöperation of the Committees of our own Society, such as certain Standards and other Special Committees. As to funds, these should be allotted as liberally as our budget permits; it is reasonably fair to assume that funds will be furnished for researches that have a special as well as a general interest, without taxing the Society's budget. Care and tact will have to be exercised to guard against the Society's being improperly used and exploited and lending its name to private enterprise.

Precedents. Attention has already been called to the existence of these within our own organization, though limited, fragmentary and without real unity of purpose. The situation is similar in other societies. The British engineers have come nearer to good coöperation research in connection with the work of their Engineering Standards Committee, made up of representatives of the large engineering societies, coöperating with the great engineering firms and with the government.

Probably no one technical society comes nearer to taking care of the problem than the Verein Deutscher Ingenieure, possibly because that society has funds sufficient to enable it to carry on investigation. I can speak with some degree of familiarity of one example that comes within my personal knowledge and of which I was reminded by Mr. Hathaway's reference to Mr. Fred W. Taylor's work reported in his paper On the Art of Cutting Metals. In the early days when Mr. Taylor's high-speed steels, as well as those of Boehler Bros. and the Bismarck Huette, began to attract the attention of the builders and users of machine tools, the Verein recognized their enormous potentialities. A committee was formed, at first under the writer's chairmanship, and a program of experimentation was laid out. Uniform report sheets were dis-

[1] The Journal, December 1916, page 972.

tributed among the largest machine shops about Berlin, and on these was recorded during six months the tool history of all the regular work going through those shops. This enormous mass of data was then classified and digested. (Owing to the writer's being too fully engaged, he relinquished the chairmanship to the very able direction of Mr. Lasche, chief engineer of the Allgemeine Elektrizitäts Gesellschaft.) This gave exceedingly valuable information in connection with the average as well as the highest type of then existing machine tools. The ultimate possibilities of the steels as they were then were determined by a series of tests carried out directly under the writer at the works of the German Niles Tool Works Company, on heavy machine tools specially arranged with a very wide range of speeds, feeds and power. Special steel ingots for turning down were provided and many tons were reduced to chips. With these tools also researches were carried out along lines indicated by the digest of the data gathered in the various shops.

I refer to this somewhat at length to draw attention to the fact that it has been recognized by at least one engineering society that research of this character is quite within its province, that it should be coöperative rather than left to individual effort, that it can be effectively carried on by such coöperation, and that effective aid and coöperation for the general benefit can be secured also from private interests which are quite ready to recognize that though their aid is to some extent altruistic, it is also, as are most truly altruistic efforts, directly beneficial from a personally selfish viewpoint; and that is why such research work, properly undertaken and organized, may count on financial support that need in no way embarrass the Society.

Henry Hess.

Philadelphia, Pa.

Impact or Shear Tests

To the Editor:

In a letter on Impact or Shear Tests published on page 1001 of the December, 1916, issue of The Journal, Mr. John Younger quotes myself as pointing out, in a paper before the American Society for Testing Materials, that "it was very strange that ingot iron or very-low-carbon steel showed greater energy necessary to shear than did the higher-grade chrome-nickel alloy."

The exact words of my paper on Impact Testing, read before that society, were as follows: "By comparing Tables II and III it will be seen that there is no easily discovered relation between the results of impact tests and those of tension tests. For example, ingot iron with low tensile strength and high ductility gives nearly as good impact results as the chrome-nickel steel of high tensile strength and rather low ductility."

No other comment is needed than a comparison of the above quotation with Mr. Younger's indirect quotation.

D. J. McAdam, Jr.

Annapolis, Md.

Engineering Societies and Public Affairs

To the Editor:

Mr. W. Herman Greul's communication appearing in the November issue of The Journal has my decided interest. Mr. Greul has apparently entirely missed or, rather, misconstrued my suggestions on "the relation of engineering societies to public affairs." As a matter of fact, Mr. Greul is far more in accord with my position than he seems to realize. Nowhere did I suggest that the engineer or the engineering societies should adopt the "wait-till-they-ask-me" position.

Quite the contrary, it is distinctively the function of the engineering societies to concern themselves with public affairs and I have advocated that, but to restrict that concern to the engineering phase while steering clear of politics.

Possibly the strongest proof of this situation is the A.S.M.E. Boiler Code matter that I also cited in my original communication. The American Society of Mechanical Engineers, in association with other engineering bodies, not only did not wait until it had been approached, but it took the initiative in working up a basic engineering code governing the construction of boilers. The thing that the Society did not do in this connection, and upon which the Society has gone on record as being outside of its province, was the formulating of laws relating to the adoption of the Code by municipalities and legislatures.

Those who are most familiar with the work that the Society did do in the working up of this Code, those who know of the weeks of continuous sessions, frequently lasting late into the night, that the original Committee and its consulting committee held, will be most emphatic in their conviction that the Society did, of its own initiative and from within, undertake most vitally constructive work connected with public affairs.

It is rather difficult to see just how this attitude of the Society can be interpreted as the engineering societies' being "afraid they cannot measure up to the requirements of such a progressive attitude" and "stay on our pedestal where we will not encounter the difficulties of constructive, aggressive work." Surely if ever any constructive work was done by an engineering society, this Boiler Code deserves that name; such constructive work was distinctly and most decidedly constructive engineering, and it would be difficult to see in what way the engineering societies can be of more use to the community than along just such lines; and it is work of this sort which was most distinctly advocated in my article.

Henry Hess.

Philadelphia, Pa.

In the *Journal of The Franklin Institute,* January 1917, is described a machine of high precision for testing the speed and efficiency of shutters in photographic apparatus, developed by the research laboratory of the Ansco Company. In this machine a simple method has been found to overcome the difficulty due to overlapping of the image in the case of shutter exposures of more than 1/50 sec.

In *The Engineer,* December 29, 1916, is presented a brief description of reinforced-concrete floating structures which have been widely employed of late. In the past, similar structures were built but they were not intended to float continuously. The article, among other things, recalls the fact that as early as 1912 a pontoon was built for the Manchester Ship Canal 100 ft. long and 28 ft. wide, to draw about 5 ft. 6 in. of water when fully loaded, and to act as a movable pumping plant which is shifted from place to place as may be desired and which is used for pumping material dredged from the canal on to any low-lying land near the banks which it may have been decided to raise.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

The features of the month just closed are the meeting of the Civil Engineers in the Engineering Societies Building, noted elsewhere in this issue, and the President's visit to the Sections.

The former means much to your Secretary for the reason that it was his privilege, fifteen years ago, to receive the gift of $1,500,000 from Mr. Carnegie for the Engineering Societies Building. This was addressed to the four engineering societies and the Engineers Club jointly, and on account of the unwillingness of the Civil Engineers to accept at that time, the whole gift was jeopardized until Mr. Carnegie consented to readdress his gift to the other organizations omitting the Civil Engineers.

The President has undertaken to visit all of the Sections at some time during his administration and by that act develop a national interest and spirit. In addition to his visits made to the Sections this month, reported elsewhere in this issue, he has also addressed a number of other organizations, and the underlying thought in all of these addresses has been to emphasize the service of the individual to society.

Calvin W. Rice, *Secretary.*

Council Notes

The regular meeting date of the Council has been changed to the third Friday of the month, in January falling on the 19th. There were present at this meeting, Ira N. Hollis, President, presiding, C. H. Benjamin, W. B. Jackson, C. T. Plunkett, Charles T. Main, Arthur M. Greene, Jr., R. H. Fernald, John A. Stevens, D. S. Jacobus, Wm. H. Wiley, *Treasurer,* Max Toltz, F. R. Hutton, Calvin W. Rice, *Secretary* and R. M. Dixon, *Chairman Finance Committee.*

L. P. Alford, F. E. Rogers and George B. Brand were appointed a Committee on Award of the Junior Prize for 1917, and W. D. Ennis, D. S. Kimball, and F. R. Hutton were appointed a Committee on Award of Student Prizes for 1917. Particulars of these awards appear elsewhere in this issue.

The Council has approved the setting ahead one day of the Spring Meeting, 1917, to permit of a joint session with the Machine Tool Builders Association. The meeting will be held in Cincinnati, May 21 to 24.

The Boiler Code Committee has been reappointed for 1917. This committee has lost by death H. G. Stott and one member by resignation.

The President announced the following appointments on Standing Committees of the Society:

Finance............W. E. Symons, to serve for 5 years
Meetings..........A. L. DeLeeuw, to serve for 5 years
Publication......George J. Foran, to serve for 5 years
Membership..W. C. Morris, to serve for 4 years, Nicholas S. Hill, to serve for 4 years
Library............A. M. Hunt, to serve for 4 years
House..............H. O. Pond, to serve for 5 years
Research........Albert Kingsbury, to serve for 5 years
Public Relations....................To be appointed
Constitution and By-Laws....Ira H. Woolson, to serve for 4 years, Jesse M. Smith, to serve for 5 years
Standardization......Henry Hess, to serve for 5 years

I. E. Moultrop has been appointed on the Board of Trustees of United Engineering Society, to fill the vacancy in the Society's representation on the Board caused by the death of Mr. Stott.

A special committee consisting of J. W. Lieb, F. R. Hutton and D. S. Jacobus was appointed to prepare resolutions in token of appreciation of the signal contribution to the society's work rendered by Mr. Stott in his service as an officer of the Society, as a member of professional committees, and as the Society's representative in many undertakings.

Special resolutions were recorded thanking the Engineering Foundation, and in turn the Founder Societies, for the assistance which has been given to the National Research Council in its work. These resolutions follow:

Whereas The Engineering Foundation, administered by the American Society of Civil Engineers, the American Institute of Mining Engineers, The American Society of Mechanical Engineeers and the American Institute of Electrical Engineers, out of public spirit and with a desire to increase the intimacy of the relations between the research workers and the engineers of the United States, has generously put its whole resources, its office facilities and the services of its Executive Secretary at the disposal of the National Research Council in order to assist the federation and coördination of governmental, educational, industrial and other agencies of research, and

Whereas the assistance of The Engineering Foundation thus tendered has been gratefully accepted; now, therefore, be it

Resolved, That the thanks of the National Research Council for this assistance be hereby expressed to The Engineering Foundation and through it to the United Engineering Society and to the American Society of Civil Engineers, the American Institute of Mining Engineers, The American Society of Mechanical Engineeers and the American Institute of Electrical Engineers, and it is further

Resolved, That the National Research Council reciprocates and hereby expresses the desire for closer relations between the research workers of the United States and the members of the engineering profession constituting the national engineering bodies, and it is further

Resolved, That the Secretary of the National Research Council be instructed to transmit a copy of these resolutions to The Engineering Foundation, to the United Engineering Society and to the governing bodies of the national engineering societies above mentioned.

Attest Cary T. Hutchinson, *Secretary.*

W. B. Jackson, member of the Council and past-president of Board of Directors of the Western Society of Engineers, presented the request of that society that the Council appoint two representatives on the Washington Award administered by the society to be annually presented to an engineer whose work in some special instance, or whose services in general have been noteworthy for their merit in promoting the public good. The President has been requested to nominate two such representatives.

Calvin W. Rice, *Secretary.*

CIVIL ENGINEERS MEET IN ENGINEERING SOCIETIES BUILDING

THE Sixty-Fourth Annual Meeting of the American Society of Civil Engineers, now a Founder Society, was, by invitation of the United Engineering Society, held in the Engineering Societies Building. Plans of the addition to the building to house the Civil Engineers and a model showing how the building will look when completed were available at the meeting for inspection. The meeting was held on January 17 and 18.

In calling the meeting to order, President Clemens Herschel introduced Mr. Charles F. Rand, President of the United Engineering Society, who "welcomed the Civil Engineers to their own home." Mr. Rand said:

"As one who has looked forward very earnestly to this day and who has made a modest effort in favor of the new arrangements, it is a peculiar satisfaction to be the representative of the Trustees of the United Engineering Society and to welcome you on the occasion of your first meeting in this building in which you now own a quarter interest.

"As this is your annual meeting, I cannot take your time for extended remarks, yet it seems proper that I should call attention to a few facts respecting the United Engineering Society with which you are now identified.

"The U.E.S. exists for the purpose of holding the legal title to certain of the property of the Societies of Civil, Mining, Mechanical and Electrical Engineers, and to act for them in certain matters. The value of its property, including real estate, the Library and the Reserve and Endowment Funds exceeds two million dollars, all free and clear.

"The total membership of the four Founder Societies is 29,000 and the membership of associate societies is 23,000, making a grand total of 52,000 engineers who now have headquarters in this building.

"As is well known the U.E.S. stands not over but under the Founder Societies. It is organized to perform for the Founder Societies certain specific acts which are governed by contracts. There is no merger of societies, each retains its individuality. The U.E.S. enables the Founder Societies to coöperate conveniently.

"The Engineering Foundation is a fund of $200,000 belonging to the U.E.S., established for engineering research with a gift from Ambrose Swasey; this fund it is hoped will soon be increased many times.

"The great Library now includes that of the Civil Engineers and contains approximately 75,000 bound volumes and 50,000 unbound volumes. It is believed to be the largest engineering collection in the world. Plans have been made for the development of the Library which contemplate the expenditure of $50,000 annually. At present the societies can only afford to spend $20,000 per year. The Library has an endowment of $100,000. This we hope may soon amount to one million dollars, as the Library needs the income from that sum.

"The United Engineering Society has been established thirteen years. It was originally developed through the efforts of the Societies of Mining, Mechanical and Electrical Engineers. To this organization the American Society of Civil Engineers has joined its strength and prestige and takes a leading part.

"Your new home is being rapidly prepared for you and will be ready during the current year. The six months of intimate association and cordial coöperation we have already had with the officers of your society indicates that a move has been taken of great value and importance to engineers.

"Gentlemen, welcome to your own home."

The professional program of the meeting was devoted to the presentation of the annual reports and the reports from several special committees and the election of officers for the ensuing year. The new officers are: George H. Pegram, president; Alfred Craven, George W. Kittredge, Palmer C. Ricketts and George S. Webster, vice-presidents; George W. Tillson, treasurer, and Charles Warren Hunt, secretary.

Among the reports was that of the Special Committee to Formulate Principles and Methods for the Valuation of Railroad Property and other Public Utilities. This report is the result of five years' work on the part of a committee of nine, who have held forty-eight joint meetings, many of them consisting of three sessions, and who have carried on a voluminous correspondence, aggregating thirteen substantial volumes. This report is of particular interest to our own membership, coming out, as it does, so soon after our own discussion at the Annual Meeting of this important subject. Those of our members who are particularly interested will find this report very helpful in clarifying this subject.

The entertainment part of the program included an inspection of the new Broadway subway in New York City, a visit to Hell Gate Bridge, and an excursion on the East and Hudson Rivers.

THE PRESS ON THE ANNUAL MEETING

THE Annual Meeting of the Society and the papers and discussions were reported by the daily as well as the technical press, some editions assigning prominent positions and considerable space. We believe that the increased attention given by the press reflects in a direct way the increasing importance of the engineer in the affairs of the State, economic as well as industrial. As to the general result of the Annual Meeting, *The Iron Trade Review* says, "In attendance, enthusiasm and general merit of the papers, the meeting surpassed those of past years," with which we are sure our members will be in entire agreement from their personal experience, for this was without doubt the most successful meeting we ever held. In saying this, we must not overlook, however, that there are several factors which contributed to this result, one of which undoubtedly is that to a certain extent these are abnormal times. The European war has acted as a stimulant on our thoughts and energies, we are living in a time of intensified activity, expectant of the future and alert as to what it may bring us. Apart from preparedness campaigns, the reflex action of the war on our national life has been the cause of many economic and industrial developments, some of them taxing the ingenuity of the engineer to his uttermost capacity.

The Chattanooga *News* in its report of the meeting says, "Many people maintain that a great moral and spiritual revolution is now in progress which will change all the thoughts and actions of the world." Although this statement may be somewhat too sweeping, yet it contains some truth. Our outlook and our thoughts are undoubtedly undergoing a change, though we may not even know in what direction, but we are

in a very receptive state of mind at present, which engineers should hail as a splendid opportunity for the initiation and execution of improvements tending to our national advancement; and we believe engineers can be relied upon to do their share in this direction.

In their reports of the meeting, a number of journals and newspapers laid stress on the fact that the field of activity of the engineer is constantly broadening and that he is increasing his influence in all directions. If this means that wherever the engineer steps in, the work will be done more scientifically and more systematically than has been the custom, then this extension of his activity must certainly be welcomed as conducive to the good of the Nation as a whole and should be encouraged in every respect. We believe that the engineering profession will not commit itself light-heartedly to additional responsibilities, but, having accepted them, will not be found wanting. Our Society has always fostered that sense of responsibility in its members which is essential to success. These points are well summarized in *The Iron Trade Review,* which says in this connection; "That the engineer's influence is bound to extend far beyond the conventional limits of the profession was emphasized in the sessions of the 37th Annual Meeting of the Am.Soc.M.E. Scientific management, industrial valuation, safety regulations for cranes and boilers—all subjects outside the old recognized limits of mechanical engineering, claimed most of the attention of the 1500 members and guests of the Society in attendance. The feeling that the engineering profession must take up a large proportion of the burden of national affairs was expressed by several different speakers and the evidence that engineers are eager to assume this added responsibility was furnished by the unusual interest displayed in the subjects of general application." We believe that this accurately expresses the consensus of opinion of the meeting.

Not only is the activity of the engineer extending in all directions, but also the range of subjects before the Society shows a broadening out and extension into the multitudinous ramifications of subjects hitherto somewhat foreign to the engineer. The press took general note of this, *The Iron Age* saying in this connection: "The efficiency of the manager, more about the human factor in industries, the need of a means of collating machine-shop information for the common good, and the undeveloped but necessary place of the mechanical engineer in industrial preparedness were conspicuous topics in the discussions." Thus the engineer not only does things but he endeavors to go to the bottom and find out how to do them best, which in a broader sense means that he is more and more departing from the individualistic standpoint and is learning to view things more from a sociological or national standpoint, even though he would seemingly depart from his customary field of action. "The surprising thing," says the Chattanooga *News,* "was the emphasis placed in many of the papers upon the moral and social aspect." This is a frank recognition of the fact that in the mind of the engineer the financial aspect is giving place to more altruistic ideals. This displacement of finance from supremacy, it will be remembered, was very tersely expressed by Mr. Gantt in his paper when he substituted the "ability to do things" for the "ability to buy things," making the financier give place to the engineer.

With regards to comments on papers before the meeting, the address of Dr. D. S. Jacobus, our retiring president, on Education in Engineering, was very generally quoted and commented on, the recommendations in it receiving unqualified endorsement.

Professor Cathcart's paper on the Development of our Fleet and Naval Stations attracted wide attention. This paper was very prominently announced by such captions as "More Naval Bases Urged," "Charleston Recommended as a Naval Base," "Naval Stations are Inadequate," "Speakers Deplore Lack of Adequate U. S. Naval Stations," "Woeful Unpreparedness on U. S. Coast Depicted," "U. S. Navy far below par in Stations and Destroyers," "South's Lack of Stations is Discussed," "Lack of Bases puts Navy in Peril," "Cathcart's Warning sent to Congressmen;" one of the papers pointing out that it was the best paper produced on the subject in recent years and would certainly receive the attention of the Government. Professor Cathcart's paper is published in this issue of The Journal.

Extensive quotations also appeared from the other papers; there was not a single paper which did not arouse interest in some quarters, though it is also fair to say that some of the papers have not received so far the attention which they merit and it is to be hoped that in due course the technical press will also do justice to these.

PRESIDENT HOLLIS SPEAKS AT CLEVELAND

On January 2, Dr. Ira N. Hollis, President of the Am.Soc.M.E., addressed the Cleveland Chamber of Commerce on the subject of Efficiency and Democracy, in which he advocated, instead of military conscription so prominent before the public in connection with preparedness, a conscription of the whole youthful population to form an army "enlisted against nature." Such an army would, for instance, supply the labor for building the Lincoln Highway across the continent, etc., and there are a thousand other great utilities it might carry out. Dr. Hollis said in part:

EFFICIENCY AND DEMOCRACY

I can hardly claim to bring you a message from New England, as I come from the same side of the Alleghenies as you. My earliest association were with the soldiers of the Civil War and the memories of that time would lead me naturally to avoid war, yet, it is difficult to talk on any subject in America today without some mention of the greatest event in history, made doubly horrible by science and modern invention. We and the whole world are involved and we cannot escape from its consequences.

The great question before the world today is the relation of government to the individual and the attitude of the individual towards his own government. Many of us believe that the whole future of democracy is at stake and that unless democracy can develop as high a national efficiency as autocracy, it is doomed. That is fundamentally the question before the United States today.

What is efficiency? It has expanded as it has become more important in the past few years, and is now applied to nations as a whole. When we take the Century Dictionary definition, namely, "a quality or power of producing desired or intended effects," it is applicable to nations as well as individuals. Another definition is "the state of being able or competent, the state of possessing or having acquired knowledge or skill in any act or profession." In the technical sense the word has a mathematical significance: it is the ratio of useful work to the total energy expended in producing it. This is perhaps the best definition, for it calls attention to the essential of efficiency, the saving of waste in energy and materials. When one stops to investigate our criminal waste of food, our lavish expenditure of time and money on useless things, and our failure to fit transportation into

the distribution of the commonest necessities for great cities, one would almost condemn us as the most inefficient nation on earth.

A few years ago Mr. Frederick W. Taylor undertook investigations to determine with accuracy the best system for workmen as well as for tools. The results ultimately grew into "scientific management," so called by Louis Brandeis, in order to direct the mind effectually to the essentials of the method: viz., getting the maximum return in manufacture for a given expenditure of time, money and effort, by the scientific planning and allotment of tasks to every tool and employee. Under Mr. Taylor's development of the subject we have always the idea of the manufactured product, but the term is capable of a much larger application in relation to communities or nations as a whole. The true meaning of efficiency, in a larger sense, is the regulation of one's life so that society shall receive the maximum return in service and in happiness.

The application of the word efficiency to our government is better brought out in connection with the real meaning of the term democracy. Abraham Lincoln defined it for all time in the words "government of the people, by the people, and for the people." It makes no difference what the head of the State may be called, so long as his definition holds. Presidents and kings alike, are equally powerful, or equally powerless, when the rules are made by the people themselves. After all, there are only two forms of government, one by the few, aristocracy, and the other by the many, democracy.

In discussing the comparative merits of the two governments democracy, as illustrated by the United States, and aristocracy, as illustrated by Germany, Americans are not always judicial. They are either unduly confident or over-sceptical as to the future of our form of government.

Is it true that efficiency is best developed under democracy and that in the long run a nation is stronger against war with the individual initiative there taught than it could be under an autocracy? Any American would naturally say yes, in the belief that men do better what they consent and wish to do, than when they act under compulsion. But we should be utterly mistaken if we judged the German nation by that measure. In contrasting Germany with the United States we have been too quick to take it for granted that German citizens were acting under the compulsion of a military caste. If so, they have been able to hide the evidence of compulsion, because they have freely consented to conscription during the vast military organization under which their people have been prepared for war, and under which their advance in a material way has been beyond the power of the imagination.

Our own country was a very interesting example of the two types of government during the early years of the Civil War. The Southern Confederacy was practically an aristocracy, with a slaveholding class who took all the offices, and a great population of whites and slaves accustomed to guidance by a governing class. At the outset of the Civil War they were more efficient than the North. It took the North a long time to organize, and it was not until after Vicksburg and Gettysburg that the Southern cause began to wane. The Northern armies had gradually been worn down into effectiveness and the administration had gone into the West, the most flagrantly democratic part of the country, for its commanding officers. This experience in our long war seems to justify the claim that democracy is strongest in the long run. I am a profound believer in democracy as Lincoln defined it. If stripped of certain ugly excrescences, it is the hope of man.

The Declaration of Independence states that all men are created equal, and that they are endowed by their Creator with certain inalienable rights; that among these are life, liberty, and the pursuit of happiness. We have by constant dwelling on the word "equality" twisted it out of the meaning that our forefathers intended to give it. As a matter of fact, the Declaration of Independence was the statement of a noble reaction against bondage in a feudal system, and it expresses fundamentally that men should be equal as to opportunity. It could never determine the equality of men as to physical and mental endowments. They are distinctly not equal and never have been, and no fiat can ever make them so. Nature has taken care of that. In our democracy, we should dwell on the equality of opportunity to serve.

On the court house in Worcester is this sentence, "Obedience to Law is Liberty." That obedience to law is a necessary element of true liberty has been the doctrine of philosophers since the dawn of recorded history. We cannot deny it and we know that our country's liberty is less for every violation or disregard of law.

The finest definition of a man's place in our democracy is found in the statement that here he will be permitted to develop himself to his maximum possibility in the service of mankind. Observe the word "permitted" to develop one's self. It signifies that the individual must learn how to use this permission before it becomes really of value to him

How far must the efficiency of the individual give way to the collective efficiency of a large number of individuals, or of the state? An engineer will understand the force of this question, because he is in the habit of effecting compromises in the selection of machinery for manufacturing or power purposes. In steamships, for instance, it is a well-known principle that a screw propeller generates its highest efficiency at a comparatively low speed of rotation, while a steam turbine is quite the opposite in reaching its higher efficiency at a very high rate of speed. When they are coupled together for propulsion, both must surrender something in order that their combined effort may produce the maximum result.

In the same way, every individual of every community should consider his conduct and his work as affecting all others with whom he is associated, and all others who live under the same flag. If his efficiency in business becomes so distorted that it interferes with the rights and the happiness of others, it must be curbed and checked so that the maximum of service and happiness will be found for all.

The chief danger to any democracy grows out of a false standard. We know in our hearts that the ideals of this country are clean and sound, and yet we stimulate enterprise and initiative by an appeal to the most selfish side of human nature. The patent laws, the entry of public land, and the rights to property, all good within limits, have produced most of the litigation because they are based on selfishness; and the worst of it is that few can see any other practicable or possible method of holding society together. It is a false standard and there is something better in our love of fair play, our charity to our neighbors, our passion to pay and our desire to serve. If we can only let them sway us in relation to our own government as in private life, the republic will be safe for all time and democracy will win the earth.

We have a very curious and striking illustration of liberty and efficiency in the acts of the trade unions. In the name of liberty they claim the right to organize against capital and then in the name of efficiency of organization, they demand the most slavish obedience from their members. There is no liberty in a trades union. Capital is not free from a similar failure to consider the true good of the state or community. The virtual control of property in the United States is in the hands of comparatively few men who have until lately paid no attention to public interests. There is little to choose between capital and labor in their indifference to the efficiency of the state and to the combined effectiveness of all. Between the two of them the public has small consideration, except to pay.

Has any healthy and mentally sound individual a place in any community to which he renders no service or where he makes no contribution to the welfare of the state? This sounds like harsh puritanism, and yet it is not when you stop to think about it. There is in machinery a quality known as hunting. It is found in the steam engine when the governor has a high initial resistance. If the speed increases and the governor does not act, the engine will run away until the governor does act; then it will act too much and carry the engine to the other extreme. This bad quality may be improved, but hunting is always present even in the turbines that supply your power and light. The engine is all the time hunting the average normal speed without ever finding it. In many respects humanity is like that, always striving and never attaining.

If I accomplish nothing else than to call your attention to an essay by William James, on the Moral Equivalent of War, I shall be satisfied with my visit to Cleveland. He has given us one of the noblest conceptions of man's future, and best of all the way out of blood and crime. In the first paragraph of his essay he says: "The military feelings are too deeply grounded to abdicate their place among our ideals until better substitutes are offered than the glory and shame that come to nations as well as to individuals from the ups and downs of politics and the vicissitudes of trade. There is something highly paradoxical in the modern man's relation to war. Ask all our millions, north and south, whether they would vote now (were such a thing possible) to have our war for the Union expunged from history, and the record

of a peaceful transition to the present time substituted for that of its marches and battles, and probably hardly a handful of eccentrics would say yes. Those ancestors, those efforts, those memories and legends, are the most ideal part of what we now own together, a sacred spiritual possession worth more than all the blood poured out. Yet ask those same people whether they would be willing in cold blood to start another civil war now to gain another similar possession, and not one man or woman would vote for the proposition."

What relation has this to the state of mind of the American people? We have had no end of discussion about national defense, the Army and Navy, and universal military service. War is clearly in the air and any one of several questions might bring it like a thunder clap. Not one man or woman would vote for it, but we are in the hands of fate. Will it be possible for any nation to remain neutral in the next war, or in this, if it lasts out another summer? I am a believer in thorough preparedness immediately, and yet I am persuaded that we have taken the public mind away from what should be the great ideal of our republic by emphasizing the word "military" at the expense of the word "service." It is service in every direction that is needed, and no young man can discharge his obligation to the state by a few months in camp. The whole matter hinges on a state of mind. Of course military training may form part of any collective training for the service of the country, but it is not the chief one.

Perhaps the settled idea of all this writing is found in the last sentence of the following paragraph: "The martial type of character can be bred without war. Strenuous honor and disinterestedness abound elsewhere. Priests and medical men are in a fashion educated to it, and we should all feel some degree of it imperative if we were conscious of our work as an obligatory service to the state." After all, it is Service that Mr. James is putting forward as the only antidote to decadence.

How can efficiency be promoted in a democracy? We must again keep in our minds the fact that there are two efficiencies: one, the efficiency of the individual; the other, the efficiency of the collective mass. Our efficiency as a whole will maintain the republic, but the efficiency of the individual acting alone will create such division as to destroy it. That of the individual is soundly promoted by complete freedom of speech, complete freedom of choice as to a career, and by a preservation of the ideals of service as distinguished from sense enjoyment. We have the first two of these eminently developed in the United States, but the last has been clouded over. We have leaned too much on literature and art as representing the higher things, in comparison with the utilities of life. As a matter of fact, neither one of them is worthy of consideration if carried to a debauch, and there is something far higher and more ennobling than either. We do not fix our high moral purpose by reading some beautiful piece of literature or looking at some great picture or by making a lot of money on some invention, but we get it by the experience of life, if that experience takes the proper perspective. It is Christ's conception of life and service that will give us efficiency as individuals in dealing with others. We are too easily misled by college professors into the belief that critical study forms the broadening and enlarging developer of man's soul and mind. Colleges have been comparatively inefficient in turning the mind towards that kind of universal service that will create in this country a united nation. The popular idea that colleges are failures in respect to public service is exaggerated, and yet one cannot but feel that they have achieved far less than might have been hoped from their claims of breadth and education.

As to the efficiency of the collective mass, my belief is that Professor James has suggested the best solution possible in the words: "If now there were, instead of military conscription, a conscription of the whole youthful population to form for a certain number of years a part of the army enlisted against nature, injustice would tend to be evened out and numerous other goods to the commonwealth would follow." It is not necessary here to suggest the elements of the warfare against nature; one of them, however, comes readily to mind. Suppose, instead of an appropriation of millions by the government of the United States and by the states to build the great Lincoln Highway across the continent, that the work on this highway were a free gift of our young men, under universal service, we should then have an enduring monument to love of country and an ennobling incentive to the right kind of patriotism. That great artery of commerce and recreation would hold memories of splendid achievement for generations to come and it would always bind the states far better than interstate laws.

The Lincoln Highway is only one of many things that can be offered by the youth of the country. There might be a Washington Highway from Maine to Texas passing through the mountains of Kentucky and Tennessee. The mind can suggest a thousand other great utilities. It has been claimed that service under the flag in Germany and France has served to educate the people. That is a pure preparation for war which has been going on during the past fifty years as the means of educating the masses. I do not believe for one instant that it offers half the stimulus that constructive service in peace would bring to our youth. All the discipline of the army can be found in the working party with the pick and shovel taking the place of the rifle.

The Army never will be in a satisfactory condition until we get rid of the dual control involved in the state-militia idea and substitute for it a citizen soldiery with only a nucleus of men permanently under arms. This involves of course the Swiss system or the Australian system of universal training, beginning in the public school and continuing for 10 or 15 years.

The appropriations are only stop gaps, however, and we must provide a lasting remedy for the loose, flabby ideas of service held by too many voters. Our main task is only begun, that of arousing a national spirit by every means in our power. Industrial preparedness is only a small part of it. Coöperation in everything is demanded, in education, in religion, in the industries and in citizenship, for the purpose of fusing this conglomerate population into a united, efficient and peaceful nation, capable of serving and advancing civilization. Let us do our share.

Junior and Student Prizes

The attention of Junior Members of the Am.Soc.M.E. and of members of its Student Branches is called to the prizes offered each year by the Society for the best paper by a Junior Member and for the two best papers by enrolled members of Student Branches. The former of these prizes is a cash prize of fifty dollars and engraved certificate, and the latter are cash prizes of twenty-five dollars each and engraved certificate.

The rules covering the award of these prizes are given in the Year Book of the Society, the 1917 Edition of which is about to be issued. The last date for submitting papers for consideration by the Committee on Awards this year is June 30, 1917.

Those who intend to participate in this competition should make their plans now so that their papers will be ready in ample time. They should select a subject of practical value and treat it in a simple, correct, clear and forcible manner. A subject might well be a description of a new mechanical invention or piece of engineering apparatus; an account of some original work in the laboratory, shop or classroom; a description of a new and novel piece of mechanical construction; a description of a novel modification to an existing plant; an explanation of plans or methods of proposed engineering work; a summary of present practice in a given mechanical field, or an argument for or against a particular mechanical apparatus, process, construction, etc.

The Secretary will be glad to furnish any information or to give any suggestions to those intending to compete for either of these prizes.

Correction

Mr. R. J. S. Pigott reports that the statement on page 1009 of the December issue that his "later work included the preliminary design and layout of the extension to the Seventy-Fourth Street Station" is incorrect. His work included not only the layout but also the actual construction and testing of this extension.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER MARCH 10, 1917

THE American Society of Mechanical Engineers is an organization for mutual service of over 7700 engineers and associates cooperating with engineers. The membership of the Society comprises Honorary Members, Members, Associates, Associate Members and Juniors, all elected by ballot of the Council. Application for membership is made on a regular form furnished by the Secretary which provides for a statement of the standing and professional experience of the applicant and requires references from voting members personally acquainted with the applicant. The requirements for admission to the various grades will be furnished upon request.

Below is the list of candidates who have filed applications for membership since the date of the last issue of The Journal. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate-Member or Junior, and those in the third class under Junior grade only. Applications for change of grading are also posted.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by March 10, 1917, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about April 15, 1917.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

Arizona

LANDRY, CALISTE F. A., Mechanical Engineer, Power Plant, Inspiration Cons. Copper Co., Globe

California

BANE, THURMAN H., 1st Lieutenant of Cavalry, U. S. Army, Aviation School, San Diego

Connecticut

EALES, WILLIAM P., Asst. Supt., Engineering and Inspection Div., Travelers Insurance Co., Hartford

District of Columbia

BROOKE, LLOYD A., Designing Draftsman, Ordnance Dpartment, U. S. Naval Gun Factory, Washington

Illinois

CARLSON, ADOLPH G., Chief Engineer, Universal Portland Cement Co., Chicago

HOWIND, H. ERNST, Checker, Mechanical Engineering Office, Illinois Central R. R. Co., Chicago

LINK, MAXIMILIAN W., Assistant Mechanical Expert, Crane Co., Chicago

NELSON, S. T., Superintendent, Chicago Plant, Sullivan Machinery Co., Chicago

PITTSFORD, WILLIAM A., Kewanee Boiler Co., Chicago

WILSON, JOSEPH B., Sales Department Engineer, Westinghouse Elec. & Mfg. Co., Chicago

Massachusetts

ANGIER, EDWARD H., President and Treasurer, Angier Mills, Ashland

ADAMS, COMFORT A., Professor of Electrical Engineering, Harvard University, Cambridge

BROWN, EDWARD C., Plant Engineer, Industrial Service & Equipment Co., Boston

CABOT, WALTER K., Assistant Manager and Mechanical Engineer, William Underwood Co., Boston

PUTNAM, ARTHUR D., Civil and Mechanical Engineer, Worcester Electric Light Co., Worcester

Minnesota

MILLER, STANLEY G., Vice-President, Crex Carpet Co., St. Paul

New Jersey

DAVIES, THOMAS H., Engineer in Charge, W. L. Dickinson High School, Jersey City

KAVANAGH, THOMAS J., General Superintendent, American Sugar Refining Co., Jersey City

MORGAN, JOHN D., Engineer, Inventory and Appraisal Dept., Public Service Elec. Co., Newark

PICKEL, HARRY A., Superintendent of Power, Hercules Powder Co., Kenvil

New York

ABA, EUGENE, Tool Designer, Pierce Arrow Motor Car Co., Buffalo

ALLEN, JARED E., Superintendent Engineering Department, Oneida Community, Ltd., Oneida

ANTHONY, JAMES T., Assistant to President, American Arch Co., New York

BOWLES, HARDY, Civil Engineer, Eastern Terminal Div., The Texas Co., New York

CLOCK, ERNEST E., Chief Inspector, Engrg. and Fly Wheel Dept., Fidelity & Casualty Co., New York

COOKSON, ALFRED W., Maintenance Engineer, Morrow Mfg. Co., Elmira

RICHARDSON, FRANCIS J., Heating and Ventilating Inspector, Board of Education, New York

RIPLEY, CHARLES M., General Electric Co., Schenectady

Ohio

GROTHE, WALTER, Mchanical Engineer, National Carbon Co., Fremont

MONAHAN, WILLIAM H., JR., Chief Draftsman and Supt. of Cons., Whitaker-Glessner Co., Portsmouth

MOSHER, CLIFFORD C., General Manager, East Iron & Machinery Co., Lima

Pennsylvania

BOCKIUS, STEHMAN A., Sales and Contracting Engineer, S. A. Bockius Co., Pittsburgh

KERSTING, ALBERT H., Charge of Ordnance Inspection Dept., Bethlehem Steel Co., So. Bethlehem

PANCOAST, ALBERT, Vice-President and General Manager, Union Spring & Mfg. Co., New Kensington

WERA, EUGENE L. J., Draftsman, Westinghouse Machine Co., E. Pittsburgh

England

THORNTON, HENRY W., General Manager, Great Eastern Rwy., London, E. C.

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

California

MASSER, HARRY L., Head Draftsman, Southern California Gas Co., Los Angeles

SOMERVILLE, GEORGE N., Chief Draftsman, Skandia Pacific Oil Engine Co., Oakland

Connecticut

ADAMS, LYMAN D., Manager Mill Dept., The Wallace Barnes Co., Bristol

Delaware

HOOPES, EDGAR M., Chief Engineer, Board of Water Commissioners, Wilmington

Indiana

BURRESS, LOYD F., Superintendent Coke Ovens, Illinois Steel Co., Gary

HEIGN, HARRY B., Engineer, Indiana Public Service Commission, Indianapolis

Louisiana

DURR, GEORGE E., Engineer, General Fire Extinguisher Co., New Orleans

Massachusetts

ROBBINS, Walter C., Chief Checker of Designs, New England Westinghouse Co., Chicopee Falls
WILLIAMS, Silas, Engineer, New England Westinghouse Co., Springfield

Michigan

SHOEMAKER, Samuel S., Technical Assistant to Superintendent, Semet-Solvay Co., Detroit

Minnesota

CALL, Almon E., Assistant Engineer of Tests, Island Creek Coal Sales Co., Minneapolis
HUBBELL, Arthur C., Machine Designer, C. D. Enochs, Cons. Engr., Minneapolis

Missouri

GAUSS, Henry F., Assistant Mechanical Engineer, Operating Section, Water Div., Dept. of Public Utilities, St. Louis

Nebraska

KYHL, Louis C., Charge Drafting Office, American Smelting & Refining Co., Omaha

New Jersey

ALLEN, Abbott, Engineer, E. H. Mumford Co., Elizabeth

New York

APPELQUEST, Jerome A., Engineer in Charge, Syracuse Office, Ford, Buck & Sheldon, Inc., Syracuse
BLANCHARD, Edward J., Assistant Engineer, R. Martens & Co., Inc., New York
BOND, William L., Time Studies and Investigations, Remington Typewriter Works, Ilion
MOFFITT, Francis A., Senior Partner, B. O. Moffitt's Sons, Binghamton

Pennsylvania

JOHANNSEN, John F., Chief Tool Designer, Remington Arms Co., Eddystone
ROBERTSON, Arthur R., Erecting Engineer, Westinghouse Machine Co., E. Pittsburgh
RYAN, Frederick J., Manager of Eastern Office, Snyder Electric Furnace Co. of Chicago, Philadelphia
STRUBLE, George W., General Superintendent Redington Plants, Bethlehem Steel Co., So. Bethlehem
WADSWORTH, John F., Associate, Richard Irvin & Co., Erie

Wisconsin

SCHERNER, John, Mechanical Engineer, The Federal Rubber Co., Cudahy

India

ABRAHAM, Kodiate J., Chief Engineer and General Manager, The Eastern Rubber Mfg. Co., Tiruvalia, Travancore

FOR CONSIDERATION AS JUNIOR

California

BARNHART, George E., Chief Tester, Aviation Motors, Signal Corps Aviation School, San Diego

Connecticut

COOPER, William K., Efficiency Engineer, Winchester Repeating Arms Co., New Haven
SANFORD, Newton W., Overseer Production and Inspection, Drafting Room, Winchester Repeating Arms Co., New Haven
STIMMEL, Virgil B., Mechanical Draftsman, S. K. F. Ball Bearing Co., Hartford

Louisiana

MOSES, Walter B., Sales Engineer, A. M. Lockett & Co., Ltd., New Orleans

Maryland

GAIL, George W., Engineering Department, Bethlehem Steel Co., Sparrows' Point
LYON, Howard B., Instructor in Marine Engineering, U. S. Naval Academy, Annapolis

Massachusetts

GUTHRIE, John F., Mechancial Engineer, Arnold Print Works, North Adams

Michigan

ASHMUN, Louis H., Engineering Draftsman, Dow Chemical Co., Midland
HARRIS, Raymond B., Combustion Engineer, Detroit Edison Co., Detroit
STEWART, Earle H., Instructor, Michigan Agricultural College, East Lansing

Minnesota

SMITH, J. Edgar, Locomotive Designer, Great Northern Railway Co., St. Paul

New Jersey

HORTON, Marshal G., Cadet Engineer, Public Service Elec. Co., Newark

New York

KEENE, Albert R., Draftsman, Doehler Die Casting Co., Brooklyn
LORENZI, Otto, Engineering Department, Combustion Engineering Corp., New York
WILLIAMS, Samuel C., Export Department, J. P. Morgan & Co., New York
WUNSCH, Joseph W., Mechanical Engineer, Hanau Engineering Co., New York

Ohio

GIBBS, Charles W., Student, The Babcock & Wilcox Co., Barberton
GUEST, W. E., Efficiency Engineer, The American Tool Works Co., Cincinnati
OSTER, Eugene A., Mechanical Engineer, Ault & Wiborg Co., Cincinnati
PHILLIPS, Victor B., Engrg. Asst. to Superintendent of Power, The Cleveland Rwy. Co., Cleveland

Pennsylvania

FLANAGAN, Walter N., Superintendent, National Brush Washing Machine Co., Pittsburgh
KLOPP, Charles G., The Pittsburgh Crucible Co., Midland
SPIETH, Benjamin S., Apprentice, Westinghouse Mch. Co., Pittsburgh
WINTERLING, Clee C., Engineer Steam Engineering Department, Cambria Steel Co., Johnstown

Rhode Island

DUNBAR, Robert H., Mechanical and Hydraulic Engineer, Providence Engineering Works, Providence

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE MEMBER

Massachusetts

COVE, James R., Master Mechanic, Massachusetts Cotton Mills, Lowell

Ohio

BIDDISON, Pascal, Construction Engineer, Ohio Fuel Supply Co., Columbus

PROMOTION FROM JUNIOR

Connecticut

LINDQUIST, E. A., Superintendent, W. & B. Douglas, Middletown

Georgia

NOTT, Albin J., Mechanical Engineer, Central Georgia Power Co., Macon

Oklahoma

HACKSTAFF, John D., General Manager, Empire Pipeline Co., Bartlesville

Missouri

AZBE, Victor J., Member, Engineering Department, Anheuser Busch Brew. Assn., St. Louis

New York

GILSON, Harry W., Secretary-Treasurer, Vincent-Gilson Engrg. Co., New York
STEWART, Charles A., Engineer, Steel & Ordnance Corp., New York

SUMMARY

New Applications	88
Applications for change of grading:	
Promotion from Associate-Member	2
Promotion from Junior	6
Total	96

NECROLOGY

HENRY G. STOTT

Henry Gordon Stott, superintendent of motive power of the Interborough Rapid Transit Company and New York Railways Company of New York, died at his home in New Rochelle, January 15, 1917, after an illness of many months.

He was a native of the Orkney Islands, Scotland, where he was born in 1866. After a thorough grounding in the fundamentals at the hands of his father and elementary school instructors, he was enrolled as a student at the Watson Collegiate School, Edinburgh. On leaving this institution he entered the College of Arts and Sciences at Glasgow, and began a course in mechanical engineering and electricity, graduating in 1885. In the year previous he had entered the employ of the Electric Illuminating Company of Glasgow. Shortly after graduating he was made assistant electrician on board

Henry G. Stott

the steamship *Minia,* belonging to the Anglo-American Telegraph Company. For the next four and one-half years he was engaged with those duties, during the course of which he saw much service in connection with repairs to the cable lines of that company. In this period he undertook a number of experiments that resulted in the introduction of improved methods of handling cable repairs. He was also identified with the "duplexing" of the United States Cable Company's main cable (2750 knots), the longest duplex cable in the world.

In 1889 Mr. Stott was made assistant engineer of the Brush Electric Engineering Company's plant at Bournemouth, England. The following year he was offered a post by Hammond & Co. as assistant engineer in the construction of an underground cable and power plant at Madrid, Spain. He remained there until 1891, when he came to the United States to install an underground cable and conduit system for the Buffalo Light and Power Company (now the Buffalo General Electric Company). This work was completed with a degree of success that reflected very greatly to the credit of Mr. Stott, and as a result he was named engineer of the company, and during the next ten years was one of the most active figures in the industrial progress of Buffalo. During this period he designed and executed some notable construction work, including a power plant on Wilkeson Street, Buffalo.

His work attracted wide attention and in 1901 he was appointed superintendent of motive power of the Interborough Rapid Transit Company, New York City, a position which he filled with signal success. At the time he took up these duties the Interborough had not yet been organized, the company having the title of the Manhattan Railway Company. The post which Mr. Stott was called to had just been created, and it devolved upon him to organize the operating force, in connection with which he completed the Seventy-fourth Street power plant of the company, various sub-stations and transmission lines.

When the Manhattan system was amalgamated with the Interborough, in 1904, Mr. Stott was invited to retain his office with the new corporation. He accepted and immediately took over supervision of the construction of the power plant on Fifty-ninth Street. Since that time he has been constantly in charge of design, construction and operation of the power-generating stations and the distributing system of the Interborough, which comprehends both the subway, elevated and surface lines of New York City.

The plans for the electric-power system of the new subway lines have been developed under his supervision and the construction has progressed so far and bears so strongly the stamp of his work that when completed it will be a monument to him.

Mr. Stott was a firm believer in coöperation among engineers through the agency of the engineering societies. He was elected president of the American Institute of Electrical Engineers for the term of 1907 to 1908. He was a manager of The American Society of Mechanical Engineers from 1907 to 1910, and from 1911 to 1912, and he was vice-president of the Society from 1912 to 1914. He was a director of the American Society of Civil Engineers in 1911, and was vice-president and a trustee of the United Engineering Society at the time of his death.

In the American Institute of Electrical Engineers he was a member of the Standards Committees, the Public Policy Committee, the Committee on Development of Water Power, the United States National Committee of the International Electrotechnical Commission, the Power Stations Committee, the Committee on Economics of Electric Service and the Edison Medal Committee. He was one of the Institute representatives on the Joint Committee on the Metric System, of which he was an ardent advocate.

In the Mechanical Engineers, he served on the Special Committee on Pipe Thread Gages in 1913 and 1914, as chairman of the Committee on Flanges and Pipe Fittings from 1912 to 1914, as chairman of the Conference Committee on Electrical Engineering Standards in 1913 and 1914. He was a member of the Executive Committee of the Council in 1913 and 1914, a member of the Advisory Committee of the Boiler Code Committee, and in 1916 was appointed a member of the Standardization Committee. He represented the Society on the Board of Trustees of the United Engineering Society.

As a result of his unusually wide experience and extended research, Mr. Stott was called upon often to contribute papers to the various engineering societies. He was especially well known for his minute analysis of engineering problems. Among the large number of papers which he has written on his subjects are The Conversion and Distribution of Received Currents, Power Plant Economics, Notes on the Cost of Power, Steam Pipe Covering and Its Relation to Station Economy, Tests of a 15,000 Kilowatt Steam Engine Turbine Unit, Power Plant Design and Operation (a series), etc.

Mr. Stott was a remarkable figure in the engineering world because he was in the front rank of both electrical and mechanical engineers; because in both branches of the art he was a master of theory and practice, and because with these technical qualifications he combined a rare executive ability and power of inspiring the confidence of his employees and of bringing out the best that was in the men who worked for him.

W. S. F.

AUGUSTUS W. COLWELL

Augustus W. Colwell, who died in New York on January 2, 1917, was a member of one of the oldest families of mechanics in New York, a pioneer in the manufacture of sugar machinery of the modern type, and a man who was associated in many ways in the engineering development of the country during the past fifty years. He was the oldest son of Lewis Colwell, founder of the Colwell Iron Works, who started in business for himself in 1840 in a small foundry on Charles Street, New York. Among the important undertakings of the Colwell Iron Works was the establishment as an adjunct of the main business a ship building yard in Jersey City, where several of the Civil War monitors were constructed and many vessels of the United States Navy were prepared.

Mr. Colwell was born in New York City on February 5, 1842, and educated in the public schools and in the College of the City of New York. In 1861 he was apprenticed in his father's machine shop and foundry, starting in the drawing room and later working in the foundry as a moulder. He afterwards was general superintendent of the plant and spent portions of each winter in Cuba inspecting the erection of the company's sugar machinery and attending to new orders. On the death of his father he purchased the interests of the other heirs and became president and owner of the Colwell Iron Works, until 1906, when he retired from business. By his numerous inventions and by leading in advanced engineering and foundry practice, he became prominent in English, French and Spanish-speaking America as a manufacturer of sugar machinery, and apparatus for the manufacture of other products requiring the use of evaporators, as well as steam engines, pumping engines, and miscellaneous machinery.

Under his supervision the first successful diffusion battery for handling sugar cane liquors was erected and operated at the Louisiana Experimental Station located on Governor Warmoth's Magnolia Plantation on the Lower Coast. He was among the first to design and manufacture machinery to use bone char for refining sugar and used it at the plantation for refining direct in one process. He was a pioneer in the use of water tube boilers on sugar plantations in which bagasse was used as fuel. He patented a bagasse burner for this purpose and installed plants using this fuel on plantations in Cuba. His system of returning all exhausts and drips to the boiler house and utilizing the exhaust steam for the vacuum pan and triple effect was much sought for by the planters.

He also was one of the first engineers to advocate clarifiers, steam trains and centrifugals to take the place of the old open kettle direct-fired as used by the earlier sugar makers. He remodeled many old style plants on sugar plantations by supplying centrifugals to eliminate the molasses from the magna after it left the vacuum pan. By contrast, the old cone moulds and banana leaf moulds which were common at that time had to be stored for weeks in dark cellars and allowed to drain in order to eliminate the molasses.

A great deal of interesting work was done by Mr. Colwell in fields totally different from those which engaged his chief attention. He patented and erected for New York City refuse crematories which were used by the late Colonel Waring when he was Commissioner of Street Cleaning. He did the steel and iron work for a number of lighthouses erected on the Atlantic and Gulf coasts. He made many experiments for the United States Government in the interest of the sorghum industry, designing and operating the machinery, and also furnished much machinery for the glucose trade. It is interesting to note that Lewis Colwell, his father, was the first to use coal in a cupola to melt iron, and that similarly he was the first, in New York City, to use coke in a cupola.

During the Civil War, in spite of the fact that the Colwell Iron Works were actively engaged in Government work, Mr. Colwell enlisted twice with the 137th New York Volunteers and was honorably discharged as Color Sergeant. About 1886 he was made Commander for the term of two years of the John A. Dix Post 135 of the Grand Army of the Republic.

Mr. Colwell was one of the charter members of The American Society of Mechanical Engineers and signed the register at the first Annual Meeting. During the past ten years he traveled extensively, once around the world, once to the Orient and once to South America. He is survived by four sons, all following the engineering profession, and by a daughter.

ALFRED C. EINSTEIN

Alfred C. Einstein was born in Hoboken, N. J., in 1866. He received his elementary education in the St. Louis Public Schools, later graduating from the Manual Training School. He began a course in Washington University, but left before its completion, to become manager of a mining property in Silver City, N. M., which position he held for several years.

In 1891, Mr. Einstein returned to St. Louis to become president of the Consolidated Engineering Co., and held this office until 1894. During that period he succeeded in building forty different plants, including waterworks, steam plants and electric- and street-railway plants.

Between the years 1894 and 1896, he was vice-president and manager of the Paducah Electric Light and Street Railway Co., of Paducah, Ky. He sold out his interest in this company in 1896 and returned to St. Louis, where he purchased the Suburban Electric Light and Power Co. He also organized the St. Louis County Gas Co.

In 1904, he sold the Suburban Electric Light & Power Co. to the North America Co., and in 1906 purchased the King Electric Light Co., which later was merged with the Suburban Electric Light and Power Co. In 1911 he became vice-president and general manager of the Union Electric Light and Power Co., which office he held at his death, November 20, 1916.

Mr. Einstein had always taken an active interest in the business and civic affairs of St. Louis. He was the fourth vice-president of the Business Men's League, and was largely instrumental in bringing many conventions to St. Louis. He became an Associate-Member of the Society in 1905.

THOMAS HATTERSLEY BELCHER

Thomas Hattersley Belcher was born in Newark, N. J., in December 1876. He was educated in the Newark High School and later in the technical and mechanical drawing schools. His early experience in mechanical work was obtained while in the employ of Cyrus Currier & Sons, Newark, N. J. In 1900 he affiliated with A. & F. Brown Co., as engineer and superintendent of installations of power transmission equipment in manufacturing plants. In 1904 he became assistant chief engineer of that concern. Between 1906 and 1913 he was with the Chicago Coated Board Co. as general mechanical superintendent. In May 1913 he became engineer and representative for the Black-Clawson Co., Hamilton, O., resigning after two years, to become manager of the Carthage Machine Co., of Carthage, N. Y. His death occurred Nov. 7, 1916, while acting in this capacity. He became a Member of the Society in 1913.

FREDERICK W. HOLMGREN

Frederick W. Holmgren was born December 29, 1891, in Brooklyn, and died there December 29, 1916. He received his early education in the Brooklyn Public Schools and attended Manual Training High School for a time. After leaving school, he took an evening course at the Brooklyn Polytechnic Institute, working in the projectile department of the E. W. Bliss Co., Brooklyn, during the day. He received his degree of Mechanical Engineer from that institution in June, 1914. He remained with E. W. Bliss Co. for a time after his graduation, resigning to enter into partnership with the Berggren & Pearson Machine Co. of New York, with which concern he was affiliated at the time of his death. He was elected to Junior Membership in the Society in November, 1915.

NAPOLEON DuBRUL

Napoleon DuBrul was born in Montreal, Canada, on June 22, 1846, and died in Cincinnati, October 23, 1916. At the age of fourteen, he became apprentice in the Gilbert Machine Shop. In 1866 he went to Chicago where he invented the tin cigar mold and later the tin-lined wooden cigar mold. He removed to Cincinnati in 1872 and in 1879 became a member of the firm of Miller, DuBrul & Peters Mfg. Co. In 1893 the members of the firm bought and reorganized the Anniston Pipe and Foundry Co., of Anniston, Ala., which was later consolidated with the American Pipe & Foundry Co. of Chattanooga, Tenn., and in turn was sold to the U. S. Cast Iron Pipe & Foundry Co.

Mr. DuBrul devoted his inventive skill to the development of machinery for making cigar molds. He designed, patented and marketed many different machines and appliances used in the cigar business in all countries of the world.

He became a Member of the Society in 1900 and was a member of the Business Men's Club and the Queen Club of Cincinnati.

WILLIAM L'E. MAHON

William L'E. Mahon was born in Detroit, Mich., June 19, 1861. His education was secured at the University of Michigan, succeeded by a course at the Massachusetts Institute of Technology. He specialized in marine-engine-construction work, beginning as an apprentice in the Dry Dock Engine Works in Detroit, and being later engaged as mechanical engineer and chief draftsman with the Frontier Iron & Brass Works, later acting as assistant superintendent on construction of heavy marine engines with the same works, and subsequently with the Brown Hoisting Machinery Company of Cleveland, O., with which company he continued several years.

Mr. Mahon was also connected several years with the New York office of Taylor Wharton Iron & Steel Company, of High Bridge, N. J., later representing them in the Pacific Northwest. It was while engaged in work with the last-named company, with headquarters at Butte, Montana, that he died, October 6, 1916, at Ogden, Utah.

Mr. Mahon was a member of the Technology Club of New York and became a member of this Society in May, 1889.

AMONG THE SECTIONS

DURING the month just closed, President Hollis has visited the Sections at Detroit, Chicago, Milwaukee, New Orleans, Birmingham and Atlanta, also the Student Branches at Purdue University and the Georgia School of Technology. In his tour of these Sections and Branches, President Hollis spoke in addition at the Cleveland Chamber of Commerce and the Detroit Chamber of Commerce, and addressed the students at Tulane University. Dr. Hollis' message to these Sections and Branches is published below, embodied in the reports of the meetings which he addressed.

Our two new sections, at Erie and Indianapolis respectively, both report progress in their plans of activities. At Indianapolis an Engineers Club is being organized and this will be an affiliation of the several local engineering organizations, including our own Section. At Erie, the new Section is putting into effect plans for securing a substantial membership. This Section will work in close coöperation with the existing local engineers' society, the Engineers Society of Western Pennsylvania, and a committee consisting of R. F. Benzinger, chairman, H. N. Dodge and F. P. Klund, has been appointed to work out the exact relations between our Section and the local society.

The New Year has brought the Providence Engineering Society a long and varied monthly program. The society is to be congratulated on its endeavor to make this year a banner year for the engineering profession in Rhode Island. No less than five meetings of the society were held in January, at two of which new sections, a Power Section and a Municipal Highway and Water Supply Section, were formed.

SECTION MEETINGS

BALTIMORE, DECEMBER 13

At a meeting of the Baltimore Section on December 13, 1916, a report of the committee handling the organization of the Associated Technical Societies was considered. This association is to consist of eight branches of national societies in Baltimore and other societies duly elected by the Board of Governors. Its purposes are to advance the interests of all technical organizations through coöperation, to promote goodwill and fellowship between the members of the various societies and to present for discussion and action, subjects of common interest, thereby strengthening the influence of technical men in matters of public welfare. The governing board will consist of the presidents of the member organizations. The individual sections will continue

to hold their separate meetings as heretofore, but members of any member section will be privileged to attend meetings of any other member section as guests. F. M. Chatard was appointed fifth member of the executive committee and H. Garner, A. Kennedy and E. B. Passano were appointed a meetings committee.

During the latter part of the evening Captain F. H. Wagner gave an address on the Recovery and Use of By-Products from Coal Tar. He illustrated the various processes of gas manufacture and by-product recovery and outlined the production of intermediates and final products. He described what had been done in this country in the development of benzol plants, aniline dye plants and plants for the production of explosives, illustrating by slides the apparatus and processes. At the close of the lecture American coal tar by-products were exhibited.

A. G. Christie,
Section Secretary.

BUFFALO, JANUARY 3

On January 3, 1917, over two hundred and fifty engineers, mechanical, electrical, civil, motor-car and others, celebrated the first convivial night of the Buffalo Engineering Society, and made merry until well after midnight.

Paul Wright,
Section Secretary.

BUFFALO, JANUARY 17

Highway Bridges was the subject of Chas. M. Spofford's address before the Engineering Society of Buffalo on January 17, 1917. He told of the great opportunity for engineers in the matter of standardization of the width of all bridges to be built, and quoted figures which proved that the increase in highway traffic during the last few years called for wider bridges. Relative to Buffalo's condemnation of several viaducts because of the effect of corrosion upon the floor supports, he claimed this was caused mostly by the forming of gas pockets in the understructures of railroad bridges. By means of lantern slides, Mr. Spofford showed various types of bridges, analyzing each design and describing various types of wearing surfaces and supports for wearing surfaces and the distribution of loads.

Frank D. Jackson, engineer of bridges and viaducts of Buffalo, followed Mr. Spofford with some of his experiences with bridges. He too advocated smooth understructures so as to eliminate gas pockets, stating that Buffalo had practically eliminated corrosion by applying red lead, sand and cement to the understructures of street viaducts.

Louis J. Foley,
Assistant to Secretary.

CHICAGO, JANUARY 5

Dr. Hollis addressed the Chicago Section at their meeting January 5, 1917, on the status of the engineer and his relation to society. His plea was for the recognition of engineering as a learned profession on an equality with medicine, law and theology. He outlined the difference between the various professions in their relation to the welfare of society. To him engineering is a constructive profession working for the welfare of humanity. He cited Eli Whitney and James Watt as instances where the work of individual men had changed the entire aspect of social and business life. Well's dictum "The history of humanity is the history of man's attainment to external power." he intepreted in the sense that the history of mankind is the history of invention, and invention is at bottom the practical expression of man's desire to benefit his fellow men.

Dr. Hollis concluded his remarks by outlining the relations that should exist betweeen the various local Sections of the Am.Soc. M.E. and other existing organizations of engineers in the same locality. He encouraged closer relations between such groups of engineers and held that the ultimate good of engineering demanded the closest coöperation of such organizations.

Robert E. Thayer,
Section Secretary.

CINCINNATI, DECEMBER 21

The Concrete Bridges and Viaducts of Cincinnati was the subject of the paper by Frank L. Raschig at a joint meeting of the Cincinnati Section and the Engineers' Club of Cincinnati, December 21, 1916. In outlining the activity of Cincinnati in the way of bridge and viaduct building, the speaker stated that since 1910 the city has expended about $2,000,000 for concrete bridges and viaducts. Four viaducts and fifteen bridges of lesser importance have been built and thirty small concrete bridges have replaced wooden structures. It is the settled policy of the Engineering Department of the city to build only concrete bridges and viaducts in the future, unless absolutely impracticable.

The Gilbert Avenue viaduct consists of 30-ft. spans of column, beam and slab construction, the entire structure supported on concrete piles. The structure is about 1200 ft. long and 80 ft. wide, with roadway 58 ft. wide. It cost, exclusive of property, $240,000 or about $2.40 per sq. ft. The main portion of the Ludlow Avenue viaduct consists of six solid barrel arches of 85-ft clear span built on a skew of 52 deg. with a roadway of column, beam and slab construction over these arches. The approaches leading up to these arches are of column and beam construction of 24-ft. spans. Length 1300 ft., width 60 ft. with 40 ft. of roadway, cost about $280,000 or $3 per sq. ft. The Hopple Street viaduct consists of a series of balanced cantilever beams arched in shape. A pier and the cantilever arms on each side compose a unit, the arms being balanced for dead load and for full live load. Length 1000 ft., width 60 ft. with 46 ft. roadway, cost about $450,000 or $3.75 per sq ft. An arch of 180-ft. span and consisting of three ribs, forms the main portion of the Park Avenue viaduct. The approaches are of column, beam and slab types with spans of 25 ft.

Mr. Raschig concluded his paper by stating that Cincinnati is planning to replace a certain number of wooden and steel structures each year so as to have finally none but concrete bridges

John T. Faig,
Section Secretary.

DETROIT, JANUARY 3

The first meeting of the Detroit Section was held on January 3, at the Board of Commerce, after a dinner given in honor of President Ira N. Hollis, at which over seventy engineers were present. Members of the local sections of the other national engineering societies and of the Detroit Engineering Society were invited to be present to greet Dr. Hollis and to hear him speak on the scope, purpose and opportunities of the local section.

Dean Mortimer E. Cooley, of the engineering department of the University of Michigan and president of the Section, presided. Before the address of Dr. Hollis, Dean Cooley called on several Detroit engineers for short talks. Those who spoke were Theodore A. Leisen, president of the local section of the American Society of Civil Engineers; A. A. Meyer, president of the local section of the American Institute of Electrical Engineers; Horace Lane, president of the Detroit Engineering Society; Clarence W. Hubbell, City Engineer, and Walter S. Russel of the Russel Wheel and Foundry Company.

Dr. Hollis took for the topic of his address the opening sentence of H. G. Wells' novel, The World Set Free—"The history of mankind is the history of the attainment of external power." He traced the development of machinery from the crude club wielded by the savage through the wheelbarrow, plow, steam engine, down to our present day complex machinery; and emphasized the fact that the progress made has always been toward the betterment of the condition of humanity. He stated that the engineer in his work sees not only the material outline of his machine as he works upon it, but sees back of his machine the relation it shares in the elimination of drudgery; and that the engineer in building his machine is like the painter in painting his picture who puts upon his canvas something besides a mere picture. "When I look at a copy of Millet's painting, the Angelus," said Dr. Hollis, "I see portrayed in the picture something of the struggle of humanity against nature and adverse conditions, something of the apparent futility of life in the face of eternity.

"Realizing the importance of their profession to all humanity, the engineers should make more of the esthetic aspects it presents. They should ever be willing in the public service. In their own ranks they should have complete organization for mutual benefit and to advance the condition of humanity by the efficiency among engineering men such organization should increase."

J. W. Parker,
Section Secretary.

INDIANAPOLIS, JANUARY 19

A joint meeting of the Indianapolis Section was held at Lafayette on Friday afternoon, January 19, in connection with the annual meeting of the Indianapolis Engineering Society and the Indianapolis-Lafayette section of the American Institute of Electrical Engineers.

The speaker provided by the Indianapolis Section of our Society was Harrington Emerson, Mem.Am.Soc.M.E., of New York, whose subject was Flow Values Through a Manufacturing Plant. This paper was illustrated by slides and covered Mr. Emerson's conception of the organization of a typical manufacturing industry in its financial aspect from the time of the assembly of the capital investment to the distribution.

The discussion of this topic by Mr. Emerson was as thorough and informing as would be expected by those who are more or less familiar with his expert services in the efficient organization of industries.

W. H. Insley,
Section Chairman.

MILWAUKEE, JANUARY 9

Dr. Ira N. Hollis, President Am.Soc.M.E., addressed the Milwaukee Section at their meeting, January 6, 1917, his subject being The Place of the Engineer and the Engineering Society in Modern Life.

Fred. H. Dorner,
Section Secretary.

NEW YORK, JANUARY 9

In line with the previous meetings of the season, the subject for the January 9, 1917, meeting was Industrial Preparedness in its Relation to Navy Yard Administration. The speaker, Commander E. P. Jessop, U. S. N., pointed out that provision has been made for those engineers beyond military age or otherwise disqualified to take up arms, to enroll for service at the navy yards in time of emergency and thereby release for sea duty the regular naval officers.

Departing somewhat from the announced topic, Commander Jessop proceeded to point out the citizen's obligations to his country and the vital necessity of every individual having his work mapped out beforehand because when trouble comes it usually comes at short notice. Scouting the idea that preparedness leads to militarism, he gave France as an example of democracy where individual liberty has not been marred by military training. England, who before the war was very much like ourselves, has taken two years to awaken to a realization of the situation and the British citizen is now fully alive to his obligations.

By way of showing some of the activities of the Navy Commander Jessop gave a most interesting account, illustrated with slides, of the trip of the *U. S. S. Tennessee* to Europe at the outbreak of the war for the purpose of succoring refugees. He followed with views of the same ship when on a voyage to South American ports and showed finally the destruction of the ship in the harbor of Santo Domingo.

An informal discussion in which attention was directed to the need of more men to handle the new ships of the Navy, closed the meeting.

Alfred D. Blake,
Section Secretary.

PHILADELPHIA, DECEMBER 14

A joint meeting of the Philadelphia Section and The Franklin Institute was held December 14, 1916. Prof. Carl C. Thomas, Mem.Am.Soc.M.E., of Johns Hopkins University delivered an illustrated lecture on The Cooling of Water for Power Plant Purposes. He briefly reviewed the methods of cooling water, making special reference to efficiencies obtained by spray ponds. He described a new form of spray head and reported upon tests made under widely varied conditions. An interesting discussion followed which dealt with factors affecting the efficiencies of spray ponds.

W. R. Jones,
Section Secretary.

PROVIDENCE, DECEMBER 27

At the meeting of the Providence Engineering Society, Prof. Frederick H. Newell, Mem.Am.Soc.M.E., addressed the society on the work of the United States reclamation service in the far West. He illustrated his address by colored slides, explaining the engineering features of the Roosevelt, Elephant Butte and Arrowrock dams, their tunnels and the Gunnison River tunnel. The pictures also showed views of the new homes built on the irrigated land and, for comparison, the same country when it was the home of the Indian and the cowboy.

Albert E. Thornley,
Corresponding Secretary.

ST. LOUIS, DECEMBER 3

At a dinner given on December 3 by the St. Louis Section, Prof. Franklin Gephart gave a very interesting talk on Some Economic Aspects in Relation to the High Cost of Living. His talk was followed by discussions from a number of the members.

L. A. Day,
Section Secretary.

STUDENT BRANCHES

ARMOUR INSTITUTE OF TECHNOLOGY

At the meeting of the Student Branch of Armour Institute of Technology held December 6, 1916, interesting and instructive talks were given by several members of the Branch. The first subject presented was The Different Types of Automobile Engine Lubrication by L. A. King, followed by an explanation of the lubrication of the spring shackles on the new model of the Marmon automobile. R. A. Morse spoke next on the Manufacture of Water Gas, explaining the steps in the manufacture of the gas in a modern plant. The last speaker was Mr. Bretting whose subject was The Construction of Stacks.

E. W. Haines,
Branch Secretary.

BUCKNELL UNIVERSITY

The first meeting of the present school year of the Student Branch of Bucknell University was open to all who would attend. The purpose and workings of the branch were explained, and all who were not members were urged to ally themselves with it as early in their course as possible.

F. E. Burpee,
Branch Correspondent.

BUCKNELL UNIVERSITY

The regular meeting of the Bucknell University Student Branch was held December 11, 1916, when C. M. Kriner gave a talk on Jigs and their Application in Modern Machine Shops, illustrative of the simple type of jig as used for plain drilling and reaming, and the more complex type used in performing a number of operations on the work it holds. Mr. Weaver joined in the discussion.

During Thanksgiving vacation ten members of the Student Branch, accompanied by Prof. Frank E. Burpee, Mem.Am.Soc. M.E. and Prof. Taylor, made a six-day inspection tour to York, Lancaster, Philadelphia, Trenton and Wilkes-Barre, visiting various factories of mechanical interest. It was the most successful trip the Branch has taken during its history, and plans are on foot for conducting several of these tours each year.

J. A. Case addressed the Student Branch of Bucknell University at their meeting on January 8, 1917, on the Reservoir and Filtration Plant for the Jersey City Water Supply. He furnished some views of the reservoir and explained, by means of a blackboard sketch, the method of filtering and testing water for the percentages of the various kinds of bacteria.

C. M. Kriner,
Branch Secretary.

CARNEGIE INSTITUTE OF TECHNOLOGY

The Student Branch of the Carnegie Institute of Technology held its regular meeting November 15, 1916. Mr. Frederick Parke, Mem.Am.Soc.M.E., gave an interesting illustrated lecture on Brak-

ing, showing the development of brakes from their primitive type to the latest Westinghouse air brake used on the railroads of the country today. He also showed the tabulated results of many tests made on various railroads throughout the United States and pointed out that the development of the railroads followed very closely the development of the air brake, since the capacity of the brake determines to a large extent the permissible speed and weight of the equipment.

On December 13, 1916, the Branch heard a most interesting address by Lieut. J. B. Oldendorf, U.S.N., on Mechanical Engineering in the Navy. The speaker explained the considerations determining the design of various types of naval vessels and described in detail the installation of power plants abroad, battleships, cruisers, torpedo boats, destroyers and colliers. He indicated the design and arrangement of boilers, engines, turbines, pumps, etc., on naval vessels and gave his opinion that the internal-combustion engine of the oil-burning type is the marine engine of the future. He cited the successes experienced with this type of engine in submarines.

More than an hour of inquiries, questions and remarks on the part of the students evidenced the interest of the members of the Branch in the discussion which followed. The meeting closed with Lieutenant Oldendorf's recounting, on request, many interesting and amusing incidents experienced during his first cruise.

J. H. Davis,
Branch Secretary.

CASE SCHOOL OF APPLIED SCIENCE

The Value of the Engineer to the Community was the subject of the address of C. E. Drayer, Secretary Cleveland Engineering Society, before the Student Branch of the Case School of Applied Science on January 10, 1917. He emphasized the present-day need of engineers in the management of municipal affairs, citing the fire and building laws, street railways, water plants and power stations as instances where the skill and knowledge of the engineer should be employed. He showed by lantern slides a few newspaper columns on the value of the engineer to the community, explaining that the newspaper was the medium used by the Cleveland Engineering Society for bringing the relation of science and public affairs before the people.

Alex. Treuhaft,
Branch Secretary.

COLORADO AGRICULTURAL COLLEGE

At a meeting of the University of Colorado Student Branch, held November 27, 1916, Mr. Gorton gave a comprehensive talk regarding the measurement of steam by means of the orifice, U-tube and Ledoux bell type of meters.

E. C. Johnson,
Branch Secretary.

COLUMBIA UNIVERSITY

The Student Branch of Columbia University reports the successful carrying out of its project of uniting the Chemical, Civil, Electrical and Mechanical engineers under a joint governing board. The officers of the Branch are John L. Kretzmer, president; William M. Henry, vice-president; R. W. Thompson, secretary and E. H. Shea, treasurer.

John L. Kretzmer,
Branch President.

CORNELL UNIVERSITY

The Cornell University Student Branch began the new year with a very interesting meeting on January 13, 1917. The speaker of the evening was Prof. Dexter S. Kimball, Mem.Am. Soc.M.E., who gave an instructive address on the problems of the practicing engineer. He described some of the difficulties and stumbling blocks of young engineers, giving his personal experiences as a designer and consulting engineer.

S. M. Barr,
Branch Secretary.

COLUMBIA UNIVERSITY

The various engineering societies on the campus of Columbia University have been consolidated into an organization called the United Engineering Societies, which is controlled by a governing board composed of two delegates of each branch society. This consolidation was the outcome of a conference between the chairman and honorary chairman of the Student Branch of the Am.Soc.M.E. The Chemical Society was formed as a result of this consolidation and the Mining Society is expected to enter the organization shortly. The chairman of the Mechanical Society was elected chairman of the governing board.

The first meeting of the newly organized society took place December 14, 1916, and was in the form of a smoker which proved most successful. The speakers were Calvin W. Rice, Secretary Am.Soc.M.E., H. H. Norris, Charles Butters and Herman A. Metz.

John L. Kretzmer,
Branch Chairman.

LEHIGH UNIVERSITY

On December 14, 1916, an interesting meeting was held by the Student Branch of Lehigh University, which the Civil Engineers also attended.

Prof. Frank P. McKibben, head of the Civil Engineering Department of the University, spoke on the Hill-to-Hill Bridge to be erected between the Bethlehems. He covered the history of the means of transportation across the river and outlined the way in which the subject of a new bridge was taken up. He told how he had planned this new bridge and exhibited several of the first plans as well as the plans for the finished structure which, when completed, will be over a mile in length and will be Y-shaped, allowing for all traffic on both sides of the river. He estimated the cost to be about \$1,000,000, most of which has already been pledged, so that the construction of the bridge is practically assured.

F. L. Benscote gave a comprehensive talk on Mechanical Refrigeration. He described the two types of refrigerating plants, the absorption and compression types, the latter of which is in more common use. By means of numerous blackboard sketches, he explained in detail the operation of the two types and the manufacture of artificial ice.

F. M. Porter,
Branch Secretary.

POLYTECHNIC INSTITUTE OF BROOKLYN

The Polytechnic Institute of Brooklyn held a meeting January 6, 1917 when The Development of Poppet Valve Uniflow Engines and their Status in the United States was discussed by Siegfried Rosenzweig, Mem.Am.Soc.M.E. He traced the development of the poppet valve uniflow engine from its origin to the present-day engines of Lenz and Stumpf. He gave as the reason for its great success, its non-destructibility under high pressure and high temperature, in which two phases it approaches in efficiency the explosion engine. Mr. Rosenzweig further favors it because there is no wear or rubbing and hence very little lubrication. He has endeavored to have locomotive manufacturers introduce these engines in their locomotives, but due to the fact that the concerns are busy manufacturing war implements, he has received very little encouragement.

The Institute has elected two men to represent the Society in editing the Engineer, their technical publication.

George Cherr,
Branch Secretary.

PURDUE UNIVERSITY

The Student Branch of Purdue University, at its meeting on December 16, 1916, was addressed by Dean C. H. Benjamin, Vice-President Am.Soc.M.E., of the Engineering School of the University, on the Thirty-Seventh Annual Meeting of the Society. His talk was general, giving a description of the Engineering Societies Building, the program which was carried out at the meeting and the method of presenting and discussing papers. He emphasized, as the great advantage of attending these conventions, the opportunity of meeting men, exchanging experiences and gathering pointers.

Geo. A. Ruess,
Branch Corresponding Secretary.

PURDUE UNIVERSITY

Dr. Ira N. Hollis, President Am.Soc.M.E., addressed the Student Branch of Purdue University on January 8, 1917. The basis of Dr. Hollis' talk was the title of H. G. Wells' book A World Set Free and he defined the engineer's responsibility for the "setting free." He especially emphasized the part played by James Watt in his improvement of the steam engine. Dr. Hollis ridiculed the idea of narrowness associated by many with the engineer and took issue with the writer of the statement that there is no romance connected with a machine. He claimed that the beauty of an engine is as real as the beauty of a picture for it is the "picture behind the picture" that makes a picture either famous or commonplace. Referring to Millet's Angelus, Dr. Hollis said that the human strife presented there would undoubtedly be present if the figures were replaced by broken machinery.

G. A. Reuss,
Branch Secretary.

THROOP COLLEGE OF TECHNOLOGY

On November 20, 1916, the Student Branch of Throop College of Technology conducted a meeting of the student body and faculty of the college, at which Charles V. Knight, inventor of the sleeve-valve motor, gave an instructive talk on the early development and mechanical features of his invention. Mr. Knight used a cut-away Stearns motor to illustrate the mechanism and operation of his motor.

Reginald Coles,
Branch Secretary.

UNIVERSITY OF ILLINOIS

Dr. Ira N. Hollis, President Am.Soc.M.E., spent a part of Tuesday and Wednesday, January 9 and 10, at the University of Illinois, where he was the guest of Past-President W. F. M. Goss. Dr. Hollis was the guest of honor at a dinner tendered him by the Dean and heads of departments of the College of Engineering, where the president, vice-president and members of the council of the university, the local members and the president of the Student Branch of the Am.Soc.M.E., were also guests.

In Dr. Hollis' address before the Student Branch, he aimed to impress upon the young men the dignity of their calling and the significance of the engineer as a factor in the social, political and economic progress of the nation.

W. F. M. Goss,
Branch Correspondent.

UNIVERSITY OF NEBRASKA

At the November, 1916, meeting of the Student Branch of the University of Nebraska, M. F. Clark gave an address on the Relation of the Engineer to National Preparedness, presenting the questions involved and some of the views expressed by the most prominent engineers on this subject. Foundry Practice was discussed by Mr. Smith, instructor at the University in that branch of work. He was followed by Prof. J. D. Hoffman, Mem.Am.Soc.M.E., who spoke on the Chicago Edison Plant, reviewing Mr. Insull's paper in The Journal, November, 1916, on that plant and adding his own observations from a personal inspection of the plant.

Orlo A. Powell,
Branch Secretary.

UNIVERSITY OF MISSOURI

The Relations of the Student Branch to the Society and the advantages realized by taking an active part in the Society, were discussed by Prof. H. W. Hibbard, Mem.Am.Soc.M.E., at the first regular meeting of the Student Branch of the University of Missouri, held October 26, followed by an illustrated lecture by D. E. Foster, Associate Professor in Mechanical Engineering, on Air Compressors and their various uses.

Louis Seuter was elected chairman for the year 1916-1917; B. W. Coots was elected treasurer and recording secretary, and C. N. Johns was elected corresponding secretary.

At the second meeting of the Branch, held November 9, M. H. Brigham, Assistant in Manual Arts, gave an interesting talk on Shop Practice, laying special stress on the production of machinery.

C. N. Johns,
Branch Secretary.

VIRGINIA POLYTECHNIC INSTITUTE

On December 8, 1916, the Student Branch of Virginia Polytechnic Institute held an interesting meeting, at which Frank B. Gilbreth, Mem.Am.Soc.M.E., gave a talk on Motion Study as a means of increasing the efficiency of operators and workmen in various occupations. Mr. Gilbreth cited several instructive instances of his observations for practical application of his method of corrected motions.

The method by which Mr. Gilbreth's observations are made is that of taking moving pictures of the operator at his work. In the background of the picture, a screen resembling a sheet of coördinate paper is placed; a light attached to the operator's hand traces a line across the screen; the graph thus obtained is studied and a wire model of the curve is made. By means of this model the shortest distance in which the space may be traversed is determined, and by instructing the operator to adopt motions in accordance with the corrected motions, his efficiency is many times increased.

By following Mr. Gilbreth's methods, three typists won the first and second international, and the first national speed prizes, and the golfers Nichols and Ouimet derived considerable benefit in their work.

G. E. Parker,
Branch Secretary.

WORCESTER POLYTECHNIC INSTITUTE

On January 5 1917, the Worcester Polytechnic Student Branch held a joint meeting with the student branches of the American Institute of Electrical Engineers and the Civil Engineers Society. The subject of the day was From Ore to Finished Pipe, by H. T. Miller, of Boston, who illustrated his lecture with motion pictures.

H. P. Fairfield,
Branch Secretary.

Am.Soc.M.E. Year Book, 1917

The new Year Book of the Am.Soc.M.E. is off the press and will be issued early in February. The volume contains general information regarding the Society, its objects and activities, calendar of events for 1917, the personnel of the Officers, Council and Committees for the year, together with the alphabetical and geographical lists of members of the Society, corrected to January 1, 1917. A list of past officers and a calendar of all general meetings since the first meeting in 1880, a list of depositories for Transactions, also the Charter and By-Laws of the Society are included in addition for reference.

The alphabetical list of members occupies 302 pages and contains 7,704 names. This is an increase of 773 over last year. The geographical list extends over 170 pages.

Attention is called to the scheme of the alphabetical and geographical lists. In the alphabetical list are given the grade of membership in the Society, the title and business connections, the business and residence addresses. In the geographical list are given under each city or town, the names and business connections of members; experience has shown that this is the information most likely to be required from this list.

Every member of the Society receives a copy of this Year Book, bound in cloth. The geographical list of members is also issued as a separate publication, bound in paper.

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping any-one desiring engineering services. The Society acts only as a clearing house in these matters.

POSITIONS AVAILABLE

In forwarding applications, stamps should be enclosed for transmittal to advertisers; applications from non-members should be accompanied by a letter of reference or introduction from a member, such reference letter to be filed with the Society. Copy for notices must be in hand by the 15th of the month.

ASSISTANT CHIEF ENGINEER. Young man who has had experience in or made special study of power plant operation, to assist in running woodworking factory of 1000 hp. Knowledge of design of exhaust steam-heating on large scale desirable. Answer, stating age, past positions and salary expected. 83

DRAFTSMAN experienced in design of heavy machinery, rolling mills, etc. Location Connecticut. 98

YOUNG ENGINEER DESIGNER with technical education and special training in the design of automatic machinery for the manufacture of small interchangeable parts; excellent chance for advancement to one who displays ability and application. Location Chicago. 139

RECENT GRADUATES in mechanical engineering from schools of recognized standing desired for testing work in large steam-operated electric power plants. Preference will be given to applicants with experience in testing work and those now located in and around New York. Answer stating particulars of education, experience and salary desired. 167

TOOL DESIGNER who is resourceful and can follow work through to completion. Technical man with practical shop experience. Salary $25 to $35 per week according to ability. Location Connecticut. 185

SALES ENGINEERS, young men, between ages of 25 and 30 years, of good appearance, graduates of some approved engineering college, preferably M.E. degree. Applicant would be expected to undergo a period of probation and training in the various offices of company before being given more responsible and higher positions in sales work. Apply by letter in own handwriting, stating age, education, previous business training, if any, salary desired, etc. Location New York. 205

DESIGNER for special machinery and labor-saving devices, capable of following work through shop to completion. Location New York State. 248

SALES ENGINEERS or AGENCY on commission for one who is handling other lines, desired for the following territories: Tennessee, North Carolina, Minnesota, North and South Dakota. Past record must show familiarity with boiler plant practice. 433.

WORKS MANAGER, unusual opportunity for right man, 35-45; must be graduate engineer and have thoroughly demonstrated ability as machine designer and production man. Good organizer and hustler, preferably with ability to invest $5,000 at the end of 3 months if satisfactory. State fully education, experience, age, etc. Correspondence strictly confidential. 642

DRAFTSMEN. Experienced mechanical draftsmen, preferably not over 30 years of age. Permanent employment and advancement to capable men. Location New York State. 751

POWER ENGINEER for large industrial corporation operating its own steam and electrical power plants; young man with executive ability, mechanical or electrical engineering graduate, experienced in power plant and power distribution, design and operation. State age, school, year of graduation, detailed experience and salary expected. Location Michigan. 763

ENGINEER, experienced in manufacture of interchangeable parts, with thorough knowledge of die and tool design. Location New York. 764

DRAFTSMAN, familiar with power house work, such as the installation of its equipment, piping, etc., competent to work out the different problems involved. Salary $25 to $28 per week. Location New York. 769

SHOP INSPECTOR, over 30 years of age, competent to take charge of factory of 500 men, manufacturing large quantities of varied equipment; to represent New York office. Salary according to man. Location Massillon, Ohio. 770

ENGINEER skilled in handling of materials, to study the handling of materials at plants of large industrial corporation; experience with conveying machinery and other mechanical means of handling transporting materials. 782

HEATING AND VENTILATING ENGINEER to study heating and ventilation and various similar problems at plant of large industrial corporation. 783

CONSTRUCTION SUPERINTENDENT for contracting company engaged principally in municipal contracting. Applicant must be capable of handling men in water works and sewer construction and able to take a financial interest in the company. Location Middle West. 784

YOUNG ENGINEER to keep up machinery and design improvements and attachments for machines now running and design new machines as thought desirable. First work will be to assist in giving lines and positions of building construction now under way. Position will pay $40 per week to start, and as soon as results are obtained a responsible position with adequate compensation will be established. Location New York State. 785.

MECHANICAL ENGINEER who would be interested in partnership in established business dealing largely in apparatus pertaining to economical production of steam, as recording instruments, steam meters, water meters, calorimeters for fuels and gases, etc. Location New York. 736

SALES ENGINEER with experience, for Chicago Branch Office of concern manufacturing power-plant specialties, high-grade valves, jet apparatus, condensers, sprays, heat-transmission apparatus, oil-firing equipment, etc. Give full particulars and references. 793

DESIGNER on fittings and valves. Good draftsman with executive ability, capable of taking charge, but willing to work. Answer stating age, education, salary expected, previous positions and references. Location New York State. 794

ENGINEER familiar with application of handling equipment in general factory work. 795

DRAFTSMAN on boiler and stoker work. Two or three years' experience. Location New York. 797

ASSISTANT PROFESSOR OF MECHANICAL ENGINEERING, with five or more years' practice in gas or steam engineering design or construction and teaching experience, for technical institution. Position open now or in September, 1917. Location Pennsylvania. 798

STAFF ENGINEERS, experienced in manufacturing efficiency work, especially in routing, motion-study, time-study, rate-setting and introduction of bonus systems. Salary $150 per month. Location Chicago. 799.

YOUNG ENGINEER to assist in installing Gantt system in light industry employing both men and women. Prefer man who has had experience along this line. Location Georgia. 800

DRAFTSMEN familiar with power-plant design, piping layouts, foundation work, light structural-steel work and timber-platform construction, especially with experience in the design, of chemical plant equipment. Location Brooklyn. 803

MACHINERY DESIGNER to take charge of drafting force. Must have good and extensive experience in building machines for working sheet metals, as presses, shears, etc. Salary $225 to $250 per month. Location, Buffalo, New York. 804

DESIGNER on heavy machine tools and similar machinery. Good opportunity for high-grade designer with chiefly drawing-office experience. Location Pennsylvania. 40

ASSISTANTS TO CONSULTING ENGINEER, recent graduates from high-grade engineering school. Personality and correct use of English as

essential is technical training. Moderate salary with advancement. Answer in own handwriting with complete record of training. Location Ohio. 805

MEN AVAILABLE

Only members of the Society are listed in the published notices in this section. Copy for notices should be in hand by the 15th of the month, and the form of the notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

RECENT TECHNICAL GRADUATE, now employed, desires to change position to one in which there is good opportunity for advancement. B-49

TECHNICAL GRADUATE, in charge of erection and design of plant and equipment for large chemical concern, wishes to change. Energetic, can purchase equipment to good advantage and install it to most economical utilization of floor space. Familiar with mechanical methods of storing and handling material. Available on reasonable notice. Salary $2100. B-50

MANAGER or SUPERINTENDENT where ability can be demonstrated and where there is an opportunity for advancement. Associate-Member; graduate mechanical engineer. Three years mechanical engineer of large steel company; two and one-half years chief engineer of electric company; two years in consulting engineering profession. Best references furnished. B-51

MECHANICAL ENGINEER with extensive acquaintance in Eastern territory would like to represent manufacturers who desire to increase their sales in the East on purely commission basis, or would form partnership with established firm of manufacturers' agents. At present employed. Salary $5000 to $10,000. B-52

ENGINEER-SALESMAN for concern desiring new business or development of special department. Capable of approaching with confidence architects and engineers or owners on larger construction operations in New York or New England and nearby states. B-53

NEW YORK SALES MANAGER, age 33, wants position with company capable of turning out special machinery, principally sugar machinery. Long experience and large clientele. B-54

WESTERN REPRESENTATIVE. Member, practical machinist, Stevens graduate. Age 36, married. Easterner with residence of ten years in the West. Engineering business and buying experience. Now employed by mechanical engineering contracting concern. Desires change and solicits position as Pacific Coast representative of Eastern manufacturer. Salary and commission basis. Would consider two non-conflicting lines. References. B-55

INSTRUCTOR or DIRECTOR. Member. Technical education and over twenty years' practical experience. At present superintendent of industrial school. Desires position in vocational or industrial school, eastern part of United States preferred. Salary $1800. B-56

SUPERINTENDENT or ASSISTANT MANAGER. Twenty years' experience on large variety of machine works. At present superintendent in a large plant. Desires position with machinery manufacturing concern. New England preferred. B-57

SALES ENGINEER. Mechanical engineer opening sales office in Detroit in near future wishes to handle complete line of power-plant machinery and specialties on salary or commission basis. Must have liberal commissions. Will push a good line and secure results. References. B-58

ENGINEER desires position as assistant manager or superintendent. Will consider position as chief engineer or resident engineer. Location immaterial. B-59

MECHANICAL ENGINEER who has done considerable consulting, general plant layout and supervision desires to make new connections with responsible concern or established office. B-60

ASSISTANT to PRODUCTION or EFFICIENCY EXECUTIVE. Technical graduate, age 27. Five years' experience in machine shop, drafting, and designing. Familiar with modern production methods and possesses originality, integrity, and accuracy. Desires permanent position with progressive company. Location immaterial. B-61

PROFESSOR OF MECHANICAL ENGINEERING, technical graduate, age 40, M.E., with 17 years' experience in teaching, engineering and consulting work. Practical experience in commercial engineering; specialized in steam power plants. For a number of years head of department of mechanical engineering in leading university. At present head of departments of mechanical and electrical engineering in university of good standing. Location abroad, China preferred. B-62

CHIEF ENGINEER, EXECUTIVE or MASTER MECHANIC. American, age 38. Held positions of chief engineer for two large chemical works. Fifteen years' experience handling men and production in large plants. Thorough shop and foundry man; also power-house engineer, competent to assume full charge of all mechanical work in a large plant. Desires position with a large industrial plant or other responsible position. Highest references; can prove ability. B-63

SUPERINTENDENT. Member, graduate in mechanical engineering. Thoroughly familiar with current practice affecting superintendency of medium-sized plant. Would consider change from present position, providing a small investment in the business would be considered. Location desired, Chicago. B-64

MECHANICAL ENGINEER or ASSISTANT MANAGER. Associate member, age 38. Twenty years' experience as shop foreman, chief draftsman, master mechanic and engineer. Has designed, constructed and operated machine shops, car shops, power and sub-stations, pumping plants, air-compressing plants, fire-protection systems, etc. Several years' experience designing and building conveyors, electric locomotives, cars, trucks, hoisting machinery, foundations, structural-steel work, and buildings. Competent to assume responsibility and produce results. Plant now erecting about completed. Available in thirty days. Salary $3000 per annum. B-65

EFFICIENCY ENGINEER. Technical graduate, age 32. Eleven years' experience, covering construction and operation of power plants and central stations. Specialty, boiler economy; can furnish excellent references on this point. Now seeks engagement with firm desiring results that a capable engineer—not a magician—can produce. Minimum salary $250 per month in United States and $300 and expenses elsewhere. B-66

SUPERINTENDENT or ASSISTANT GENERAL MANAGER. Mechanical engineering graduate, age 27. Technical apprenticeship with motor-truck company. Successful experience in designing, handling men, increasing production, reducing costs and installing modern methods. Some purchasing and selling experience. Now employed as superintendent by well-known concern manufacturing large and small interchangeable-part machines. Desires better opportunity for future. B-67

MECHANICAL ENGINEER. Graduate University of Illinois, age 35, married. Five years' practical experience in shops, engineering and sales offices. Five years' outside erection, inspection, trouble work, and testing of power-plant equipment and accessories, including boilers, Corliss, oil and gas pumping engines, steam turbines, condensers, electrical equipment. Thorough, capable and aggressive, possessing executive ability and eager for responsibility where results are desired. Prefers position with consulting engineers or firm requiring traveling constructor, inspector, tester or sales engineer. Best of references from past and present employers as to integrity, honesty and ability. B-68

SUPERINTENDENT, MASTER MECHANIC or EQUIPMENT ENGINEER. Age 33. Fourteen years' experience in drawing and stamping of sheet metal. At present assistant equipment engineer in plant having 10,000 employees. B-69

COMBUSTION ENGINEER. Technical graduate about to end four-year term as head of smoke-inspection department of large city, desires to connect with some concern to whom his experience would be of value. Prominent in national smoke-abatement movement. B-70

PUBLICITY ENGINEER. Mechanical graduate, age 33, married, excellent health. Thoroughly experienced in the advertising of mechanical equipment. Expert in the preparation of sales literature, trade paper advertising, and sales correspondence. Minimum salary $200 per month. Available for interview any time in New York City or vicinity. B-71

MECHANICAL ENGINEER. Associate-Member, age 30, technical training. Three years on civil engineering work: foundation, concrete, steel, building and power-house erection. Four years' mechanical engineering experience, on boilers, engines, special apparatus, hydraulic machinery, shop work, producer-gas engines and generators, industrial plant work. Two years in electrical work, on a.c. and d.c. generation, transmission and distribution. Good executive, desires to specialize. B-72

EXECUTIVE ENGINEER, ASSISTANT TO EXECUTIVE OFFICER or CONSULTING ENGINEER. Graduate of leading technical school. Twelve years' experience as special engineer in shop, factory, sales and general office administration work. Good organizer and experienced in directing men. B-73

JUNIOR MEMBER. Stevens graduate, with varied experience in the development of machinery and scientific inventions, wishes to connect with aeroplane or automobile manufacturer. At present engineer for a large electrical manufacturing company. Available on reasonable notice. B-74.

ENGINEERING SURVEY

A Review of Engineering Publications in All Languages. All the leading periodicals of the engineering world, embracing over 1000 different publications, are received at the Library. These are systematically examined for review each month in the Survey.

SUBJECTS OF ABSTRACTS

ARRANGED IN THE ORDER OF THEIR APPEARANCE IN THE SURVEY.

Particular attention in this issue is called to the section Internal-Combustion Engineering, especially the abstracts of articles on the development of the use of Diesel engines in shipping, both in America and in Europe. It is unfortunate in this connection that the data of the article in *Motorship* describing the motive power of the M. S. *Deutschland* are so obscure. With all this, however, the article represents a good example of enterprising work in the field of engineering journalism and contains data which are not otherwise available.

THIS MONTH'S ARTICLES

In a paper before the Annual Meeting of the Society of Automobile Engineers, now transformed into Society of Automotive Engineers, Capt. V. E. Clark and his associates in the Signal Corps present a brief discussion of some problems in aeroplane construction. This paper is in line with the policy inaugurated by Col. George O. Squier (compare his paper presented in the Engineering Survey for January, 1917) of inviting the collaboration of the engineering profession at large in the working out of technical problems by the Aviation Branch of the War Department.

In the section Engineering Materials attention is called to an advance notice of a technological paper of the Bureau of Standards on the manufacture and properties of sand-lime brick.

In the same section will be found an abstract of a paper on Heat Treatment of High-Speed-Steel Tools, the authors of which show how important it is to carefully control the hardening temperature and to apply to each particular steel the proper heat treatment.

The Resistance of Lubricating Oils to Emulsification is discussed in another advance abstract of a technological paper of the Bureau of Standards, where it is stated that the majority of the oils on the market are either very good or very poor. A stirring test is suggested as being more sensitive than chemical tests only.

Sawdust Firing on a large scale as practiced at the Singer plant at South Bend, Indiana, is described in an abstract from an article in *Power*.

From the *American Gas Engineering Journal* are abstracted data of interesting experiments on the measurement of flow of unpurified gases at high temperature by means of pitot tubes, which show that the flow of hot gas can be measured in this way and that the temperature of the gas does not apparently affect the tube or interfere with the indications of the gage, at least when the measurement is carried on for a limited period of time.

In the section Hydraulics are described experiments on the effect of sudden enlargement upon the flow of water in pipes, likewise conducted by means of pitot tubes. In this case a special attachment described in the abstract was used for facilitating the set of the tube. A modified Borda formula is suggested for expressing the loss of head in feet due to sudden enlargement.

In the same section is presented an abstract of a paper on the Determination of Capacity and Design of Wood-Stave Pipe.

A novel two-cycle two-cylinder oil engine developed in this country is described: it is characterized by the employment of a cylinder in which operate two working pistons opposite to each other. A special arrangement for uncovering the exhaust ports is used.

Several abstracts are presented on Diesel engines. From a Bulletin of the Iowa State College are abstracted data obtained from a study of oil engines in Iowa power plants.

Another abstract describes in detail the matter of piston and small-end lubrication in Diesel engines. This discussion covers the subjects of selection of lubricating oil and design of lubricating system.

A paper read at the Annual Meeting of the S.A.E. by Prof. Walter T. Fishleigh and W. E. Lay presents data of a very interesting investigation of the heat-balance performances of automobile engines, including a complete heat balance for certain runs.

Locomotive-axle failures due to improper manufacture are discussed in an abstract from the report of an engineer of the Interstate Commerce Commission.

The erosive effect of steam on turbine-blading material formed the subject of an investigation carried out in the

post graduate department of the Naval Academy. While the investigation was only of a preliminary nature, the data obtained are already of considerable interest.

Another article in the same section, Steam Engineering, describes the use of Curtis steam turbines and Alquist reduction gears in the propulsion of cargo ships. From an article abstracted from the *General Electric Review* it appears that the abnormal conditions of American freight shipbuilding are now all favorable to the development of standardized production and to the use of the class of machinery here described. Data are presented on the comparative economy of reciprocating engine- and turbine-propelled cargo ships, showing considerable economy in favor of the latter class.

The Moore steam turbine, a newcomer in this line of production, is described from an article in *Power*.

From an article in *Engineering* is abstracted a discussion of the Willans Line for Steam Turbines, where it is shown how to obtain a corrected Willans line, and what a corrected line represents.

Aeronautics

Some Problems in Aeroplane Construction, Capt. V. E. Clark, Capt. T. F. Dodd, and O. E. Strahlmann

Enumeration with brief remarks of some important problems connected with the construction of aeroplanes intended for military use in the United States, some of these problems also applying, however, to aeroplanes built for commercial and sporting purposes.

The paper gives definitions of the main classes of military aeroplanes, viz., strategical-reconnaissance machines, tactical-reconnaissance machines, field-artillery fire-control, long-range bombers, pursuit machines and over-sea reconnaissance machines.

As to problems in construction, the question of two propellers is discussed in some detail. Methods of reducing the vibration are touched on somewhat cursorily. Gasoline-supply systems, on the contrary, are discussed in considerable detail and illustrated by drawings.

Of the other subjects, the following are touched on more or less: Metal construction for aeroplanes; flexible piping; muffler requirements; shock absorbers for landing gear; brakes required when landing; floating landing gear; gasoline-supply gage; fire safety devices; altitude adjustment for carburetor; firing machine gun by engine shaft through the disk of the propeller; variable radiators; ignition and cooling systems.

The paper discusses in particular detail the two important problems of variable-camber wing and propellers with variable pitch angle.

The question of propeller stresses is also discussed in detail and illustrated by several curves indicating the various stresses at various points of the propeller. (*S. A. E. Bulletin*, vol. 11, no. 3, December 1916, pp. 213-236, 15 figs., *g*)

Engineering Materials

The Manufacture and Properties of Sand-Lime Brick, Warren E. Emley

Sand-lime bricks are made of sand and lime, hardened by exposure to the action of steam at high pressure. They compete in numerous localities with common building bricks made of clay. There is a widespread demand for information as to just what sand-lime bricks are, how they are made, and what properties one may expect them to have. In this paper an attempt has been made to compile this information and make it accessible. A short theoretical discussion leads to certain conclusions as to the desired properties of the raw materials —sand and lime. The different steps of the process of manufacture are then taken up in detail, and comparisons made of the different mixing, pressing, and hardening operations as carried on in various factories. The testing methods generally employed for the examination of common building bricks are described in detail, and a summary is given of the results obtained when sand-lime bricks are subjected to these tests. An appendix contains detailed descriptions of the equipment of seven typical factories. (Abstract of *Technologic Paper* no. 85, Bureau of Standards)

Identification of Light-Gray Inclusions, George F. Comstock

There seems to be a common opinion among metallographists that all light-gray inclusions seen with the microscope in polished sections of steel are manganese sulphide. Slate-colored inclusions are considered to be silicates, and dove-gray inclusions manganese sulphide. This, however, is not correct, and scale which is apt to accumulate along the edge of any piece of steel if it be well polished and preferably unetched, will show light-gray in appearance. As a matter of fact, however, it is not manganese sulphide at all but chiefly iron oxide, and contains sulphur only as an impurity.

It therefore becomes important to find a method of distinguishing oxides from sulphides. It has been found that this can be done by the use as etching material of boiling alkaline sodium picrate, which produces blackening of the sulphides. This action seems to be due to an actual solution of the manganese sulphide by the etching liquid, so that instead of a smooth, polished surface we now have a surface full of pits or hollows where the sulphides were, and as these hollows do not reflect any light back into the microscope with vertical illumination, they appear black in the field of vision.

At the same time this liquid does not attack oxide inclusions at all. A further advantage of the use of this solution for the described purpose is that it is already used for etching cementite in high-carbon steel and is, therefore, familiar to metallographists.

The article contains numerous microphotographs showing the application of the described method, (*The Iron Trade Review*, vol. 59, no. 24, December 14, 1916, pp. 1195-1197, 17 figs., *eA*)

Notes on the Heat Treatment of High-Speed-Steel Tools, A. E. Bellis and T. W. Hardy

The problem of heat treatment of high-speed steel becomes increasingly important as the design of cutters becomes more and more complicated with the growth of efficiency of mechanical operations. While hundreds of dollars are spent in the design and manufacture of milling cutters of special form for rapid production of duplicate or interchangeable parts, the final efficiency of the operation depends on the ability of the tool to perform the work, and this in its turn depends on the heat treatment given it. In order to be on the safe side, the average tool hardener uses a temperature much too low to give the best results with the high-speed steel he uses. In the case of cutters which are finished to a given diameter before hardening, it is impossible to grind the tool after hardening, so that it is essential that the surface be

protected from oxidizing or decarbonizing. In this paper are described some experiments on hardening high-speed steel in which metallographic means were used to determine the correct hardening temperature.

Six specimens from the same bar of each kind of steel (5 kinds were taken) were hardened from different temperatures and photomicrographs made. The temperature from which the piece was hardened is given under the photomicrograph in each case (cp. Fig. 1). Photographs were made of the longitudinal section, care being taken to grind off the outer surface. The specimens ¼ in. square in section were first preheated at 1500 deg. fahr. and then quickly placed in the high-speed furnace already heated to the desired temperature, left at this temperature for one minute, and quenched in oil.

In interpreting the micrographs the author regards that at

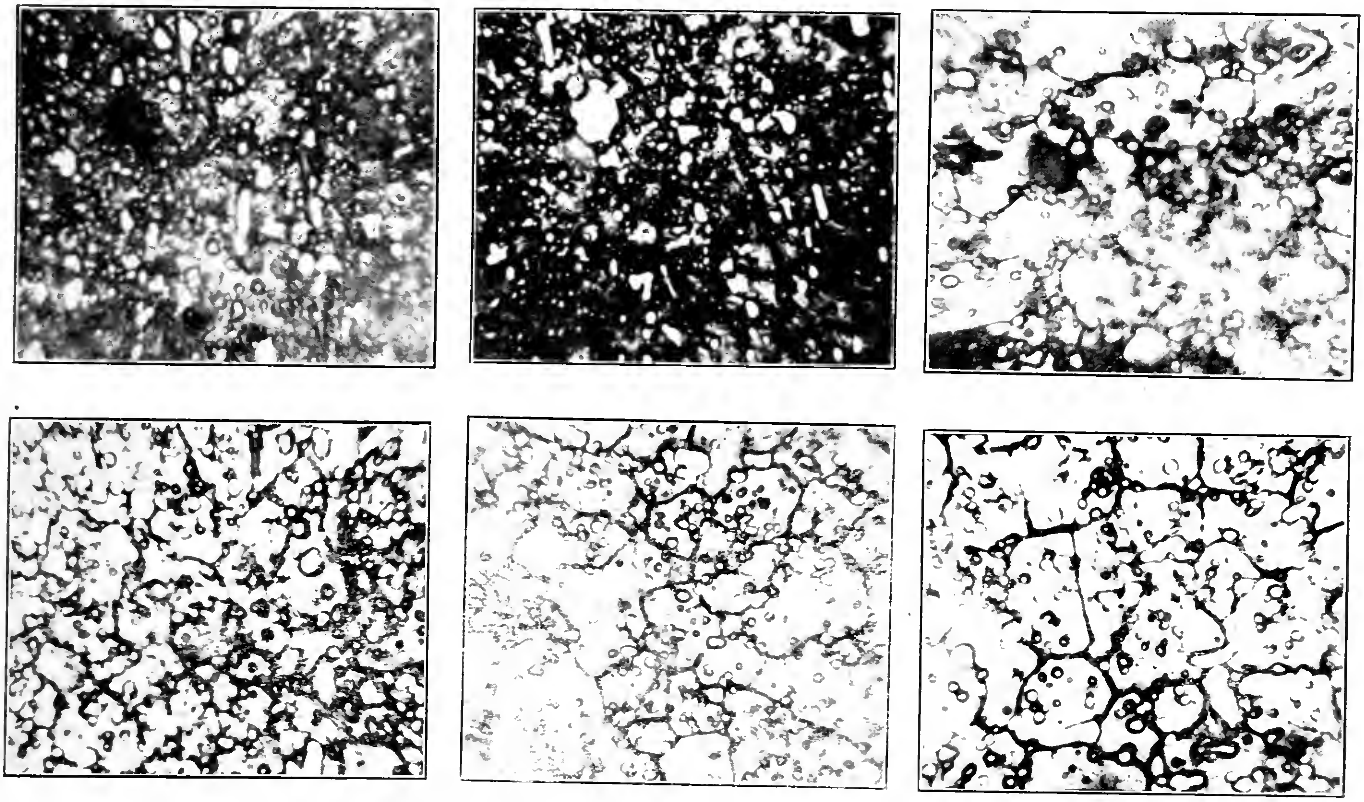


Fig. 1 Microphotographs of Specimens of High-Speed Tool Steel Treated at Various Temperatures
Upper Row (from left to right): 2050, 2100, 2200 deg. fahr. Lower Row (left to right): 2250, 2300, 2350 deg. fahr.

2100 deg. fahr. as a dark matrix showing a large excess of free carbide; as the temperature is raised, more and more of the carbide dissolves and the network structure of austenite is more noticeable.

In general, the steels that show some excess carbide even at the maximum hardening heat are the most efficient. These as a rule are the steels with high tungsten content; they harden from a higher temperature and over a wider range than the lower-tungsten steels, and for this reason do not require as careful treatment as the latter. On the other hand, the steels with lower tungsten and higher vanadium give better results when hardened at the lower-tungsten temperatures than do higher-tungsten steels when these are hardened at the same low temperatures. The comparison is not so advantageous to the lower-tungsten steels when the steel with higher tungsten is given the proper hardening heat.

It is highly important to carefully control the hardening temperature and to apply for each particular steel the proper temperature. The custom of using only one "high-speed temperature" for all steels is very poor practice.

A good deal of trouble is experienced in hardening through oxidation at high temperatures. The use of a barium chloride bath to eliminate this difficulty has the disadvantage that the surface of the tool becomes decarbonized. A method that has proved satisfactory is to place the tools, after preheating, in the reducing temperature of a carbon-resistance electric furnace already heated to the required temperature. The very short time necessary to get the tool to the temperature of the furnace eliminates injurious surface effects.

The increased efficiency and cutting power of tools that have received the proper heat treatment are out of all proportion to the time given to the study of the particular steel involved and to the care given the work. (*Bulletin of American Institute of Mining Engineers*, no. 121, January 1917, pp. 61-68, 5 plates. *epA*)

Report of Committee on Specifications for the Purchase and Preservation of Treatable Timber

Only parts of this report are here abstracted.

As regards the selection of preservatives, the report states that from the standpoint of permanent protection of wood against decay and marine borers, coal-tar creosote is the best available preservative for general purposes. It possesses the necessary theoretical requirements and has stood all practical tests through many years' use under varying conditions of service and in many different kinds of materials.

Zinc chloride is of great importance as a preservative and deserves full consideration in regions of low precipitation, in dry sections, and where general low cost is essential. While

the life of zinc-treated material is usually less than that of creosoted, the expense is also less.

Factors to be considered in comparing preservatives:

1 The toxicity of the preservative, namely, its ability to prevent decay.
2 The ability of the preservative to penetrate the wood.
3 The permanency of the preservative in the wood.
4 The effect of the preservative on the strength of the wood.
5 The effect of the preservative on the corrosion of spikes and plates, and the operation of block signals.
6 The cost of the preservative.
7 The uniformity in composition of the preservative and the ease of securing it.
8 The combustibility of the preservative.
9 The ease of handling the preservative and wood treated with it.
10 The ease with which the penetration of the preservative can be determined.

In treating with creosote it is recommended that a maximum injection of creosote sufficient to insure the penetration of all treatable wood be required. All the sapwood and as much of the heartwood as is possible for the particular species shall be thoroughly impregnated. This applies equally to full-cell and empty-cell treatments.

In treating with zinc chloride it is essential that all timber be treated to refusal.

As to selection of treatable timber, the fundamental requirements of structural timbers for treatment are strength and capacity for treatment to an extent which will insure protection against decay on all exposed surfaces. A penetration of one-half inch on the heart faces may be recommended as a safe minimum on structures above ground.

The report covers also the subjects of restrictions on knots, shakes, checks, cross-grain, sapwood, etc.; track ties; piles; preparation of timber for treatment, and treatment proper. (Abstracted from advance copy of report to be made at the Annual Meeting of the American Wood Preservers' Association in New York. January 23-25. 1917.)

THE RESISTANCE OF AN OIL TO EMULSIFICATION, Winslow H. Herschel

In forced-feed lubrication, such as is used with high-speed engines and turbines, there is often trouble due to the emulsification of the oil. Service tests are not practicable, on account of the time and trouble involved, so that there is great need of a laboratory test. Moreover, it is highly desirable that the test should make it possible to express the resistance of an oil to emulsification by a single numerical value, as experience has proved that it is almost impossible to enforce in a contract any less definite specification.

A study of the literature showed that though several emulsification tests were described, they were all more or less indefinite, and no one of them was in general use. It was therefore necessary to devise an entirely new test, which may be briefly described as follows:

Twenty cubic centimeters of the oil to be tested, and double that volume of distilled water, are heated to 55 deg. cent. (130 deg. fahr.) in a 100-cc. cylinder of 26 mm. (1 in.) inside diameter, and stirred for five minutes at a speed of 1500 r.p.m. The paddle is simply a plate of metal, 89 x 20 x 1.5 mm. ($3\frac{1}{2}$ x 13/16 x 1/16 in.), approximately. Since the test is not sensitive to slight changes of paddle dimensions, they need not be exact, and no calibration is required. The cylinder and contents are allowed to stand at the same temperature, and readings are taken at more or less frequent intervals (according to the type of oil) of the volume of oil settled out from the water. From these readings a maximum rate of settling, called the "demulsibility," is easily taken from a table.

A German test, used for steam-engine cylinder oils, would appear at first sight to discriminate against the good oils containing compounding in the attempt to eliminate the poor oils which contain soap. Examination of the experience with the test, however, shows that the method of agitation is not very effective, so that only oils which contain soap will emulsify. Good oils, even if they are compounded, will not emulsify. The test here described might be so modified as to make it applicable to steam-engine cylinder oils, but this has not yet been attempted, and in considering the results obtained with the test for demulsibility, compounded oils have been omitted, except where noted.

It has been found that the majority of oils on the market are either very good or very poor. The best transformer, dynamo and turbine oils settle out in a minute or less, thus showing a demulsibility of 1200 cc. per hour, which is the highest value on the arbitrary scale adopted. On the other hand, when an emulsifying marine-engine or crank-case oil is tested, no oil will settle out of the emulsion up to the end of the hour that the test is continued, and the demulsibility is recorded as zero.

Comparison with chemical tests shows that the stirring tests are the more sensitive, and this is in agreement with the experience of others. This explains why it has been such a troublesome problem to chemists, why one oil would emulsify and the other would not, when according to their tests, both oils were equally pure. The stirring test shows that a minute amount of impurity, which cannot be detected by chemical means, will cause a marked increase in emulsification.

Oils which have a suitable demulsibility will not emulsify in use, but there is still the trouble that, after a considerable length of time, they may disintegrate and deposit sediment, due to oxidation, polymerization, or some other similar chemical change. On this account an investigation of used oils was undertaken, and it was found that there was a marked decrease in demulsibility with continued use. The conditions of operation are so different in different power plants that exact values can not be given for the rate of deterioration to be expected, but it is believed that the test should prove of great assistance to power-house engineers in keeping track of the deterioration of the oil in their plants. (Abstract of *Technologic Paper* no. 88, Bureau of Standards)

Fuels and Firing

NEW METHOD OF INDICATING DENSITY OF SMOKE, as Installed on the U. S. S. *Conyngham,* Rear-Admiral R. T. Hall, U. S. N.

The system installed on the after stack of the ship consists of a light transmitter installed on one side of the stack, a light receiver installed on the opposite side, and an indicating meter with suitable control appliances installed in the boiler room.

The basic principle of operation of the system is dependent on the peculiar property of selenium, namely, that its electric resistance is inversely dependent on its illumination.

In this case a beam of light is projected across the stack, and its intensity when it reaches the selenium varies with the density of the smoke. Hence, if a plate of selenium of suitable structure is placed opposite to the source of projected light, its electrical resistance will vary with the density of the smoke, and by connecting the selenium plates in series with a suitable indicating meter to the source of electric-current supply, variations of smoke density will be made manifest by variations in the current flowing through the meter.

On a metal plate in the boiler room are installed the smoke-indicating meter and a potentiometer, the latter being provided with a slidable brush for adjusting the potential on the selenium plate and serving as a simple and effective means for setting the indicator on the "clear" indication, as when no smoke is issuing from the stack. The system is connected with the ship's lighting main at 125 volts. (Paper before the Annual Meeting of the Society of Naval Architects and Marine Engineers, November, 1916, from an abstract in the *International Marine Engineering*, vol. 21, no. 12, December 1916, p. 539. *d*)

Sawdust Firing at the Singer Plant at South Bend, Thomas Wilson

One of the large branch factories of the Singer Manufacturing Co. is located at South Bend, Ind. Here all cabinet work and stand-part operations are performed, from the raw material to the finished product. A large plant was required to supply these works with steam for heating, factory use and power purposes. There are three boiler plants with a total of 3016 boiler horsepower in 18 units, consisting mostly of small water-tube boilers provided with plain grates and arranged for burning coal and sawdust.

The most interesting feature of the plant is the system for burning the sawdust.

The sawdust is fed to the boiler furnaces independently of the coarser material. The collector system (Fig. 2) consists of four steel towers outside the machinery building. All the various trunk ducts are carried into these main towers, the suction being furnished by eight large motor-driven fans, two for each tower (the fans are driven by four 180-h.p. synchronous motors). Four small fan equipments in series, each somewhat larger than its predecessor, remove the sawdust which drops into the collectors and deliver it successfully from tower to tower until it is finally discharged into the collector located above the boiler room.

Upon leaving this latter collector the sawdust drops through chutes into a horizontal scraper or flight conveyor. Through gates in the conveyor bottom the sawdust drops into six steel tanks, one for each boiler. As soon as the first tank is filled, the gate may be closed or in any event the sawdust will automatically pass on and drop into the next opening. These tanks are on a level with the firing floor. They are oval at the top and flare out at the bottom so that there will be no difficulty from the sawdust arching and lodging in the upper part.

At the bottom of each tank are two friction-disk-driven screw conveyors which carry the sawdust over and drop it into the chutes on top of the boiler furnaces. Means are provided for individual adjustment of the rate of feed of each furnace.

The method here described obviates the danger of unevenness of the fuel supply and excess of either air or fuel and permits of accurately controlling both fuel and air.

Since the power plant has been installed, general conditions forced certain changes. It had been the plan to store the excess of sawdust in the summer months when the demand for fuel is low, and use the surplus to supplement the supply during the heating season. Various conditions have greatly reduced the output of waste available for use as fuel, and coal has to be used at times. When so used it is burned exclusively at night for supplying steam for the dry-kilns, pumps and lighting.

The original article reports data of tests of the boilers with sawdust fuel. It is of interest to note that with this fuel a superheat of 560 deg. fahr. is attained, an evaporation of 4.33 lb. of water per pound of fuel as fired, and an equivalent evaporation per pound of fuel from and at 212 deg. fahr. of 5.09 lb. of water. The efficiency of boiler and furnace combined, based on dry fuel, was found to be 64.9 per cent. (*Power*, vol. 44, no. 25, December 19, 1916, pp. 838-844, *d*)

A unique scheme is used in the design of the apparatus for controlling the high-duty elevator pumping engines at this plant, described in *Power*, vol. 44, no. 26, December 26, 1916, p. 874.

Hydraulics

A Theory of Fluid Friction, William Gatewood

An attempt to correlate the laws of fluid motion having a bearing on the subject of frictional resistance, and to formulate a theory.

This theory may be summarized as follows:

1 Frictional resistance per unit of surface varies as the square of the equivalent rubbing velocity determined by considering the flow to be laminar.

2 Friction between adjacent laminæ of the fluid varies as the rate of change of velocity occurring at their boundary.

3 In the case of a fixed body and a moving fluid, the frictional resistance experienced up to a given distance abaft the cutwater must be balanced by the loss of head in the wake at the same distance abaft the cutwater.

4 The width of the wake at a given distance abaft the cutwater and the reduction of velocity in the wake at various distances from the fixed body may be determined by the consideration that the loss of head outboard of any lamina is equal to the frictional resistance experienced by the lamina before reaching the given distance from the cutwater.

5 The determination of the loss of head in the wake is complicated by the condition that the volume of the fluid passing the fixed body is not altered, although the velocity in the wake is decreased. The consequent elevation of the surface of the fluid becomes of considerable importance when the velocity is relatively small or the reduction in velocity occurs quickly on account of roughness of surface.

6 The energy and action of the eddies may be assumed to be such that the loss of head may be determined as though the flow was entirely laminar. (Paper read before the Annual Meeting of the Society of Naval Architects and Marine Engineers, November 1916, abstracted from *International Marine Engineering*, vol. 21, no. 12, December 1916, pp. 543-544. *t*)

The Effect of Sudden Enlargement upon the Flow of Water in Pipes, T. J. Rodhouse

Paper describing experiments conducted for the purpose of determining the effect of sudden enlargement of section upon the flow of water in pipes. Coincidentally the action of the pitot tube has been studied under disturbed conditions of flow,

with a view to determining the conditions under which the tube may be relied upon to give accurate indications.

The paper describes the apparatus used. The investigations were limited to the two cases of the effect of sudden enlargement from pipes of 1 in. and $1\frac{1}{2}$ in. in diameter to one whose diameter is 2.096 in. The pipes were straight, smooth, seamless drawn brass tubing.

The pitot tube consisted of a straight cylindrical german silver tube $\frac{1}{16}$ in. in diameter and projecting about $\frac{3}{32}$ in. from the end of a larger brass tube of $\frac{5}{16}$ in. external diameter by $\frac{3}{16}$ in. internal diameter having hose connections and a setting arm or pointer for indicating correctly the position of the impact opening when placed in the pipe. The tube had only a single impact opening $\frac{1}{32}$ in. in diameter located passes through a thumbnut set in the upper end of the frame. By turning the thumbnut the tube can be quickly and accurately set and firmly held at any desired position in the traverse. The author attributes the uniformity of readings in practically all of these traverses largely to this accurate means of controlling the position of the impact point. The impact opening was circular, $\frac{1}{32}$ in. in diameter, and in making a traverse the opening was kept pointing directly upstream, its axis always parallel to the axis of the pipe.

The writer suggests the following expression for the loss of head in feet due to sudden enlargement:

$$H_b = K\left(\frac{A_2}{A_1} - 1\right)^2 \frac{V_2^2}{2g}$$

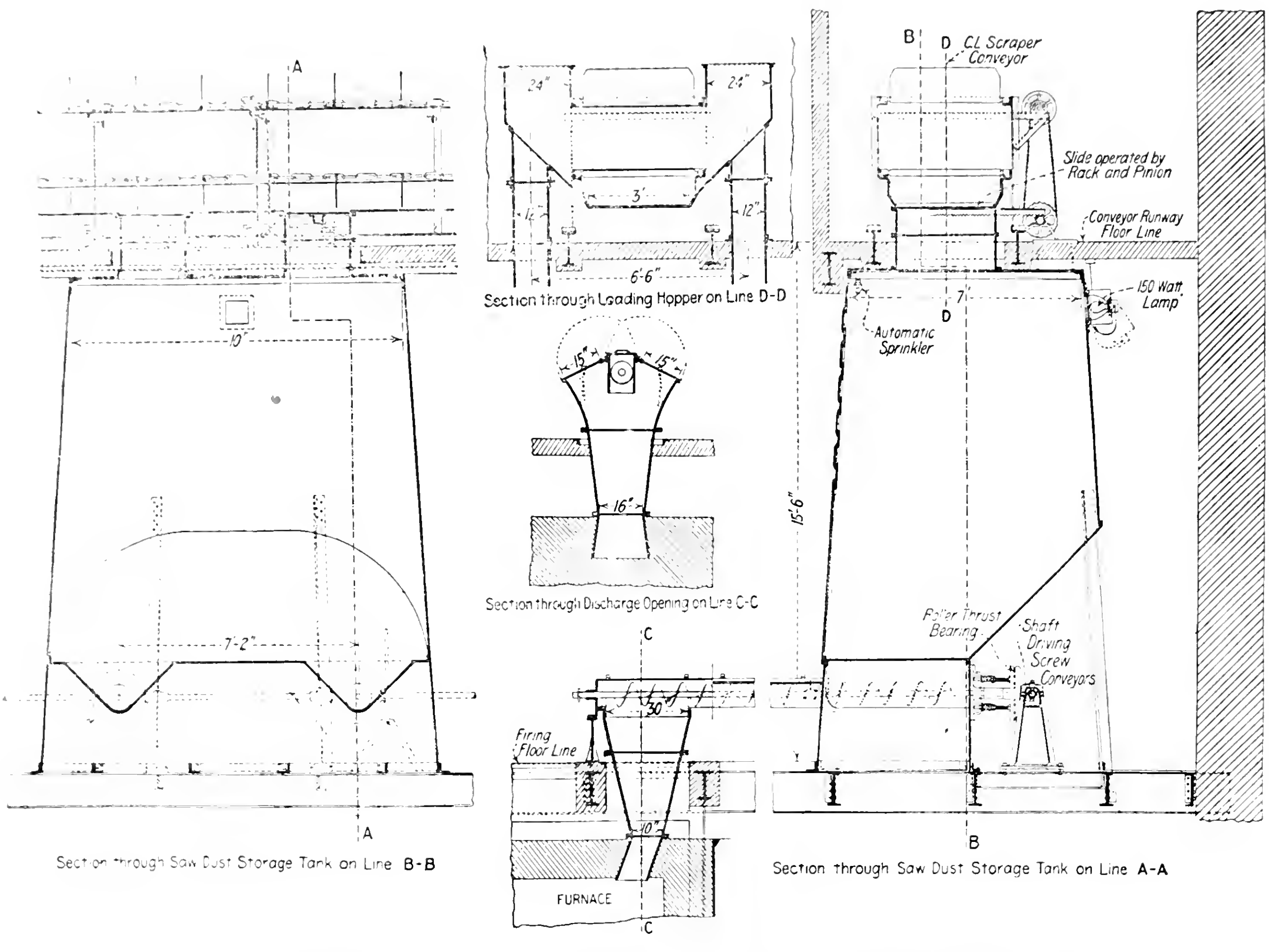


FIG. 2 SAWDUST-FIRING PLANT OF THE SINGER MANUFACTURING CO., SOUTH BEND, IND.

0.04 in. from the end, with its axis intersecting at right angles the axis of the tube. The static pressure was taken at the piezometer at the wall of the pipe in the same plane with the tube. The pressures from the impact opening and the static piezometer were conducted to the triple differential gage through $\frac{1}{4}$-in. heavy cotton-insertion rubber tubing.

An attachment invented by Prof. G. S. Williams for facilitating the setting of the tube was used. It consists of a brass frame whose base fits snugly over the stuffing box and is securely clamped there by three set screws. The frame is slotted on each side for guiding the central tube which receives the main stem of the pitot tube, holding it in place by a large thumbscrew. This central tube is threaded its full length and which is a constant, times the theoretical loss by Borda's formula. In this equation, A_2 and A_1 are the areas of the larger and smaller pipes. V_2 is the mean velocity in feet per second in the larger pipe (in the formula on p. 59, apparently by typographical error, V is used.—Ed.) and $g = 32.2$; K is a coefficient. Two tables are given in the article in which values of K are given. These tables show a slightly smaller loss of head as observed than the computed theoretical loss due to enlargement as expressed by Borda's formula. In the opinion of the writer, this discrepancy may be due to one or two causes, or perhaps to both. Either the frictional loss which enters into this equation is less than that which occurs in the case of the straight pipe with undisturbed flow, due perhaps to the cen-

ter of velocity of the jet as it enters the larger pipe and continues in this condition for some distance before spreading out and obtaining its full pressure and frictional effect on the wall of the pipe, or else the loss in the impact of the particles in the expanding jet due to the enlargement of the pipe section does not follow exactly the law for sudden enlargement as expressed in Borda's formula, failing to obey this law, perhaps, on account of conditions which might be considered as producing a water cone of gradual instead of sudden enlargement. The author prefers the latter theory as a possible explanation rather than the former, for it is difficult to imagine any reduction in frictional resistance less than that for straight pipe in the region of these greatly disturbed conditions.

As regards the pitot tube, the final results obtained in this investigation are summarized by the author in the following words:

1 The pitot tube measures with a fair degree of accuracy, always within two or three per cent and more frequently within one per cent, the velocities of flow in a pipe where the resultant motion of the water throughout the entire cross-section at the point where the tube is inserted is a forward motion, and where the distribution of velocities is symmetrical about the axis of the pipe.

2 The pitot tube is a means by which eddies or whirls caused by obstructions in the pipe may be detected, but it will not measure with any degree of accuracy the discharge of a pipe when inserted in the immediate region of such eddies.

3 The rating coefficient of discharge of the pitot tube for normal conditions cannot be applied in the case of abnormal conditions produced by sudden enlargement where eddies exist, but immediately below the region of eddies the rating coefficient of discharge may be applied with a fair degree of accuracy.

4 The eddies produced by sudden enlargement of section extend for the short distance of only about two or three diameters below the enlargement.

5 The disturbance caused by sudden enlargement of section produces abnormal conditions in the distribution of velocities which continue down the pipe for a distance of about 35 diameters.

6 The ratio of the mean velocity to the velocity at the center, $\frac{V_m}{V_c}$, increases in value, in the case of sudden enlargement, from a minimum near the point of enlargement to a maximum at a point about 11 diameters downstream, after which it begins to gradually decrease, approaching the value of the ratio for flow in straight pipe at a distance of 35 diameters below enlargement.

7 The pitot tube reversed, i. e., the impact point turned downstream, gives a negative pressure head, which reduced to velocity, negative, gives a value whose ratio with the velocity in the upstream direction is fairly constant for any given form of tube. But the relative values of the downstream readings to the upstream readings for different forms of tubes vary greatly. The maximum negative pressure or suction action at the impact point of the pitot tube occurs when the direction of the axis of the opening is approximately perpendicular to the direction of flow. (*The Cornell Civil Engineer*, vol. 25, no. 2, November 1916, pp. 49-61, 2 figs. *et*)

The Flow of Water in Wood-Stave Pipe, Fred C. Scobey

A paper on the determination of capacity and on the design of wood-stave pipe, based both on the theoretical investigations and field tests.

The author offers a new set of formulæ based on experiments on round wood-stave pipe described in engineering literature and supplemented by an extensive set of experiments in which he was aided by Ernest C. Fortier. These formulæ are as follows:

$$H = \frac{7.68\,V^{1.8}}{d^{1.17}} = \frac{0.419\,V^{1.8}}{D^{1.17}} \ldots\ldots\ldots\ldots [1]$$

$$V = 1.62\,D^{0.65}\,H^{0.555} \ldots\ldots\ldots\ldots [2]$$

$$Q = 1.272\,D^{2.65}\,H^{0.556} \ldots\ldots\ldots\ldots [3]$$

where H is the head of elevation lost in overcoming internal resistances within a fairly straight pipe of uniform size per 1000 linear feet of pipe; V the mean velocity of the water during test in feet per second; D the mean inside diameter of the pipe in feet; d the mean inside diameter of the pipe in inches; and Q the mean discharge of the pipe during the test in second-feet.

The exponents of V and H in these formulæ are the same as those in the corresponding formula proposed by E. A. Moritz (*Engineering Record*, vol. 68, no. 24, p. 667). The difference in the formula is caused by the divergence in the intercept curves in the logarithmic diameter shown in the original article. As indicated in these curves, the difference becomes greater as the larger pipes are approached, for the reason that all data for large pipes in the Moritz formula came from his tests on the 55¾-in. Mabton pressure pipe.

The writer comes to the following conclusions:

1 That the new formula herein offered is the best now available for use in the design of wood-stave pipes, as its application meets (within one per cent) the mean of all observations and the mean capacity of all wood pipes upon which experiments have been made.

2 That a very conservative factor of safety should be used where a guaranteed capacity is to be attained.

3 That the Kutter modification of the Chézy formula is not well adapted to the design of wood-stave pipes.

4 That the data now existing do not show that the capacity of wood-stave pipe either increases or decreases with age. This statement of course does not consider sedimentation, a purely mechanical process.

5 That if silted waters are to be conveyed, the pipe should be designed for a working velocity of from five to ten feet per second.

6 That if sand is present in the water, the design should be for a velocity of about five feet per second, which will be high enough to carry out a large part of the sand and at the same time not so high as to seriously erode the pipe. The better method, of course, is to remove the sand by sumps or other means.

7 That air should be removed from the intake end of every pipe line, especially when the capacity load is approached.

8 That wood pipe will convey about 15 per cent more water than a ten-year-old cast-iron pipe or a new riveted pipe, and about 25 per cent more than a cast-iron pipe 20 years old or a riveted pipe ten years old. (*United States Department of Agriculture, Bulletin No. 376*, 96 pp., 7 figs. and several large plates, *et.*1)

Internal-Combustion Engineering

An American Oil Engine, Frank C. Perkins

Description of a novel two-cycle two-cylinder oil engine developed at Milwaukee, Wis.

This oil engine works on the two-cycle Diesel principle,

and is characterized by the employment of a cylinder in which operate two working pistons opposite to each other, as shown in Fig. 3. Shortly before the upper working piston has reached its uppermost position, it uncovers the exhaust ports arranged along the whole circumference of the cylinder, at which time the burned gases from the previous working cycle pass through an exhaust manifold into the surrounding atmosphere.

Immediately after this the lower working piston uncovers its scavenging ports likewise arranged along the whole circumference of the cylinder, through which the scavenging air rushes in, driving out the remaining products of combustion and charging the cylinders with fresh cold air. The placing of the ports for the admission of scavenging air at the cool lower end of the cylinder allows cold air to be admitted and insures a more effective charge. During the following compression stroke of the two working pistons the charge is compressed to a temperature well above the ignition point of the fuel employed.

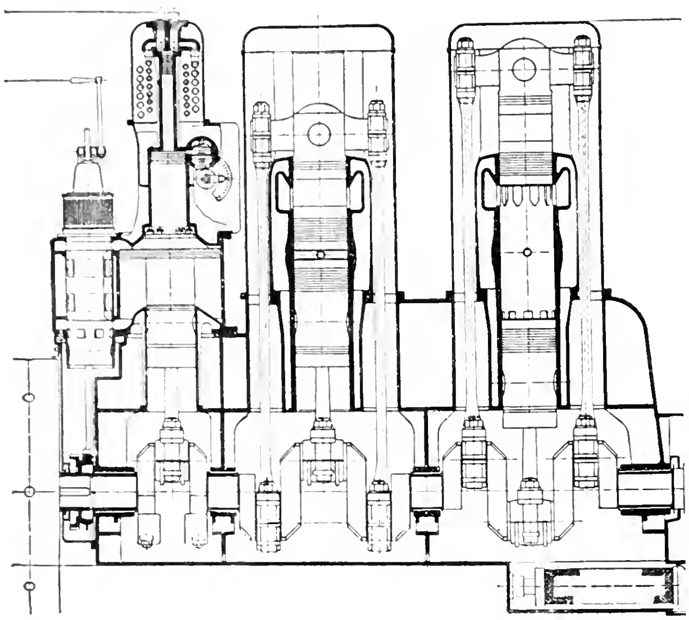


Fig. 3 Opposed Pistons, Two-Cycle, Two-Cylinder Oil Engine

The engine built produces 60 b.hp. when operating at the speed of 400 r.p.m. The cylinders have a bore of 6 in. and stroke of 14 in. It is stated that the forces developed by the combustion of the fuel are entirely taken up by the two working pistons with their connecting rods and cranks.

It is claimed that the air receiver is separated from the crank case, so that the dampness of the lubricating oil from the crank case cannot contaminate the scavenging air. The working output of the scavenging pump is small because it delivers the scavenging air to the receiver under a pressure of only 2 lb. per sq. in., which is entirely sufficient to clean the working cylinders of the burned gases. The compressed air for fuel injection is produced by a single-acting two-stage air compressor mounted in tandem over the scavenging pump, whose stepped piston is the extension of the piston from the scavenging pump. The air pressure in the injecting-air bottle delivered from the high-pressure stage should remain constant at about 1,000 lb. per sq. in. under the varying load of the engine. The compressor delivers a little more air than is required for fuel ignition, and this surplus, passing through a by-pass valve connected with the low-pressure stage of the compressor, is stored in the starting tank under a pressure of about 150 lb. per sq. in.

The valves on the compressor are of the automatic type. Special relief valves are fitted after every stage of the compressor to prevent excessive pressure in the air mains. The fuel pump is driven by means of helical gears direct from the crankshaft, and a separate plunger is provided for each working cylinder of the engine. The governor actuates the suction valve of the fuel pump in such a manner that the amount of fuel delivered to the working cylinders is in accordance with the load carried by the engine.

It is claimed that the combustion space between the two pistons, being a circular chamber without projections or recesses, constitutes the most efficient form of combustion chamber. The period of injection of the fuel into the working cylinder is variable in such a manner that the needle of the fuel-injecting valve remains open for a longer period when operating under a full load, and closes earlier when under a light load. This arrangement prevents the disturbance of combustion because the quantity of air needed for breaking up the fuel and injecting it into the combustion chamber is in accordance with the varying load of the engine. It reduces further the power output of the air compressor and gives the engine a high degree of speed variation.

The engine is started by means of compressed air at low pressure. By turning the starting lever the compressed air is admitted through a distributing valve to both sides of the piston of the scavenging pump, which now acts as an air motor and sets the engine in motion. It is stated that this engine can be started at a low air pressure of 150 lb. per sq. in., but the starting continues to be effective even should the pressure drop to 60 lb. per sq. in. The article also describes the forced-feed lubricator used on this engine. No data of tests are reported. (*The Isolated Plant,* vol. 8, no. 12, pp. 13-14, 2 figs., December 1916. *d*)

Diesel-Engine Construction in the United States

Up to a couple of years ago it cannot be said that there was any extensive production of Diesel engines in the United States, even though arrangements for it were being made. Since then, however, mainly because of the impetus given by the abnormal conditions in shipping, extensive developments have taken place. About a year ago three of the most important shipbuilding companies in the United States, having recognized that the large merchant motorship had come to stay, laid plans for the immediate and near future by securing constructional licenses from prominent European firms who had obtained practical success with high-powered marine Diesel-type oil engines.

Although Germany is the original home of the Diesel engine, they went for their designs not to that country but to Denmark and Holland, where greater strides have been made with the marine development. The William Cramp Ship and Engine Building Company secured a license from Burmeister & Wain, of Denmark; The New York Shipbuilding Company and the Newport News Shipbuilding & Dry Dock Co. licenses from the Werkspoor Company (Holland).

It is stated that no sooner had these firms concluded negotiations than they were overwhelmed with orders for steamships, which has somewhat delayed motorship building.

It is also stated that the shipbuilding yards controlled by interests connected with the Bethlehem Steel Company are now developing a Diesel-engine type under the supervision of engineers of that corporation.

In this connection, of considerable interest are data referring to a Diesel motorship designed by The New York Shipbuilding Company at Camden, N. J., to the order of an important American oil company.

She is a single-screw ship designed to carry oil in bulk, and is of the single-deck class with poop bridge and forecastle. Length overall, 260 ft.; breadth, 42.5 ft.; draft, 20 ft.; deadweight capacity, 3000 tons; indicated horsepower, 1360; speed loaded, 10 knots.

The engine is to be a six-cylinder, single-acting, four-cycle model of the Werkspoor pure-Diesel design. Cylinders, 22 in. bore by 39⅜ in. stroke; the total of 1360 i.hp. to be developed at 125 r.p.m.; mean effective pressure, about 100 lb. per sq. in.

The length of the engine overall will be 27 ft. 3 in., and height above shaft center, 16 ft. 9 in.; the net weight will be about 122 tons, while the total machinery weights are expected to be in the neighborhood of 220 tons. Auxiliaries will be steam-driven, and probably the exhaust gases from the main engine will partially be used for firing the donkey boiler, so as to economize on fuel.

An oil-fired or coal-burning steamer of the same dimensions and speed could not carry this amount of cargo and would, therefore, have a much lower earning power. In addition to this, the fuel bill of the motorship will be about one-fourth that of a steamer. Her tonnage bill will be less in proportion to cargo, and there will be no wages or food bill for stokers. Her oil-fuel bill for a 17-day voyage will be under $1000, this with oil at $1.50 per bbl.; but as she will take oil in Texas or Mexico, this cost will actually be reduced by 50 per cent. Hence it is expected that, as compared with a steamer of the same size, she will show high economic advantages. (*Motorship*, vol. 1, no. 8, December 1916, p 10, 1 fig. *dc*)

The Motive Power of the M. S. Deutschland, Russell Palmer

Description of the motive power of the merchant submarine *Deutschland* from data obtained from the officials of the company operating the vessel. The article is based upon a personal interview with Chief Engineer H. Kleis of the *Deutschland,* at New London, Conn., on November 6.

From data published in the article it appears that the engines are of the Krupp type and are built on the four-stroke cycle. Further, the well-known Krupp bronze construction is not used in this instance (it is stated that it has been retained only in the two-stroke-cycle motors which continue to be built), and steel and cast iron are employed instead.

According to the statement of the Chief Engineer, the submarine is fitted with two six-cylinder engines somewhat smaller than the regular Krupp submarine engine and somewhat simpler in construction.

As to dimensions, Mr. Kleis, in the first interview, stated that the cylinders have a bore of 45 cm. (17.35 in.) and a stroke of 60 cm. (23.4 in.). Subsequently, however, Mr. Kleis changed these dimensions to 40 cm. × 50 cm. He also stated that while these engines have a range of speed from 200 to 400 r.p.m., the ordinary operating speed is 380 r.p.m., i. e., not far from the maximum. Assuming that this maximum speed is correct, that would mean a piston speed of nearly 1600 ft. per min. and an output of almost 1300 b.hp., which, if true, is certainly remarkable. It seems, however, more likely that the ordinary operating speed is not 380, but 280 r.p.m. A stroke of 60 cm. would mean that the engine is 9 ft. high, which is, however, not impossible, as the submarine has a generous beam to give her the cargo-carrying capacity so essential in her work.

It is stated that a special adjustment to the fuel-injection valve permits it to be adjusted, when the engine is at a standstill, for each general range of speed, either high or low. Pressure in the cylinders at the moment of fuel injection is from 42 to 45 atmospheres. No trouble from cracked pistons or cylinders was experienced, even though, on the first round trip, the engines are stated to have turned over more than 11,000,000 times.

An illustration in the original article reproduces the only photograph ever made of the engine room of the submarine. That the engines are Krupp is shown by the beveled cylinder heads with fuel-injection valves set in on angle. This is a unique feature of the Krupp motor. It is also apparent from the double valve mechanism that these are four-cycle engines. As this photograph could not be reproduced for technical reasons, another illustration (Fig.4) is given, which the editor has

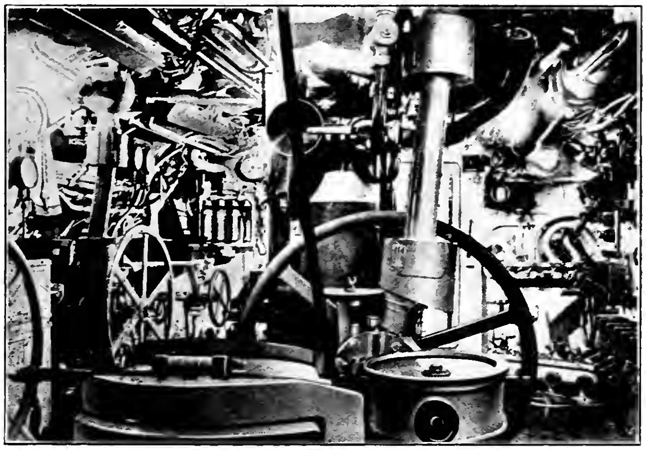


Fig. 4 Central Control Room of the Submarine "Deutschland," Depth Rudder to the Left

been able to secure through the courtesy of Mr. Chas. H. Bedell, Electrical Engineer, Electric Boat Company, Groton, Conn. (*Motorship,* vol. 1, no. 8, December 1916, pp. 3-4, 1 fig. *d*)

A Study of Oil Engines in Iowa Power Plants, H. W. Wagner

Bulletin of the Iowa State College of Agriculture and Mechanic Arts.

The bulk of this Bulletin was written in the early part of 1915 and was based on data gathered before that time. During the interval between the writing and publication, many industrial and commercial changes have occurred, and in particular the price of fuels has changed and the cost of many materials of construction has become abnormal. The Bulletin, however, retains a considerable amount of interest. It covers the use in Iowa of oil engines, carburetion, semi-Diesel and pure-Diesel types, and presents a large amount of valuable statistical material.

It was planned by the Iowa Engineering Experiment Station to secure a list of oil engines in the State, to visit them, and to test some of them, the primary object of the tests being to secure fuel-consumption figures at various loads. For this reason only electric-light and power plants were chosen, as the current from the electric generator offered the most convenient reliable medium for measuring the power developed. Other related measurements were taken, however, such as quantity

of cooling water used, temperatures, indicator cards, and data necessary to calculate a fuel heat balance.

In general it was found that a high-compression or Diesel engine has better fuel economy than the medium-compression or semi-Diesel engine, which in its turn has better fuel economy than the low compression or carburetion engine. The engine with higher compression not only consumes less fuel for a given output of power, but also burns a fuel which costs less per gallon; but its first cost is higher than that of a low compression engine.

Tests on twelve engines of various makes and types showed a fuel consumption per estimated b.hp-hr. ranging from 2.95 to 0.55 pints. Reports of monthly operating records from seven of the most efficient oil-engine plants in the state show a range of from 2.60 to 1.03 pints of fuel oil per kw-hr. generated. Corresponding fuel costs ranged from 1.30 to 0.39 cents per kw-hr. The high figure is taken from a plant containing three carburetion engines with a total rating of 330 hp., burning distillate figured at 4 cents per gal. The low cost is from a plant containing a 225-hp. Diesel engine burning fuel oil figured at 3 cents per gal.

Fuel combustions during tests did not always average as good as guarantees submitted by manufacturers and agents for the same engines at the same loads. Most of these tests were made without any special preliminary adjustments.

Attendance labor is less in small plants when an oil engine instead of a steam engine is employed, and such is also likely to be the case for larger plants when coal is fired by hand. Lighting plants in many towns of about 500 or 600 population are operated by oil engines, and seem to be holding their own in a financial way. The cost of generating by steam under the same conditions might be almost prohibitive. For engines of over 225 hp. capacity, additional experience is necessary to determine whether best final economy is to be reached by Diesel or steam power.

As to reliability, it is stated that the present oil engine of any type is inherently less reliable than the steam engine or turbine, and more skill is required to keep the oil engine running smoothly. Recent installations indicate, however, that power engineers are gaining confidence in the reliability and general advantage of semi-Diesel and Diesel engines for small and medium-sized power plants.

Oil-engine lubrication has presented a perplexing problem in numerous cases. Proper characteristics required by individual engines and possessed by particular lubricants are not well enough known. Some oil engines are cooled by raw well water, which is then run into the waste. Other plants have installed a cooling tower or basin and use the same water over and over.

Practically all oil engines possess a tendency to knock or pound at times.

Difference of final costs with carburetion and semi-Diesel engines is less than might be expected. A lower price per gallon of fuel oil and a lower fuel consumption with the semi-Diesel are partly offset by the lower first cost of the carburetion engine and lower assumed rates of depreciation and repairs. These rates have been assumed on the basis of past performance. It seems likely that, in the future, such rates will be more nearly equal. Broader experience at both the manufacturing and operating ends is leading to better reliability and fuel economy in the semi-Diesel engine. Also increased production is likely to lower the first cost of the latter type. In the above calculations the price of fuel oil for the carburetion engine is assumed at four cents per gallon and that for the semi-Diesel at three cents. The difference is only one cent, but when it is more, as often occurs, the advantage in favor of the semi-Diesel will be increased accordingly.

The Bulletin contains cost figures of operation of various types of oil engines based upon prices existing during 1914 and 1915. A summary of these calculations is given in the following table:

Unit of Energy	Engine Carburetion 50 hp.	Semi-Diesel 50 hp.	Diesel 120 hp.
Brake hp-hr.	2.91	2.75	1.72
Kw-hr. generated	6.60	6.28	3.50
Kw-hr. delivered to line	9.79	9.39	3.50
Kw-hr. delivered to consumers	14.83	14.34	5.78

Consideration of general operating factors, and the actions of manufacturers, then, point to greater future advantages of the semi-Diesel over the carburetion engine than would be indicated by figures in the above tabulation.

In noting the lower energy costs with the Diesel engine, it should be understood that they are due not only to better fuel economy but also to a larger unit and to a greater service demand which eliminates the necessity of a storage battery. (*Official Publication of Iowa State College of Agriculture and Mechanic Arts,* vol. 15, no. 10, August 20, 1916, Bulletin 42, Engineering Experiment Station, 159 pp., 55 figs, *ecs*)

Piston and Small-End Lubrication in Diesel Engines, George B. Vickers

Discussion of lubricating troubles in Diesel engines, which the speaker ascribed either to the use of unsuitable lubricating oil or to faulty design.

For Diesel-engine lubrication, pure mineral or hydrocarbon oils are the best, as they contain a much smaller percentage of acid than animal or vegetable oils. Many compound oils are good, but, although they may be carefully blended originally, there is sometimes evidence of disintegration under repeated use. They are also liable to give a gummy deposit. The best test of lubricating oil is on the air compressor. If the oil causes pitting on the compressor valves and shows an acid scouring action on the valves in the air-bottle beds, one may expect the main-cylinder-liner wear to be excessive. As to the amount of the latter, figures taken from a number of engines give a mean wear of 0.010 in. to 0.012 in. per 1000 hours run when the engine is heavily taxed. The lubrication requirements of the small ends and the pistons are contradictory. For pistons, an oil with a moderate viscosity of say 130 to 180 at 140 deg. fahr. gives good results, while an oil with a good viscosity of say 400 to 500 at 140 deg. fahr. is best for small-end lubrication.

For enclosed-type engines thicker oil is required than with the open type, as the temperature inside the crank case is much higher than on open-type engines.

In the works of Hick, Hargreaves & Co., Ltd., a number of naval high-speed engines were constructed and tested under load. With thin oil which had a viscosity of 110 at 140 deg. fahr., difficulty was experienced and the fuel consumption was high. Thicker oil having a viscosity of 140 at 140 deg. fahr. was then used, reducing the consumption from the minimum of 0.45 lb. per b.hp-hr. to 0.419 lb.

A lubricating oil used for pistons or small ends should not emulsify, so that if any water drops in the crank pit it can afterward be separated. When a different oil is used for top-end lubrication than is used for the piston, care should be taken that the oils will blend.

Filtered oil should not be used too often on the pistons, as its viscosity gets too low for this work.

The customary method of piston lubrication is through four or six stems or quills leading through the water jacket to the liner. Many engineers now insist on having a separate feed to each quill, that is, they have a six- or eight-feed lubricator fitted for each cylinder. It is costly but a good plan. Piston seizures have been caused by faulty arrangement of lubricating pipe and leaky back-pressure valves.

Trouble resulted also from improper arrangements of lubricating pumps. In the majority of cases they are driven from the crankshaft and so are placed much higher than the quill line. The result is after a short stoppage the feed pipe has been drained and the piston fails to receive any lubrication for a few minutes after starting. A good plan now adopted by one or two firms is to have the lubricators fixed well below the lubricating belt line and work off the indicator gear on the vertical shaft, thus insuring that the pipes are always charged. The pump should be fitted with a flushing arrangement in case of necessity, and preferably sight feeds with regulating valves. The check valve on the lubricator pipe should be well designed and periodically examined to make sure that there is no bituminous matter holding the valve up and interfering with the supply.

Trouble has been avoided (Mr. Lyle) by altering the piping so that the check valve was vertical and therefore assisted by gravity in keeping on its setting.

The method of securing the quills is sometimes a cause of trouble. Some makers prefer a tapered hole in the liner and provide the quill with a rounded nose: the quill is then screwed home tight over a tapped hole on the water jacket. When the parts get warm and expand, these quills have been found to act as struts and have caused piston seizures immediately opposite to the lubricating holes. An improved method is to have the quill screwed into the liner, a plain hole in the water jacket, and an external joint made. In England a telescopic quill is used.

Some makers have adopted instead of the quill method of lubrication one termed "splash system." With this system the pistons have skirts which protrude well beyond the lower edge of the liner at the bottom of the stroke. The piston relies on the splash from the bottom end of the connecting rod for its lubrication. It was found that this system is effective on pistons up to 14 or 15 in. in diameter, but quite unreliable on larger-type engines. Its chief trouble is that lubrication cannot be regulated, is very uncertain, and there is a tendency to wastage.

Top-End Lubrication. Phosphor-bronze bearings are usually adopted for the top-end bearings, and attempts to use white metal proved unsatisfactory. The wear on phosphor-bronze bearings is seldom more than 0.001 in. per year, while white-metal bearings may show more wear than this in one week. When a phosphor-bronze split bush is used, the average clearance is 0.003 in. vertically and 0.006 in. at each side. More clearance is required if the bush is solid, say 0.006 to 0.008 in. vertically and 0.008 in. at the sides.

The gudgeon pins should be fully case-hardened at the ends as well as on the bearing surface. A case occurred recently where the pin was left soft at the ends, and when tapping the pin into the piston the end of the pin was bulged, and when forced into the piston it split the boss in two places.

The position of the gudgeon pin in the piston is very important. If the pin is located too low, the piston will tend to heel over at the top when maximum compression pressure occurs; similarly, if the point is located too high, the piston will tend to heel over when the maximum working thrust occurs. A good long skirt is advisable to act as a guide and to reduce the pressure per unit area due to thrust. The length of guiding surface on the piston should be 1.4 to 1.6 times the diameter for slow-speed engines, but may be reduced to 1.2 times the diameter for high-speed engines.

The writer proceeds to describe the methods for lubricating the top-end bearings: viz., the scraper system, the banjo system, and the one using one or two slots in the piston which pass over the leads from the oil-supply pipes and hose leading from the bottom of the slots through the piston to the center hole in the gudgeon pin. If this latter method is used, it is preferable to have two slots in the piston, one midway between crankshaft center line and cross center line on the front side of the piston, and one directly opposite, so that whichever side of the liner the piston is thrust against, one of the slots is able to scrape the maximum quantity of oil from the liner. The slot is best when V-shaped in section, and the top and bottom should be undercut at about 45 deg., the scraping edges being left moderately sharp. A sluice should also be cut to connect the top of the slot and a circular scraper groove cut in the piston to take advantage of the oil scraped off the walls by this groove. The slot should be fairly long, but a moderate head of oil should be allowed between the bottom of the slot and the top of the gudgeon pin. The oil hole should have a large countersink both in the piston and also where it enters the pin. The hole in the center of the pin should be at least $1\frac{1}{4}$ in. in diameter for a 6-in. pin, as it acts as a reservoir for the oil. Two holes at least should be drilled from the top of the pin to the center, one close to each end of the bearing surface: these holes may be drilled at 30 deg. to vertical center line. Both these holes should lead into a longitudinal groove on the top surface of the pin. These grooves should have well-rounded edges to assist the oil to escape.

A system of forced lubrication on all of the bearings effectively solves the problem of top-end piston lubrication, but has its disadvantages, as it is thought likely that the piston will receive too much lubrication. The oil is thrown from the bottom-end bearings on to the liner walls, and when the piston is on its suction stroke the slight pressure in the crank chamber tends to force the oil past the relaxed rings, the result being that the lubricating oil is burned, and very peaky indicator cards are obtained, showing a maximum pressure frequently of from 100 lb. to 150 lb. above compression pressure. The high consumption of lubricating oil has retarded the progress of the enclosed type of engine. These difficulties have been overcome, first, by guarding the bottom-end bearings to avoid splash on to liners; second, by preventing the oil from creeping from top-end bearings along the gudgeon-pin keyway on to piston surface; third, by providing scraper grooves on pistons with return ducts to inside; fourth, by dissipating the vapor in crank chamber, this vapor tending to pass the rings on the suction stroke.

The speaker objected to the common method of withdrawing the oil vapor in the crank chamber, which is to take the air-compressor suction or the main-cylinder suction from the chamber. He believes that this causes dirty valves, is wasteful, and in a few cases has proved dangerous. He found that the vapor is most effectually withdrawn by a belt-driven extraction fan; the gases are led to a baffle box, where they are condensed, thus recovering the oil which by other methods is burned.

In the discussion which followed, it was pointed out that when the sulphur content of the fuel oil reaches a certain limit, the sulphur reacts on the lubricating oil, especially if compounded with vegetable oils, and causes a sticky deposit

analogous to vulcanized bitumen, which destroys the lubricating properties of the oil. (Paper read before the Diesel Engine Users' Association; abstracted from *The Mechanical Engineer*, vol. 38, no. 985, December 8, 1916, pp. 439-441. cp)

HEAT-BALANCE TESTS OF AUTOMOBILE ENGINES, Prof. Walter T. Fishleigh and W. E. Lay

The authors show how a demand for better performance and economy and the ever-increasing cost of volatile fuels have emphasized the necessity for thorough engineering work in the successful automobile manufacturing plant.

The paper is based on a comprehensive test of an automobile engine enclosed in a hood similar to that used on the car in normal service, an air blast being directed through this hood of speeds approximating those at which the engine would drive a car with a given gear ratio.

The results from the heat-balance tests at the three operating speeds of 640 r.p.m., 1000 r.p.m. and 1350 r.p.m are shown in Fig. 5. These curves show that the heat that goes into brake horsepower ranges from 8.6 to 19 per cent, and increases at any one speed as the load is increased. The highest value is found for the greatest load taken at the lowest speed. At 6.25 hp. output, which is about necessary on a good level road for propelling the car at 18 m.p.h., the thermal efficiency of the engine based upon brake horsepower is 10 per cent. This means that when an owner uses in his engine $1.00 worth of gasoline, he develops at the flywheel and delivers to the transmission box just ten cents' worth of power. Where the other ninety cents go is indicated by the relatively long ordinates of the other curves.

Heat loss to the cooling water was practically constant at 600 r.p.m. and was about 40 per cent. At the two higher speeds it decreased with increased output.

The percentage of heat dissipated to the cooling air appeared variable at the low speed, while at 1000 and 1350 r.p.m. there was evident a slight decrease with increased output. The heat loss in the exhaust at 640 r.p.m. varied regularly from 26.6 per cent at low output to 18.6 per cent at 20 hp. At the two higher speeds it was relatively much larger with slight increase in output. It appears, therefore, that the trend of exhaust-gas losses is contrary to that of losses to the cooling water.

The fuel consumption per unit horsepower per unit of time at any speed was high at low horsepower output and decreased steadily as maximum output at any speed was approached. Thermal efficiency correspondingly increased at any speed as the output increased. Under maximum output conditions, which constitute an infrequent and unimportant automobile operating range, fuel consumption is relatively low and thermal efficiency relatively high.

Mechanical efficiency at any speed improves with increased load.

The complete heat balance for one run was found to be as follows:

	B.t.u.	Per Cent
Input	368,000	100.00
Output (b.hp.)	50,560	13.74
Cooling water	113,750	30.90
Cooling air	60,600	16.47
Exhaust	139,632	37.94
Total	364,542	99.05
Heat unaccounted for		0.95

The paper describes in detail the methods and apparatus used.

As regards the fields for future developments, the writer believes that probably overcooling at low speed and output, where ample capacity is provided for all extreme demands, has already received some attention, but important improvements can be brought about from an entirely different direction. Alloy metals can be developed that will stand a far higher average operating temperature. The present metal construction can be entirely replaced by a built-up alloy-metal construction that will need no cooling system, or, at best, only an air draft. Porcelain or other heat-resisting substances can be utilized for part or all of the combustion chamber, and better lubricants

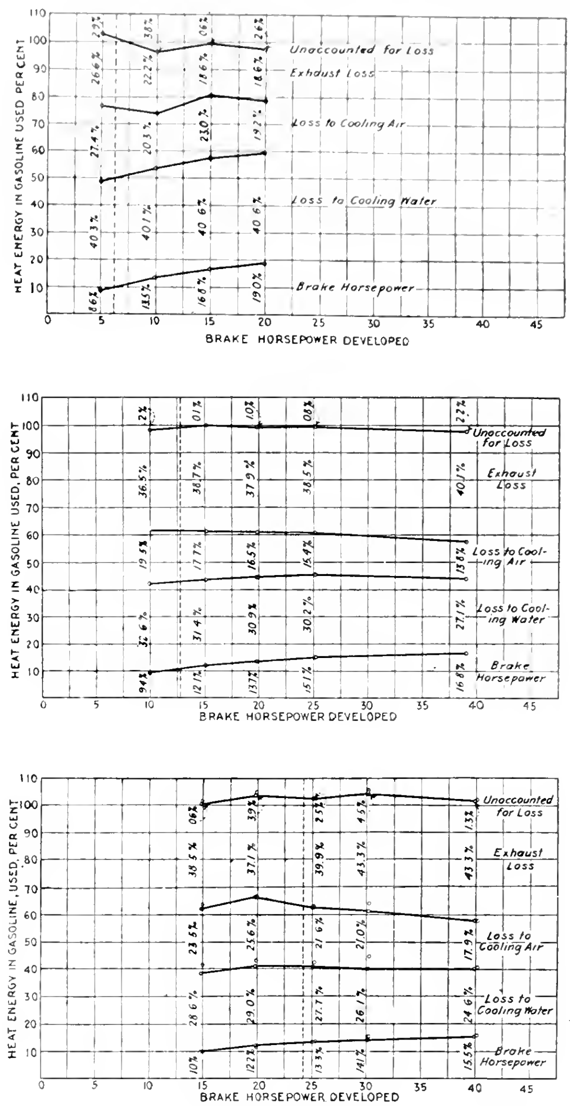


FIG. 5 RESULTS OF HEAT-BALANCE TESTS OF AUTOMOBILE ENGINES AT VARIOUS SPEEDS

are possible. But a fascinating ideal is always a type of engine in which the same wall does not serve as a part of a high-temperature combustion chamber and at the same time as a lubricated surface upon which the most important high-speed reciprocating mass must prevail and have its bearing. Under present limitations higher thermal efficiency might be had by the use of a cooling liquid whose boiling point is higher than that of the conventional water.

The reduced efficiency and increased fuel consumption under normal light loads at any speed are deserving of the most serious attention. The internal-combustion engine op-

erating upon the present Otto cycle is not well adapted to efficient operation upon partly opened throttle, and the author suggests as promising fields of research larger valves or ports and more of them, variable timing of the valves so as to insure fairly uniform compression, higher compressions with direct fuel injection as in the Diesel or semi-Diesel engine, and the constant-pressure cycle. *(S. A. E. Bulletin*, vol. 11, no. 3, December 1916, pp. 271-287, 8 figs., *eA)*

Measuring Apparatus and Measurements

Standard Substances for the Calibration of Viscometers, Eugene C. Bingham and Richard F. Jackson

For the purpose of the calibration of viscometers there is a need for one or more liquids of viscosity greater than water which can be easily obtained in pure condition and whose viscosity is known with a considerable degree of certainty. The substances selected, besides water, were mixtures of ethyl alcohol and water, and sucrose and water. Previous work upon water and alcohol was adequate and consequently the experiments were confined to the sucrose and water. The sucrose was purified by repeated recrystallization from water solution and contained residual impurities of the order of one-thousandth of a per cent. The solutions used in the measurement were analyzed by determination of density and by polariscopic test.

The viscometer used in the investigation consisted essentially of a U-tube fitted with a capillary on one limb surmounted by a bulb with constrictions which could be used to measure the volume of liquid. A bulb of similar size and shape was sealed on the other limb. The viscometer was connected to a manometer and pressure apparatus for the application of pressure. From the observations the viscosity was calculated by the usual formula

$$\eta = Cpt - C' \rho \; t$$

by measuring the time of flow of pure water at 20 deg. cent. and substituting its viscosity 0.01005.

The viscosity was measured at a variety of applied pressures. To obtain the true effective pressure, the height of liquid in the manometer is corrected for air buoyancy, column of connecting air, and hydrostatic head of the liquid undergoing measurement. In order to be certain that the drainage of solution was complete, the time of flow required to discharge and to fill the bulb was measured. Furthermore, viscosity was found to be independent of applied pressure. To test calculations and corrections the viscosities of water were measured, using a considerable range of pressures. The value was found to be constant.

In order to avoid the arbitrary scales of commercial viscometers and the inconvenient magnitudes of the absolute units, we suggest the use of the "centipoise" as a unit of viscosity. This is one-hundredth part of the C.G.S. absolute unit. The centipoise is almost exactly the viscosity of water at 20 deg. cent. (1.005), and hence is at the same time the specific viscosity of any substance referred to water at very nearly 20 deg. cent.

The viscosities of water have been determined by several investigators. The existing data have been reviewed in order to correct them so far as possible according to our present knowledge. The mean values expressed as fluidities may be expressed by the formula

$$\varphi = 2.1482 \left\{ (t - 8.435) + \sqrt{8078.4 + (t - 8.435^2)} \right\} - 120$$

in which φ is fluidity and t centigrade temperature.

Mixtures of ethyl alcohol and water may be used as standards. Their fluidities expressed as functions of temperature and weight and volume percentage of alcohol accompany the complete article.

The viscosities of a 39.99 per cent sucrose solution were measured at temperatures varying from 0 deg. cent. to 95 deg. cent. The observed values correspond to the formula

$$t = 0.597\ (\varphi + 20) - \frac{1438.6}{\varphi + 20} + 38.24$$

Inasmuch as some discrepancy was found to exist between this and former values, the experiment was repeated and practically the same values were obtained.

The measurements were then made on 20.007 per cent and 59.96 per cent sucrose solutions. The fluidities at the latter concentration corresponded to the formula

$$t = 1.472\ (\varphi + 5) - \frac{323.2}{\varphi + 5} + 58.62$$

The values found in the present investigation indicated a higher viscosity than those of previous investigators. (Abstract of *Scientific Paper* no. 298, Bureau of Standards)

Measurement of Flow of Unpurified Gases at High Temperatures by Means of Pitot Tubes, J. M. Spitzglass

During the past year experiments were conducted at the Pitney Court Station of the People's Gas Light & Coke Company of Chicago, on measuring the volume of gas flowing from an individual generator. The device employed, shown in Fig. 6, consisted of a special pitot tube inserted in the flow of gas, connected to a differential gage indicating the pressure difference created by the flow.

As can be seen from the figure, there are here two points available for measuring the flow of gas from the superheater before the gas enters a common main. One is at the outlet from the superheater before the gas enters the washbox, where the average temperature of the flowing gas is about 1200 deg. fahr., and the other is at the outlet from the washbox, where the temperature varies between 180 and 190 deg. fahr., but where there is a possibility of excessive moisture to be entrained from the washbox, the distance from the latter being very short in this case.

As a rule there is now little difficulty in determining the volumes of flowing gases from the velocity pressure developed by the impact of the flow; and the relation between the two physical quantities, velocity and pressure, is well known for ordinary temperatures. But where gases are flowing at high temperatures this relation becomes more or less complicated, as the impact of the flowing mass creating the pressure difference is a complex quantity equivalent to the weight of the flowing mass times the square of the velocity, and the change in the force of the impact may be due to a change in the velocity of the flowing mass or a change in the density of the gas, or to both.

The installations as made proved that the flow of hot gas could be measured in this way and that the high temperature of the gas did not apparently affect the tube or interfere with the indications of the gage. It was found, however, that the tube could not be operated continuously on account of the carbon accumulating and covering the small openings through which the differential pressure is transmitted to the velocity gage. This carbon deposit was found to consist of a layer of lampblack mainly on the side from the flow.

An attempt was made to blow out the tubes with steam with-

out removing them from the gas main, but in many cases it was found necessary to remove them and clean them out mechanically.

Various arrangements of tubes were used with somewhat different results in the flow tests. The one which worked apparently better than other shapes had the ends cut off to a 60-deg. angle from the horizontal.

The results of the tests are presented in charts and tables. One table appended to the article gives the general properties of dry air from 0 to 212 deg. fahr. and also the pressure and density of saturated water vapor. A second table gives the properties and correction factor of saturated gases. This correction factor is independent of the specific gravity of the gas and can be used directly for correcting the volumes of saturated gases at the given temperatures between 0 and 212 deg. fahr. at 30 in. absolute pressure. Other tables give the factors prepared for determining the ratio of the density of atmospheric air at the given temperatures and of gases from 0.75 to 0.40 specific gravity to the density of dry air at 60 deg. fahr. temperature and 30 in. absolute pressure. This "specific ratio" is substituted for the specific gravity of the gas in computing the v lume of the flow.

For the purpose of computing the flow of saturated gases, the writer gives the following equation:

$$Q = 21.7Cd^2\sqrt{\frac{H}{S}}$$

where Q is the quantity of gas in cubic feet per minute flowing through the pipe at the given temperature and pressure; d = diameter of the pipe in inches; C = a numerical coëfficient depending upon the shape of the pitot tube used; H = differential head in inches of water; and S = specific gravity of the gas as referred to air. A numerical example of the application of the formula is given.

The article recommends a method of procedure for the computation of the flow of gases. Among other things is fully covered the question of the use of the correction factor. The tables may be utilized also for other purposes, such as determination of the carrying capacity of pipes for saturated gases and of conditions of partial saturation. (*American Gas Engineering Journal*, vol. 106, no. 1 (whole no. 3069), January 1, 1917, pp. 5-10, 3 figs., *et*)

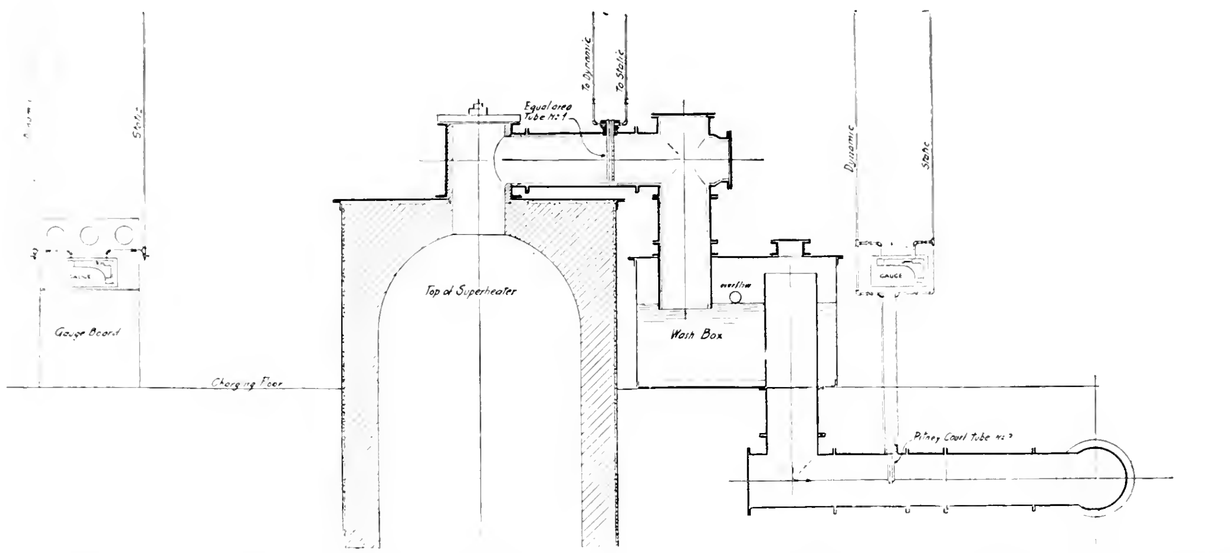


FIG. 6 INSTALLATION FOR MEASURING THE FLOW OF UNPURIFIED GASES AT HIGH TEMPERATURES BY MEANS OF PITOT TUBES

Mechanics

REMARKS ON DYNAMICS OF THE AUTOMOBILE, N. W. Akimoff

Discussion of the fundamental principles of a theory of spring suspension, with a brief consideration of the dynamics of spring damping, kinematic features of harmonic motion, energy consumption, and shock absorbers.

The oscillation of a spring will necessarily be a damped one and will have a tendency to die out after a certain interval of time. This damping is due partly to external friction, but also to a considerable extent to some sort of internal, molecular action. Certain properties of damping oscillations are, however, often lost sight of. If the friction is constant the amplitude of motion decreases but the period remains unchanged. If the damping is proportional to velocity then the period is only slightly increased, but so little that here, too, it can be considered unaffected while the amplitude decreased.

This refers to so-called free vibration of a spring, but a spring subject to any periodic action, for example, actuated by some sort of a connection with an unbalanced engine, will vibrate precisely at the rate of the latter. This constitutes what is known as forced vibration, which the spring quickly converts into a free vibration of its own natural period as soon as it is freed from the influence of the periodic forces. All this, however, holds good only for such cases as that of a spring arranged vertically and supporting a weight, but this formula can under no circumstances be applied to a case of a body rocking about one end and spring-supported on the other. This might induce an error as great as 100 per cent or more, and an entirely new formula would have to be derived.

The writer vigorously objects to applying the plain pendulum formula to cases of automobile suspension involving rolling or pitching.

From the kinematics of vibrating motion can be found under what conditions the passenger will be thrown from a seat vibrating according to a plain pendulum law.

From this the author proceeds to a statement of his objection to frictional shock absorbers. The objection appears to be that in climbing up a bump, the action of the spring is retarded, thus throwing a certain amount of extra load on the tire and spring, already overloaded owing to the upward impulse due to the obstacle. In allowing the compressed spring

to come gently to its normal position, the absorber performs its useful work provided the action is not delayed too much. When the wheel drops into a pocket or depression, the reverse conditions are present. The absorber retards the descent of the wheel and does its best work in restoring the wheel to its normal position, although here, too, the action should not be delayed too much. It is evident that these actions are contradictory. What one would like to have is an absorber that is inert when the wheel goes over a bump and active in coming down, also inert when the wheel goes down into a hole and active in restoring it to its normal position; but it does not appear possible for any absorber to answer these requirements.

The author believes that the fight between the champions and the antagonists of absorbers is progressing on altogether wrong grounds.

The analysis of the elemental suspension system is carried out by means of an imaginary elemental car consisting of one wheel provided with a pneumatic tire, a platform representing the unsprung weight, a spring above it and over the spring another platform, which is the sprung weight. In such a system there will be two independent modes of vibration. One mode will comprise simultaneous oscillations of both weights possessing the *same period*, both moving up or down at the same time. The second natural mode will be such that both weights move in opposite directions although with the same period, but through a much shorter amplitude than before. Neither the short nor the long period is the same as it would be if the sprung weight alone vibrated on its spring. This shows the inadequacy of the pendulum formula if directly applied to the problem of natural oscillations of the car even when simplified in the above way.

The automobile can vibrate in a number of different ways, the main modes of oscillation being plunging, rolling and pitching. The problems of vibrations in automobiles can be solved by Lagrange's equations and, for example, for pitching the author proposes the following formula:

$$\text{Period} = T_p = 2\pi\,(\sqrt{\delta/g}\,\sqrt{2k^2/l})$$

where δ is the initial (static) deflection of each spring under its load; $g = 32.2$; k is the radius of gyration about the center of oscillation; and l the wheelbase. From this formula the author comes to the conclusion that the wheelbase should be kept as short as possible because the period is inversely proportional to its length. From this point of view, the writer believes that if the cantilever arrangement of springs gives better riding qualities, the reason lies in the fact that the spring is fastened more closely to the center of the body, thus giving the same effect as would reduce wheel base, i.e., a slower period of pitching.

The distribution of the weight appears to be of importance, as is evidenced by the radius of gyration k, to which the period is directly proportional. In other words, to secure easy riding (slow period of pitching) the loads should be placed as far as possible from the center of the car. The mere fact that they give the same deflection does not in itself preclude the possibility of entirely different effects due to load distribution. (*S. A. E. Bulletin,* vol. 11, no. 3, December 1916, pp. 262-270, 5 figs, *t*)

Railroad Engineering

Locomotive-Axle Failure and Its Causes

Abstract from the report of the Chief of the Division of Safety, Interstate Commerce Commission, covering the investigation of an accident which occurred near Hoffman, Ill., when an axle failed under a freight engine of the Southern Railroad.

The investigation showed the presence of an area of metal at the surface of the journal which contained chatter marks and short incipient cracks made by the roughing cut in the machining of the forging from which the axle was made.

It was further found that the axle was made from an untreated solid-steel forging and was finished turned throughout its length.

In addition to the discussion of this particular instance, the report touches on some matters of general interest.

Heavy machine-tool cuts tear the metal and also introduce internal strains. There is a close resemblance in the effect of such heavy tool cuts to shearing and punching effects if, indeed, they are not of the same order. Shearing and punching of steel are very properly prohibited in certain specifications, and it is also important that equivalent effects be avoided.

A further possibility of incipient fractures is introduced by the operation of quenching, with spontaneous rupture taking place. In fact, certain specifications with this in view require a shock test to be made of heat-treated axles to detect whether interior fractures have not been made by this process. The final state of internal strain in quenched axles which have had their temper drawn will be of lesser magnitude than the temporary state of strain which prevailed at the time of quenching.

The report emphasizes the necessity of securing workmanship of a high order in the machine finishing and fitting of material which is exposed to such situations as those which are occupied by axles, that is, repeated alternate stresses of tension and compression. While the magnitude of the stresses in the service of axles is somewhat indeterminate, there is no doubt that on some occasions very high fiber stresses are reached. Under these circumstances stresses which are incident to surface conditions should not be augmented by internal strains of fabrication, if they are found to be detrimental.

It has been customary apparently to consider only those stresses in axles which were due to the external loads coming from the weight of the engine or cars, as the case may be. But internal strains at the time of quenching—those which result from heavy machine cuts in rough turning and those which accompany the operation of cold rolling on journals for finishing purposes—appear to attain a magnitude comparable to the direct stresses which are caused by the wheel loads. It is true that such internal strains are mostly those having a tangential direction, while the failures of axles commonly occur by tension in a longitudinal direction, but coincident surface strains of compression have been found to exist in the quenched metal in both tangential and longitudinal directions. (*Iron Trade Review*, vol. 59, no. 26, December 28, 1916, pp. 1309-1312, 7 figs. *dp*)

Steam Engineering

Erosive Effect of Steam on Turbine-Blading Material, Lieut. (J. G.) T. J. Keleher, U. S. N.

In the summer course of the Post-Graduate Department of the Naval Academy an investigation of the erosive effect of steam on turbine-blading material was taken up as a research problem.

The apparatus used was a brass box 9 in. x 9 in x 7 in., which acted as exhaust chamber and contained the brass blading holders and blades, which were stationary and placed at

an angle of 10 deg. to the nozzles in order to avoid the spattering effect. On the front of the box was a steam chest containing expanding nozzles designed for 100 lb. gage pressure and 27 in. vacuum.

Extruded brass, rolled brass, rolled cupro-nickel, monel metal, Parsons metal, and drop forged steel were tested. The tests were preliminary in their nature and will be followed next summer by tests at different steam velocities and with varying qualities of steam and degrees of superheat.

The results are shown in the form of photographs and a table of weight losses. From this table it appears that extruded brass stood up best in the 3400-ft.-per-sec. velocity with steam quality of about 87 per cent. Here the loss was 0.121. Monel metal followed with 0.273 and steel with 0.386.

Because of difficulty in obtaining the blading material there were dissimilarities in the dimensions of the pieces tested, particularly in the case of the steel specimens. These discrepancies in blading width and thickness vitiate weight losses when determined as percentages of the original weights of the specimens. In the case of steel, its width was less, and its thickness considerably less, than that of the other materials.

Rolled brass, cupro-nickel and Parsons metal did not compare at all favorably with the others. In general, there appears to have been no particular uniformity in the amount of erosion during the different periods.

On the photographs (which were taken at about 2 diameters after 3½ hours) can be seen the saw edges of the rolled brass and monel metal, and in particular the long points of the cupro-nickel which, it would appear, are the results of lack of uniformity in the structure of the metal. Steel appears also to begin to develop a similar edge. (*Journal of the American Society of Naval Engineers*, vol. 28, no. 4, pp. 836-838, and 2 pp. of photographs, *e*)

Operation of Curtis Steam Turbines and Alquist Reduction Gears in the Propulsion of Cargo Ships, W. J. Davis, Jr.

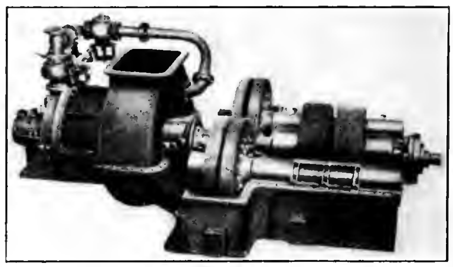
The first commercially successful steam-turbine-driven freighter, the S. S. *Vespasian*, built in England and equipped with a 1000-hp. Parsons turbine with reduction gear, was placed in service in 1909, but it was not until November, 1915, that the first American-built turbine freighter was commissioned.

The first cargo ship built in the United States and equipped with the new drive was the S. S. *Pacific*. This ship was built by the Union Iron Works Company at San Francisco, and propelled by a 2400-hp. Curtis turbine with Alquist flexible gears manufactured at the Schenectady works of the General Electric Company.

The use of the steam turbine in stationary plants resulted in extraordinary reductions in cost of power generation. The writer is familiar with a case where eight 1500-kw. reciprocating engines were replaced by a 12,000-kw. turbo-generator. Whereas it required twenty-four boilers to supply steam for the engines, eleven of these boilers were sufficient to enable the turbine to carry the same load.

It has been well known for a long time that any attempt to drive a ship propeller directly from a steam turbine must result in a compromise in which the efficiency of both turbine and propeller must be sacrificed. In the case of very-high-speed ships, such as destroyers and certain classes of passenger vessels, where certain advantages in the way of increased speed, reduction in vibration and saving in weight overbalance the failure to give the best attainable economy in fuel, it has been possible to make such a compromise. But this would not apply to slow-speed freight-carrying vessels because of limitations of propeller speed.

Take, for example, a freighter or tanker of 8000 to 10,000 tons capacity, with a speed, loaded, of 11 knots. Such a ship will require about 2500 hp. to drive it. The most economical speed for the propeller would be about 90 r.p.m., while that for the turbine would be not less than 3000 r.p.m. The difference is here so great that any attempt to drive the propeller direct would result in an arrangement so greatly inferior in economy to a reciprocating-engine drive as to outweigh any other possible advantage. The use of speed-reducing means between the turbine and propeller becomes, therefore, imperative if turbine drive is to be employed at all. The Alquist flexible gear as manufactured by the General Electric Company is one of the means of high-speed reduction. The wheels for this type of gear are made up of rolled-steel plates or disks rigidly bolted together near the center and keyed to the shaft. Each disk is reduced in thickness between the hub and rim sufficiently to give a small amount of flexibility in an



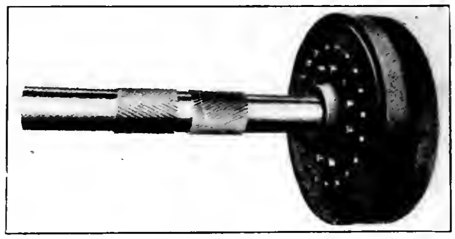


Fig. 7 Top Cut: Upper Half of the Alquist Gear with Gear Casing Removed; Bottom Cut: Intermediate Shaft of Reduction Gear

axial direction, and to permit this movement a clearance of about ten thousandths of an inch is provided between the disks at their rims. As the gears are of the double-helical type, this construction insures equal distribution of pressure along the face of the teeth. If the pressure applied by a pinion tooth at any point should exceed the normal pressure, the axial component will cause a slight axial flexure of the disk. Experience has shown that changes in alignment or slight inaccuracies in tooth cutting or assembling of the gears, which would cause objectionable noise, loss in efficiency, high temperature, and excessive wear on the teeth of solid gears, have little effect on the operation of the flexible-disk type.

Accurate measurements of the teeth of the Alquist reduction gears on the S. S. *Pacific* show the wear of the flexible-gear teeth to be almost negligible.

An interesting commercial feature of the present abnormal production of steel cargo vessels in this country is the uniformity in capacity, speed, and power requirements. Fully 90 per cent of the turbine ships completed or under construction by the Pacific Coast yards are provided with turbines

of the same type and practically of the same size, viz., 2400 to 2600 hp.

In practically all cases the ahead turbine is designed to run at 3380 r.p.m. It is of the Curtis type of impulse turbine and consists of five stages, the first having two rows of buckets mounted on a single wheel, and each of the succeeding stages a single row of buckets. The speed of the turbine is controlled by means of a lever-operated balanced throttle valve in the main steam line, but in order to overcome the loss of efficiency due to throttling when running at reduced speed, two hand valves are provided which block off a number of the first-stage nozzle sections. By this means it is possible to obtain 58, 75, 83 and 100 per cent of full power with full-speed pressure at the nozzles, resulting in a net saving of 3 per cent to 5 per cent in fuel when it is necessary to run the ship at reduced speed in a rough sea.

The astern turbine has two stages of similar construction but of smaller diameter, and is mounted on the same shaft and in the same casing as the ahead turbine, both having a common exhaust. When the ship is running forward, the wheels of the astern turbine revolve in a vacuum and therefore consume but little power.

The speed of the propeller being 90 r.p.m. and that of the turbine 3380 r.p.m., it is necessary to obtain a gear reduction of 37.5. This is accomplished by means of a double reduction, the high-speed gear having a ratio of 7.36 and the low-speed, 5.10. The reduction gear is of the "one-plane" type, i.e., axes of the high- and low-speed pinion and gear shafts lie in the same horizontal plane. This arrangement reduces the head room, simplifies lubrication, and facilitates inspection and accessibility of all parts.

Power is transmitted through the high-speed or driving pinion to two gears, one on each side, and thence through the two low-speed pinions to the low-speed gear. Rigid bearings are used throughout for the gears and pinions. Fig. 7 shows the intermediate shaft of the reduction gear, while Fig. 2 shows the gears with the top half of gear casing removed.

On the score of simplicity it is highly desirable to be able to use the same grade of oil for both the turbine bearings and the reduction gear, thus preventing the duplication of oil pumps, strainers, coolers, storage tanks, settling tanks, etc. It has been possible to accomplish this by the use of a moderate tooth angle and by reason of the flexible-disk construction of the gears. Several grades of oil were tried out on the S. S. *Daranger,* the best results being obtained with a medium-heavy oil having a viscosity of 260 (Saybolt) at 100 deg. fahr., which proved to be right for the dual purpose for which it was used.

The article gives detailed data as to dimensions and fuel consumption of tank steamers *Los Angeles* and *La Brea.* These ships differ from each other only in the character of the propelling machinery and the cargo-pumping systems. The *Los Angeles* is driven by a triple-expansion engine with a propeller speed of 65 r.p.m., and has the usual type of centralized steam pumping plant for discharging her cargo of oil. The propelling machinery of *La Brea* consists of a 2600-b.hp. Curtis turbine with Alquist reduction gear giving 90 revolutions at the propeller. She is fitted with a unique cargo-pumping system originated by O. B. Kibele, Superintendent of Transportation of the Union Oil Company, in which a separate electric-motor-driven pump is provided for each compartment, power being supplied to the motors from a 300-kw. 60-cycle alternating-current Curtis turbo-generator located in the engine room.

Although the average speed of *La Brea* is ½ knot better than that of the reciprocating-engine-propelled *Los Angeles,* it has been found that the increase in fuel consumption of the latter over that of the steam-turbine ship under operating

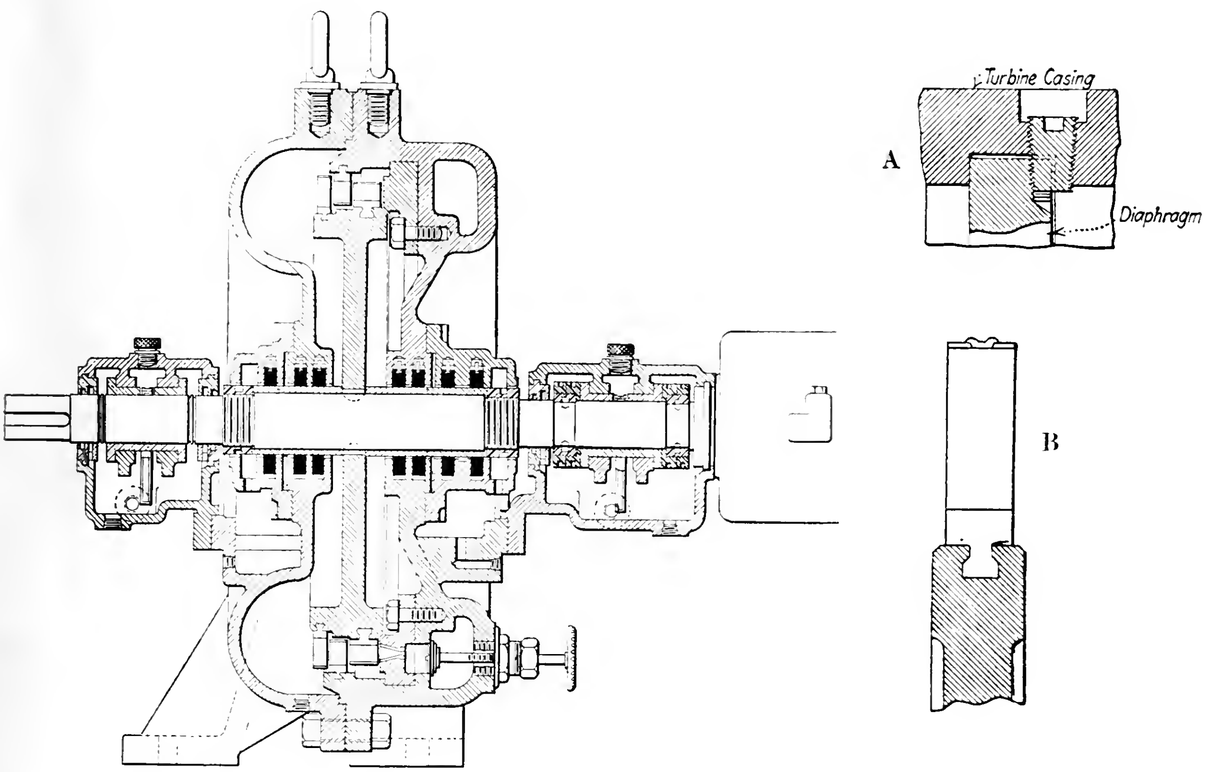


Fig. 8 Moore Steam Turbine

conditions is

While steaming ..17.9 per cent
While steaming and in port......21.1 per cent

With further improvements in the way of increased steam pressures, higher superheats, and power plant design and equipment, there are still further possibilities in reducing operating costs of steamships driven by geared turbines. (*General Electric Review*, vol. 20, no. 1, January 1917, pp. 57-62, 4 figs. *dc*)

The Moore Steam Turbines

Description of steam turbines manufactured by the Moore Steam Turbine Corporation, of Wellsville, New York, a newcomer in this line of production.

The company will manufacture a single-stage machine and a multi-stage turbine. The single-stage machine consists of a single-velocity stage made up of a set of diverging expanding nozzles and a wheel carrying two rows of moving blades with a set of stationary reversing blades following the first row of moving blades. The builders will limit the speed of the larger machines to 3600 r.p.m. and of the smaller ones to 5000 r.p.m. as a maximum.

The multi-stage turbine consists of the same single-velocity stage followed by two or more single-pressure stages, each of the stages consisting of a set of nozzles and a wheel.

In both types of turbine the casings are divided both vertically and horizontally, which allows of lifting the casing without breaking the steam or exhaust connections.

The diaphragms (Fig. 8A) are halved and are held in the casing by a set of special tapered screwed plugs inserted in the vertical joints while the diaphragm and casings are held in a fixture (as a rule in turbine construction dowel pins are used instead of screwed plugs).

The wheels and shaft are of steel and the first-stage wheel is of built-up or solid-forged construction. The wheels of the single stage are machined from solid steel plates. The buckets are of drawn steel and dovetailed into the periphery of the wheel as shown in Fig. 8B. The clearance over the bucket is about one-half inch and the endwise clearance is liberal, with the further provision that the side of the wheel and not the bucket will rub should the rotor become displaced in an endwise direction. (*Power,* vol. 44, no. 25, December 19, 1916, pp. 848-849, 7 figs. *d*)

Willans Line for Steam Turbines

With throttle-governed steam turbines, Willans' law that the total steam consumption plotted against output gives nearly a straight line is followed with very considerable accuracy.

The writer has drawn the Willans line for the 5000-kw. Rateau turbine at the London County Council Power Station from data taken from the paper read by K. Baumann before the Institution of Electrical Engineers in 1911, but used in plotting brake kilowatts and not the power developed at the switchboard. The four points plotted in the diagram, Fig. 9, lie very fairly in a straight line which, if prolonged, cuts the horizontal axis at B. It has frequently been assumed that the distance OB measured on the kilowatt scale represents the power required to drive the turbine light, and that the slope of the line BA is proportional to the blading efficiency of the turbine. The author shows that neither of these suppositions is correct and states further some interesting deductions made from a study of the Willans line of a turbine.

A turbine differs from a reciprocating engine in that by far the larger proportion of its wastes of energy, which are due mainly to windage, leakage losses and fluid friction, are proportional to the load. The resistance and losses which are independent of the load are only those due to the bearings, thrust block, the oil pump and governor drive, and to the glands. If water glands are used, as in the turbine under consideration, the gland losses are represented by the power absorbed by these glands, while if steam-packed glands are used, the loss is represented by the supply of steam necessary to prevent the entrance of air through the glands into the condenser.

The writer calculates these constant losses and shows that this can be done with fair accuracy.

Adding together all of the resistance, he gets a total of 89 hp. or, say, 66 kw., which is only about one-sixth of the distance represented by OB in the diagram, which scales 450

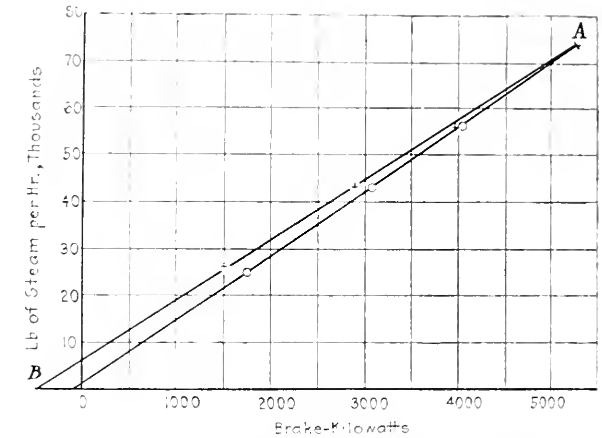


Fig. 9 Willans Line for Steam Turbines

kw. This wide discrepancy is due to the fact that the Willans line BA is not a line of constant indicated efficiency. The indicated efficiency of a turbine varies with the ratio of expansion, and, in many cases, particularly with reaction turbines which (for commercial reasons) have hitherto been run much below the most economical speed, the indicated efficiency at first increases as the load is reduced, afterwards diminishing again somewhat rapidly. It is however possible, to a fair degree of accuracy, to deduce from the actual Willans line a line corresponding to a constant indicated efficiency by making use of the proposition, which is very approximately true, that when a turbine is throttle-governed the indicated efficiency depends solely on the ratio of initial and final pressures. This proposition is necessarily true with a perfect gas, and even though steam is not a perfect gas, the rule holds with considerable accuracy throughout a large range of output.

The data from which the diagram was plotted are as follows:

Output of Turbine, B.kw.	Total Steam per Hour, Lb.	Ratio of Initial to Final Pressure
5347	73,930	228
4000	56,070	185
2885	42,630	123
1449	25,070	74

Of the total resistances of the turbine those due to fan action, leakage and the like are substantially proportional to the load. The fixed resistances have been estimated above as

66 kw., so that the gross output corresponding to the total torque developed at full load will be 5347 + 66 = 5413 kw. Calling this the gross kilowatts the steam consumption per gross kilowatt is 13.66 lb. By the foregoing rule the consumption per gross kilowatt will be the same at all powers, provided the ratio of the initial and final pressures is the same. At the lowest load tabulated above, the initial pressure was 56 lb. absolute and the back pressure 1.55 in. of mercury. To get the same gross efficiency this back pressure should have been approximately $\frac{74}{228}$–1.55 = 0.68 in. of mercury, and in that case the output would have been $\frac{25\,070}{13.66} = 1836$ gross kilowatts, or 1836 — 66 = 1770 b.kw.

This value has been plotted as a round dot in the diagram, and the other observations have been similarly reduced. The corrected Willans line thus obtained cuts the axis at a point sealing about 70 kw., and thus passes very approximately through the estimated value of the bearing, gland, and other fixed losses.

Thus, with the Willans line as ordinarily plotted, the heat available per pound of steam passed falls off as the load diminishes. Hence less work is done per pound of steam and the line at low loads is raised accordingly. The Willans line adjusted as above can be used to estimate approximately the increase in consumption at full load due to reduction in vacuum, and the writer shows that a diminution of vacuum from 28.51 in. to 27.23 in. would reduce the gross output from 5413 to 5100 gross kw., or to 5034 b.kw. Hence such a decrease of vacuum would increase the steam consumption per b.kw.-hour by about 6 per cent. (*Engineering,* vol. 102, no. 2657, December 1, 1916, p. 521. 1 fig. *t*)

Society of Automotive Engineers

The Society of Automotive Engineers is our youngest national technical society. Into it are fused the varied and yet similar and sympathetic interests of the automobile engineer, the aeronautic engineer, the motor-boat engineeer and the agricultural-tractor engineeer. The parent of this organization is the Society of Automobile Engineers, which has been in existence since 1905. Because of the fact that its members are engaged in making very similar products, and because of the tremendous wealth of this one industry, the society has found itself in a unique position to practically enforce coöperation in a technical sense amongst its members.

The outstanding feature that differentiates the S.A.E. from other societies is the stress laid upon standardization. Under the initial guidance of Howard E. Coffin, great progress has been made in the elimination of unnecessary and wasteful variations in unimportant design.

The work that had already been done in the standardization of screw threads was not allowed to stop, but has been carried to a point where lock washers, sizes of steel tubing, steel specifications, fine-thread bolts and nuts, spark plugs, tire bases, magneto fastenings, and so on, have had their important dimensions standardized. This information has been disseminated to all automobile manufacturers and engineers, with the result that considerable labor, time and expense are saved in design by the ability to use what might be called staple dimensions.

The Winter Meeting of the Society of Automobile Engineers, at which the change was made to the Society of Automotive Engineers, was held in the Engineering Societies Building, January 9, 10 and 11, and the following additional standards were discussed, and in the majority of cases approved:

- Direction of engine rotation for aeronautic engines
- Thrust bearings
- Mounting of starting and lighting equipment
- Size of storage-battery jars
- Hand starting cranks
- Size of poppet valves
- V-belts for fans
- Steering-wheel-hub dimensions
- Nomenclature
- Car performance test
- Spring-rebound-clip dimensions
- Pneumatic-tire rims

A sum of $14,000 has been appropriated for the coming year for the work of the Standards Committees, and provided the committees do not run away too strongly with the standards idea, this money will be well spent. There is a tendency to standardize many things which are yet in a transition state, but this is an evil which can easily be overcome, and is indeed usually overcome in itself.

The Standards Committees are usually formed of the chief engineers of the leading companies interested, and one of the features, not the least important, is the opportunity of discussing in an informal way the various problems common to all. This is of material help in advancing the industry and has tended to promote a wonderful feeling of *esprit de corps* and coöperation amongst automobile engineers.

The professional session of the meeting occurred on the afternoon of January 11, at which the following papers were scheduled to be read:

Some Problems in Airplane Construction, Capt. V. E. Clark, Capt. T. F. Dodd, and O. E. Strahlmann
The Ultimate Type of Tractor Engine, H. L. Horning
Dynamic Balancing of Rotating Parts, F. Hymans
Remarks on Dynamics of the Automobile, N. W. Akimoff
Some Essential Features of High-Speed Engines, A. F. Milbrath
Heat-Balance Tests of Automobile Engines, Walter T. Fishleigh and Walter E. Lay
Aerial Navigation over Water, Elmer A. Sperry.

This session was opened by the presentation of a series of unusual stereopticon and motion pictures taken on the various war fronts in Russia, with brief explanations by Capt. V. E. Clark, U.S.A. Aeroplanes, hydro-aeroplanes and captive balloons were illustrated. An interesting feature of the aeroplanes was that, contrary to the general belief in this country, rotary-type motors seem to be very widely used. One of the slides bore the significant statement that 20,000 aeroplanes are used on the French front.

Captain Clark made a statement that the War Department welcomes and seeks the collaboration of the engineers in the development of its technical problems in general and those concerning aeronautics in particular.

Mr. Horning presented orally a general survey of the tractor engine situation. He emphasized very strongly the fact that a tractor engine must be primarily built so that it will run, and those parts which may require renewal or replacement should be designed in such a manner that whenever possible they can be replaced by some makeshift available on a farm.

As a rule the tractor is used in places away from well-equipped machine shops and has to do work which cannot

be delayed. Hence the design of a part may often be influenced quite as much by the possibility of replacement as by considerations of efficiency. As an example of selection on such grounds of expediency rather than engineering efficiency, the speaker mentioned the case of a V belt to drive a fan. It is more efficient than the flat belt, but the farmer may be unable to find it in the local store when needed in a hurry. The flat belt can be easily manufactured out of an old piece of harness, and is therefore used in preference.

The solution of the kerosene engine problem, in the opinion of the speaker, lay in the better-heated intake manifold, and such an arrangement that the heat be increased as much as possible at low speed and reduced at high speed.

Because of lack of time some of the papers were read by title only.

American Association for Advancement of Science

At the meeting of the American Association for the Advancement of Science and the affiliated national scientific societies held in New York City during the last week of the past year, there was a registration in the neighborhood of 2100. The Association met in twelve sections. There were fifty-six separate societies in session, including the four national engineering societies, which held one general meeting with the Association at the Engineering Societies Building. Dr. Henry M. Howe of Columbia University, chairman of the section, presided, and Dr. Bion J. Arnold, the retiring Vice-President and Past-President of the American Institute of Electrical Engineers, gave an address, which was followed by addresses by Mr. Clemens Herschel, President of the American Institute of Civil Engineers, and Dr. Ira N. Hollis, President of The American Society of Mechanical Engineers.

The fundamental idea which was apparently in the minds of the speakers at the meeting of the Association for the Advancement of Science in the Engineering Building, was to properly express the relation of what is commonly known as pure science to engineering as an expression of the so-called applied science.

Dr. Ira N. Hollis, President of the American Society of Mechanical Engineers, expressed on behalf of the engineering profession the most hearty wishes for the continued influence and success of the American Association for the Advancement of Science.

He stated that he had been associated intimately with teachers of science for many years and had never seen one of them engaged in research through which he did not hope to render service either by actually discovering something useful to man or by giving him a true reverence for the Almighty's works, and the last was sorely needed in the present times. Indeed, the speaker stated that if he had to choose he would prefer the rush light with the love of God and his neighbor to the finest electric light with materialism. "We men of science have made the external world what it is, and now we have a most imperative duty not in one or two societies but on the part of all of us, teachers, leaders in science and engineering, to exorcise the Frankenstein that is now trampling the life out of Europe.

"There is no pure science because no man knows the whole truth. . . . We can classify and group related phenomena and we can devise formulæ to express a great range of observation, but they are imperfect and must always remain so. The great function of this Association is something more than a clearing house for science. It must break down the fences that divide science into town lots, and should be freely supported by every engineer and every engineering society.

"It has been proposed that the National Academy and the engineers form some kind of an alliance for research. That would be good, but is not this Association the natural meeting ground for all scientists, and ought not national research to be conducted under the advice of all that the Association can supply?"

The speaker carefully emphasized that there was no distinction between what was called pure science and what was sometimes called applied science. When Theodore Richards was devoting his life to weighing the elements he was accomplishing more for the world than could be found by all the combinations of aniline dyes. In enlarging man's conception of the universe and in supplying him with tools to study it the better, his work was preëminent.

SELECTED TITLES OF IMPORTANT ENGINEERING ARTICLES

AERONAUTICS

Possible Improvements in Carrying Capacity and Speed of Rigid Airships, C. Dornier, Count von. Zeppelin's Engineer. Aviation and Aeronautical Engineering, vol. 1, no. 10, December 15, 1916. 4 pp., 4 figs.

Enemy Aircraft Engines. The Automobile Engineer, vol. 6, no. 97. December 1916, pp. 350-357, 19 figs.

† Some Problems in Airplane Construction, Capt. V. E. Clark, Capt. T. F. Dodd, and O. E. Strahlmann. S.A.E. Bulletin, vol. 11, no. 3. December 1916, pp. 213-236, 15 figs.

Method of Obtaining True Angles of Wiring Plates for Aeroplanes, Seaplanes and Airships. Aeronautics, vol. 11, no. 165, December 13, 1916, pp. 386-388, 11 figs.

How Steel is Used in Aeroplanes, W. S. Doxsey. The Iron Trade Review, vol. 60, no. 1, January 4, 1917, pp. 97-100, illustrated.

The Sturtevant Model 5A, 140 HP. Aeronautical Engine. Aerial Age, vol. 4, no. 17, January 8, 1917, pp. 434-435, illustrated.

A Method of Aligning Single-Engined Tractor Biplanes, Byron Q. Jones. Aviation and Aeronautical Engineering, vol. 1, no. 2, January 1, 1917, pp. 358-359, 1 fig.

Les Biplans allemands, L. V. G. Jean Lagorgette. L'Aérophile, vol. 24, nos. 21-22, November 1, 15, 1916, pp. 326-340, 45 figs. German L. V. G. biplanes.

L' "Aviatik." Jean Lagorgette. L'Aérophile, vol. 24, nos. 19-20, October 1, 15, 1916, 15 pp., 50 figs.

† Abstracted in the Engineering Survey in this issue.

AIR MACHINERY

A Machineless Air Compressor. Power, vol. 44, no. 26, December 26, 1916, 3 pp., 5 figs.

AUTOMOBILES AND TRACTORS

Suggests a New Testing Method, Daniel Roesch. The Automobile, vol. 35, no. 25, December 21, 1916, 4 pp., 9 figs.

Russian Motor Car Requirements. Railway Gazette, vol. 25, no. 23, December 8, 1916, 2 pp.

The Modern Farm Tractor, Joseph Jandasek. The Gas Engine, vol. 19, no. 1, January 1917, pp. 1-8, 9 figs.

See also Internal-Combustion Engineering; Mechanics.

ENGINEERING MATERIALS

The Heat Treatment of Steel, D. K. Bullens. Technology Club of Philadelphia. Proceedings of the Engineers' Club of Philadelphia, vol. 33, no. 145, December, 1916, 1 p.

†Identifying Light-Gray Inclusions, Geo. F. Comstock. The Iron Trade Review, vol. 59, no. 24, December 14, 1916, 3 pp., 17 figs.

Practical Handling of Iowa Clays, with Application of Ceramic Principles, Homer F. Staley and Milton F. Beecher. Official Publication of Iowa State College of Agriculture and Mechanic Arts, Bulletin 43, Engineering Experiment Station, vol. 15, no. 15, 48 pp.

Failure of Brass 2.—Effect of Corrosion on the Ductility and Strength of Brass, Paul D. Merica. Department of Commerce, Technologic Papers of the Bureau of Standards, no. 83, November 14, 1916, 6 pp., 3 figs.

Failure of Brass 3.—Initial Stress Produced by the Burning in of Manganese Bronze. Paul D. Merica. Department of Commerce, Technologic Papers of the Bureau of Standards, no. 84, November 17, 1916, 8 pp., 5 figs.

The Plastic Elongation of Wire, A. V. DeForest. The Iron Trade Review, vol. 59, no. 26, December 28, 1916, pp. 1305-1307, 4 figs.

†Notes on the Heat Treatment of High-Speed Steel Tools, A. E. Bellis and T. W. Hardy. Bulletin of the American Institute of Mining Engineers, no. 121, January, 1917, pp. 61-68, illustrated.

Modifications de la Dilatabilité de l'Invar par des Actions Mécaniques ou Thermiques, Ch. Ed. Guillaume. Comptes Rendus des Séances de l'Académie des Sciences, vol. 165, no. 22, November 27, 1916, pp. 654-658.
Changes in the coefficient of expansion of invar due to mechanical working or heat treatment.

Cast Iron: With Special Reference to Engine Cylinders, J. Edgar Hurst. The Mechanical Engineer, vol. 38, no. 987, December 22, 1916, pp. 475-478.

Timber Protection Methods on the Santa Fe. Railway Age Gazette, vol. 62, no. 1, January 5, 1917, pp. 7-11, illustrated.
A description of the methods by which the tie requirements of this line have been reduced 650,000.

Aluminum-Bronze Tests and Their Significance, W. M. Corse and G. F. Comstock. The Foundry, vol. 45, no. 293, January, 1917, pp. 21-28, 25 figs.

Selecting Abrasives for Specific Uses, R. G. Williams. Industrial Management, vol. 52, no. 4, January, 1917, pp. 461-468, 6 figs.

Cast Iron for Engine Cylinders. The Engineer, vol. 122, no. 3182, December 22, 1916, pp. 549-550.

Report of the Hardness Tests Research Committee. The Mechanical Engineer, vol. 38, no. 988, December 29, 1916, pp. 497-501, 7 figs.

EVAPORATORS

The Prache and Bouillon Evaporating Plants. Engineering, vol. 102, no. 2661, p. 637-640, 8 figs.

FIRING

Essential Characteristics of Mechanical Stokers, C. F. Herington. Steam, vol. 18, no. 6, December, 1916, 3 pp., 3 figs.

Mechanical Firing of Locomotives, W. S. Bartholomew. St. Louis Railway Club, vol. 21, no. 7, November 10, 1916, 49 pp., illustrated.

HYDRAULICS

Effect of Channel on Stream Flow, Nathan C. Grover. Journal of the Boston Society of Civil Engineers, vol. 3, no. 9, November, 1916, 12 pp., 6 figs.
See also Pipes and Piping.

†The Effect of Sudden Enlargement Upon the Flow of Water in Pipes, T. J. Rodhouse. The Cornell Civil Engineer, vol. 25, no. 2, November, 1916, pp., 49-61, 3 figs.

Freezing of Water in Subaqueous Mains Laid in Salt Water and in Mains and Services Laid on Land, William Whitlock Brush. Journal of the American Water Works Association, vol. 3, no. 4, December, 1916, pp. 962-980.

†The Flow of Water in Wood-Stave Pipe, Fred C. Scobey. United States Department of Agriculture, Bulletin 376, November 25, 1916, pp. 1-96, illustrated.

INTERNAL-COMBUSTION ENGINEERING

†Heat-Balance Tests of Automobile Engines, Prof. Walter T. Fishleigh and W. E. Lay. S.A.E. Bulletin, vol. 11, no. 3, December, 1916, pp. 271-287, 8 figs.

Tests of a Modern Touring-Car Engine, G. L. Guillet. Mechanical Engineer, vol. 38, no. 985, December 8, 1916, 2 pp., 2 figs.

Vapors for Heat Engines, William D. Ennis. Stevens Indicator, vol. 33, no. 4, October, 1916, pp. 318-331, 2 figs.

Trial of a 600-B. Hp. Two-Stroke Direct-Reversible Nobel Diesel Engine, Baron G. Steinheil, Petrograd. Engineering, vol. 102, no. 2660, December 22, 1916, pp. 608-612, 7 figs.

Trials on a Diesel Engine, and Application of Energy-Diagram to Obtain Heat Balance, F. Trevor Wilkins. The Institution of Mechanical Engineers, Advance Paper read at meeting on October 20, 1916, 26 pp., 10 figs.

†A Study of Oil Engines in Iowa Power Plants, H. G. Wagner. Official Publication of Iowa State College of Agriculture and Mechanic Arts, Bulletin 42, Engineering Experiment Station, vol. 15, no. 10, 157 pp., illustrated.

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Diesel Engine Construction in Philadelphia. Motorship, vol. 1, no. 8, December, 1916, pp. 8-9, illustrated.

†The Motive Power of the M. S. "Deutschland," Russell Palmer. Motorship, vol. 1, no. 8, December, 1916, pp. 3-4, illustrated.

Authoritative Comparison Between Steam and Motor Vessels, T. Orchard Lisle. Motorship, vol. 1, no. 8, December, 1916, p. 15.

Spark Ignition, J. D. Morgan. Engineering, vol. 102, no. 2653, November 3, 1916, 1 p.

Why Not a Water-Cooled Plug? Gas Energy, vol. 10, no. 12, December, 1916, p. 23, 1 fig.

The Gas Engineer of the Last Century, Harry E. Jones. The Journal of the Institution of Mechanical Engineers, no. 9, December, 1916, pp. 631-674, 5 figs.

LUBRICATION

Automatic Lubricating Apparatus. The Mechanical Engineer, vol. 38, no. 985, December 8, 1916, 2 pp., 2 figs.

Graphite Cylinder Lubrication, E. W. Johnston. The Mechanical Engineer, vol. 38, no. 987, December 22, 1916, pp. 479-480.
See also Machine Shop.

MACHINE PARTS

†Friction Clutches, William G. Gass. The Mechanical Engineer, vol. 38, no. 980, November 3, 1916, 3½ pp.

Système Nouveau de Transmission par Joint à Billes, M. R. Guillery. Comptes Rendus des Séances de l'Académie des Sciences, vol. 12, no. 20, November 13, 1916, 562-564, 5 figs.
New system of transmission by universal joint.

Notes on the Design of Elliptic Gears. Machinery, vol. 9, no. 220, December 14, 1916, 2 pp. 269-270, 8 figs.

Internal Spur Gearing, Reginald Trautschold, Machinery, vol. 23, no. 5, January, 1917, pp. 405-409, 7 figs.

Theory of Enlarged Herringbone Pinions, E. W. Miller. Machinery, vol. 23, no. 5, January, 1917, pp. 401-403, 8 figs.

Variable Speed Gears for Motor Road Vehicles, Robert E. Phillips. The Engineer, vol. 122, no. 3182, December 22, 1916, pp. 560-563, 1 fig.

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MACHINE TOOLS

Standardization of Machine Tools, Carl G. Barth. The Iron Trade Review, vol. 59, no. 24, December 14, 1916, 3 pp., 9 figs.

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MEASUREMENTS AND MEASURING APPARATUS

Determinazione dell'Altezze per Mezzo dell'Altimetro, Mario Tenani. Rivista di Aeronautica, vol. 11, nos. 3, 4, May to July, 1916, 3¾ pp., 1 fig.
Determination of altitudes by means of an altimeter.

Formola per il Calcolo delle Altitudini, Luigi Mina. Rivista di Aeronautica, vol. 11, no. 3-4, May to July 1916, 3¾ pp.
Formula for determining altitudes.

Planimeter Theory, G. B. Upton. The Sibley Journal of Engineering, vol. 31, no. 3, December 1916, 4 pp., 2 figs.

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Measuring Gases by a Standard Orifice, Thos. G. Estep, Jr. The Blast Furnace and Steel Plant, vol. 5, no. 1, January 1917, pp. 16-18, 2 figs.

†Points Out Advantages to be Derived in Regulating Operations of Water Gas Sets by Measuring Flow of Gases at Superheater Outlet. American Gas Engineering Journal, vol. 106, no. 1, January 1, 1917, pp. 5-10, illustrated.
J. M. Spitzglass describes tests made with pitot tubes in measuring flow of unpurified gases at high temperatures at Pitney Court Station of People's Gas Light and Coke Company.

MECHANICS

†Remarks on Dynamics of the Automobile, N. W. Akimoff. S.A.E. Bulletin, vol. 11, no. 3, December 1916, pp. 262-270, 5 figs.

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MODO DE EVITAR LAS VIBRACIONES PRODUCIDAS POR LAS MAQUINAS. Anales de Ingenieria, vol. 23, nos. 279-280, May and June 1916, 2½ pp., 1 fig.
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THE DESIGN OF CONTINUOUS BEAMS, Ewart S. Andrews. The Society of Engineers, vol. 7, no. 10, October 1916, 27 pp., 17 figs.

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Method for calculating the perturbations of a known movement.

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Systematic variation of kinetic energy in the elastic impact of bodies.

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SHELL MAKING IN MONTREAL. Monthly Bulletin of the Canadian Mining Institute, no. 56, December 1916, 7 pp., 3 figs.

HIGH EXPLOSIVE SHELL MANUFACTURE. Canadian Machinery and Manufacturing News, vol. 16, no. 24, December 14, 1916, 8 pp., 16 figs.

SPECIFICATION REQUIREMENTS OF MUNITIONS MATERIAL. Canadian Machinery and Manufacturing News, vol. 17, no. 1, January 4, 1917, pp. 1-2, illustrated.

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Manufacture of cast iron pipe by centrifugation.

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See also Hydraulics.

POWER PLANTS

POWER PLANT AT FORT SILL, Irving O. Montgomery. Practical Engineer, vol. 20, no. 24, December 15, 1916, 5 pp., 9 figs.

PERFORMANCE OF A SMALL MUNICIPAL NON-CONDENSING LIGHT AND WATER PLANT, R. L. Mossman. Southern Engineer, vol. 26, no. 5, January 1917, pp. 61-62, 3 tables.

PUMPS AND PUMPING ENGINES

MOTOR-DRIVE OF HYDRAULIC-ELEVATOR PUMPS, Charles J. Carlsen. Electric Review, vol. 69, no. 25, December 16, 1916, 4 pp., 4 figs.

HIGH-LIFT CENTRIFUGAL PUMP. The Engineer, vol. 122, no. 3182, December 22, 1916, 1 p.

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RAILROAD ENGINEERING

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Vaporization in an ordinary locomotive boiler.

FUEL ECONOMY AND BOILER DESIGN, J. T. Anthony. New England Railroad Club, October 10, 1916, 41½ pp., 12 figs.

RELATIONSHIP OF BOILER HEATING SURFACE TO ECONOMIZER, M. C. Sherman. Power, vol. 44, no. 26, December 26, 1916, 2 pp., 1 fig.

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Part V. Superheaters.

CHARTS

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EXPANSION IN PIPING. Practical Engineer, vol. 21, no. 1, January 1, 1917, 7 pp., 14 figs.

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

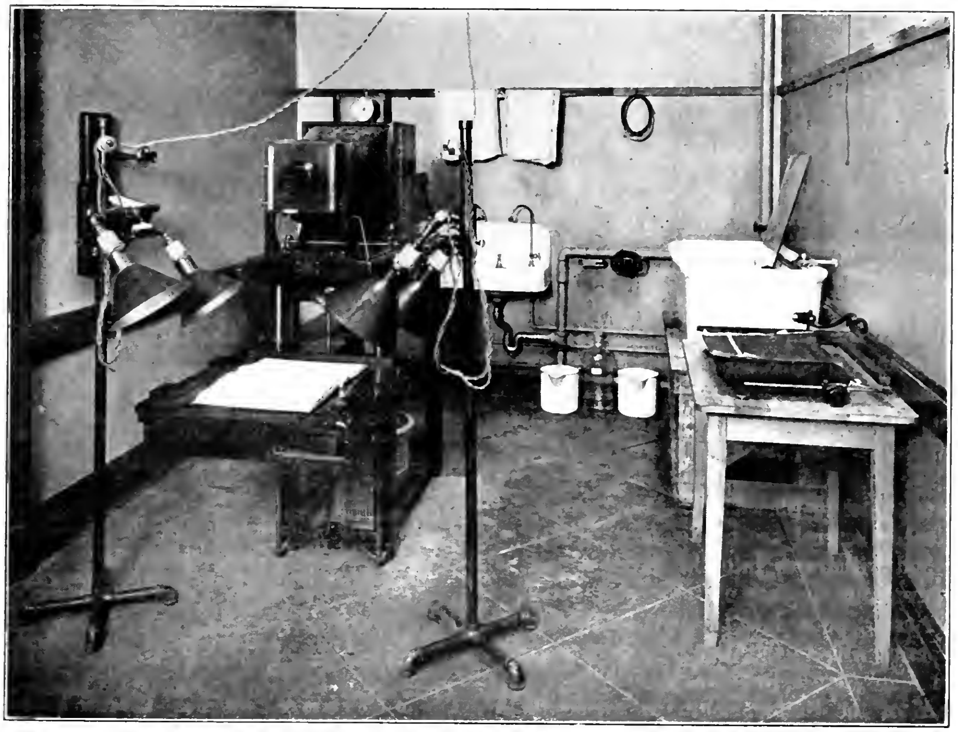
LIBRARY NOTES

From the Library of the United Engineering Society, Engineering Societies Building, New York. Includes Accessions to the Libraries of the Four Founder Societies

Annual Report of Library Board

The Library Board administering the Libraries of the American Society of Civil Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Institute of Mining Engineers, maintained as the Joint Library of the United Engineering Society, has just issued its annual report for 1916.

On August 16, 1916, when the American Society of Civil Engineers became a Founder Society, it entered into the same library agreement as the other Founder Societies. Its collection of books, which was started more than forty years ago and contains nearly 90,000 accessions, has therefore been added automatically to the Library of the United Engineering Society. This collection has for many years been a working civil-engineering library and all of the books (with the exception of periodicals) have been thoroughly analyzed and indexed. This library is particularly rich in engineering works of historic interest. It will be most valuable to the engineering profession when merged into the Library of the United Engineering Society, since it will furnish 67,000 entirely new accessions. The books are still in the house of the American Society of Civil Engineers, but will be moved to the Engineering Societies Building within a short time.



Photostat Room in Library of United Engineering Society

The Board for 1916 consisted of

Edward D. Adams	W. M. McFarland
W. P. Cutter	Harold Pender
J. V. Davies	Calvin W. Rice
Karl Eilers	Lewis D. Rights
Alfred D. Flinn	E. F. Roeber
George A. Harwood	Samuel Sheldon
Alex. C. Humphreys	W. I. Slichter
Charles Warren Hunt	Jesse M. Smith
F. L. Hutchinson	E. Gibbon Spilsbury
John W. Lieb	Bradley Stoughton

Leonard Waldo

Messrs. Davies, Flinn, Harwood, Hunt and Rights were added to the Board on October 13, 1916, to represent the American Society of Civil Engineers, which became one of the Founder Societies of the United Engineering Society on August 16, 1916.

Accessions to the Library during the year amounted to 2902 pieces, and the collection totaled, on December 31, 1916, 63,199 volumes.

The Library has received many notable gifts of books during the year. In addition to this, Dr. James Douglas generously donated the sum of \$100,000, the income of which will be used for library purposes as mentioned in the last issue of The Journal.

Quite a large section of the report is devoted to the subject of recataloguing, which the report states must be undertaken in the near future. The necessity for this arises from the fact that when the libraries of the original three Founder Societies were united, their catalogues were assembled so as to form a catalogue of the united collection. The Dewey system had been employed in making each set, but many entries in

the catalogue, requiring judgment, had been determined by at least three different minds from different points of view. The resultant catalogue therefore lacks consistency. The report further states that it would not be wise to undertake this recataloguing before a satisfactory classification has been made of sufficiently broad scope to comprehend the library collection of the future. The report contains a time study of the processes of cataloguing and the determination of the cost to the Library of cataloguing various kinds of books.

Installation of Photostat Machine

Photographic processes for reproducing maps, plates, diagrams, manuscripts and material from printed books, have been in use by engineers and other workers for many years. These processes have been slow and expensive. A few years ago, however, there was developed a machine which makes possible the quick reproduction of such material at a slight expense. Photographs are produced on bromide paper without the intervention of a glass plate.

As will be seen from the illustration, the machine consists of a device for holding the object to be photographed, an apparatus for illuminating the object, and an optical combination of a lens and reversing prism. In addition, a camera capable of adjustment for focusing contains a roll of sensitized paper. The camera box is also provided with a mechanism to rotate the roll of paper, and a cutting knife to be used in separating a sheet of the paper after unrolling and exposure, as well as a manually-operated mechanism for transferring the severed sheet into the developing and fixing pans. The whole apparatus forms one unit. The lighting units are 200-watt Mazda C lamps, supported as shown on special stands.

The book or other object is placed as shown, the camera focused, an exposure of several seconds is made, the sheet rolled off and cut, and withdrawn into the developer; it remains there for the requisite number of seconds, and then is withdrawn through rinsing water into the hyposulphite fixing bath. The whole operation from the time of exposure to the time of fixing is not more than a few minutes.

The Library Board of the United Engineering Society installed in April, 1916, such an apparatus, with proper washing and drying auxiliaries, and has made prints for the clients of the Library Service Bureau during the last nine months of 1916.

This apparatus makes it possible to furnish anyone at a distance with an exact copy of any article in a technical periodical, including text illustrations, maps and diagrams, and thus renders, in connection with reference lists, the resources of the Library available to anyone within reach of the world's mails.

A charge is made to cover cost of labor, materials and current, which is figured at twenty-five cents per exposure.

W. P. C.

Am. Soc. M. E. Accessions

American Ceramic Society. Transactions, vol. XVIII. *Columbus, 1916.* Gift of Society.

Colorado Industrial Plan, John D. Rockefeller, Jr. Including a copy of the plan of representation and agreement adopted at the coal iron mines of the Colorado Fuel and Iron Company. 1916. n. p. Gift of author.

Cost Accounting and Burden Application, Clinton H. Scovell. *New York, D. Appleton & Co., 1916.* Gift of publisher.
Treats the subject in the following order: Material Cost; Labor Cost; Burden Cost, Manufacturing Cost: Selling Price. The last few chapters are devoted to special kinds of manufacturing: Foundry; Textiles; Paper and Candy. W. P. C.

The Factory The Master Tool, by Max Toltz and W. E. King. *St. Paul, 1916.* Gift of Max Toltz.

Institute of Accountants in the United States of America. Year Book, 1916. *New York, 1916.* Gift of Institute.

International Railway General Foremen's Association. Proceedings of 12th Annual Convention. 1916. Gift of Association.

Lock Gates, Chain Fenders and Lock Entrance Caisson of the Panama Canal, by Henry Goldmark. Paper presented at the International Engineering Congress at San Francisco, 1915. *New York, n.d.* Gift of author.

Mediation, Investigation and Arbitration in Industrial Disputes, By G. E. Barnett and D. A. McCabe. *New York, D. Appleton & Co., 1916.* Gift of publishers.
This study is based on a report submitted in June, 1915, by the authors to the Commission on Industrial Relations. It is based on a survey of the agencies for mediation in Massachusetts, New York and Ohio. W. P. C.

U. S. Bureau of Lighthouses. Annual Report of the Commissioner, 1916. *Washington, 1916.* Gift of Bureau of Lighthouses.

U. S. Interstate Commerce Commission. Annual Report of the Chief Inspector of Locomotive Boilers. *Washington, 1916.* Gift of Interstate Commerce Commission.

U. S. Navy Department. Annual Report of the Paymaster General of the Navy, 1916. *Washington, 1916.*
——— Annual Report of the Secretary, 1916. *Washington, 1916.* Gift of Am.Soc.M.E.
——— Statement of Hon. Josephus Daniels, accompanied by Lieut. Byron McCandless. December 11, 1916. Gift of U. S. Navy Department.

Water Supply System, 1916. City of New York Department of Water Supply, Gas and Electricity. Gift of Municipal Engineers of the City of New York.

When is the Drilling of Off-set Wells for Natural Gas Justifiable? Samuel S. Wyer. *Columbus, 1916.* Gift of author.

Wisconsin Gas Association. Journal of Proceedings 13th and 14th annual convention. *Milwaukee, 1914-1915.*

U. E. S. Accessions

American Railway Association. Car Shortage Statistics. *New York, 1916.* Gift of Association.

American Society for Testing Materials. Proceedings of the Annual Meeting. 19th, 1916. 2 pts. *Philadelphia, 1916.*

Armour Engineer. General Index. vols. I to VIII, 1909 to 1916. *Chicago, 1916.*

Atlanta, Birmingham and Atlantic Railroad Co. Valuation of the property of, before the Interstate Commerce Commission. Gift of Clemens Herschel.

Bibliography of Australian Mineralogy, New South Wales. Department of Mines. Mineral Resources no 22. *Sydney, 1916.*

Boiler Code of the American Society of Mechanical Engineers, S. F. Jeter. Address before the National Association of Cotton Manufacturers. April 26, 1916. Gift of Frederick R. Hutton.

Boiler Safety Orders. Issued by the Industrial Accident Commission of the State of California. Effective January 1, 1917. *California, 1916.* Gift of Frederick R. Hutton.

Colorado Springs, Colo. U. S. Geological Survey, Folio 203. *Washington, 1916.*

Cotton Production and Distribution Season of 1915-1916. U. S. Census Bureau. Bulletin 134. *Washington, 1916.*

Descripcion de Algunas Plantas Liasicas de Huayacocotla. Ver. Boletin no. 34. Instituto Geologico de Mexico. *Mexico, 1916.*

Elementary First Aid for the Miner. U. S. Bureau of Mines. Miners' Circular 23. *Washington, 1916.*

Exploitation of Minerals in Mysore. Department of Mines and Geology. Gen. Ser. Bulletin no. 8. *Bangalore, 1916.*

Federal Valuation of the Railroads in the United States. Circular communication to chairmen of valuation committees. *December 15, 1916.* Gift of Clemens Herschel.

Federal Valuation of the Railroads in the United States. Statement prepared by Thomas W. Hulme, of the developments in connection with Federal valuation as of December 30, 1916. Gift of Clemens Herschel.

Field Geology, F. H. Lahee. *New York, 1916.*

Galena-Elizabeth, Illinois-Iowa. U. S. Geological Survey. Folio 200. *Washington, 1916.*

Geology of Cincinnati and Vicinity. Ohio Geological Survey, Bulletin no. 19. *Columbus, 1916.*

Gold Mining in Korea, Edwin W. Mills. Royal Asiatic Society, Trans. vol. VII, pt. I. *v. p 1916.* Gift of Edwin W. Mills.

Handbook of Westinghouse Watthour Meters. Publication no. 5150. Gift of Westinghouse Electric & Manufacturing Co.

Institution of Automobile Engineers. Proceedings. vol. X. *Westminster, 1916.*

Ironmonger Diary. 1917. *London, 1917.*

Kansas City Southern Railway Company. Tentative Valuation by Interstate Commerce Commission, November 20, 1916.
——— Report of the cost of reproduction new and cost of reproduction less depreciation. Engineering.
——— Summary and explanatory text of the land report. Gift of Clemens Herschel.

Legislation to Govern Construction of Boilers. Editorial from Dallas News, June 22, 1916. Gift of Frederick R. Hutton.

Lives of Alchemystical Philosophers, A. E. Waite. *London, 1888.*

Manufacture of Carbide of Calcium. Charles Bingham. *London, 1916.*

Mineral Resources of Mysore. Department of Mines and Geology. General Ser. Bulletin no. 7. *Bangalore, 1916.*

Mineralogical Society. By-Laws and List of Members, November, 1916. *London, 1916.*

Modern Theory of Solution. H. C. Jones. *New York, n. d.*

Napier, David, Engineer. 1790-1869. An autobiographical sketch with notes. *Glasgow, 1912.*

New Pearl of Great Price. A. E. Waite. *London, 1894.*

New Orleans, Texas and Mexico Railroad Company. Tentative Valuation by Interstate Commerce Commission, November 21, 1916. Gift of Clemens Herschel.

New York State Museum. Report of the Director, 1915. *Albany, 1916.* Gift of University of the State of New York.

New Zealand. Department of Internal Affairs. Annual Report of the Dominion Laboratory. 49th, 1916. *Wellington, 1916.*

Numerical Classification of Photography. *Rochester, 1916.* Gift of Eastman Kodak Company.

Ohio Boiler Inspection Law, 1916. Gift of Frederick R. Hutton.

Ohio Boiler Inspectors' Convention. Report of the Proceedings of First. *1916.* Gift of Frederick R Hutton.

Pennsylvania Department of Labor and Industry. Second Industrial Directory, 1916. *Harrisburg, 1916.*
——— Department of Agriculture. Tabulated analyses of commercial fertilizers. Bulletin no. 282. *Harrisburg, 1916.*
——— Flavoring Extracts. Bulletin no. 285. *Harrisburg, 1916.*
——— Water Supply Commission. Annual Report. 1915. *Harrisburg, 1916.*

Pittsfield (Mass.) Ordinance Amending Building Ordinance. Gift of City Clerk.

Plea for Uniform Boiler Specifications, T. E. Durban. Paper read before the American Boiler Manufacturers' Association, September 1913. Gift of Frederick R. Hutton.

Practical Enameler, with Especial Reference to Enameling Sheet Steel and Cast Iron Ware. Otto Grampp. *New York, 1909.*

Production of Spelter in Canada, 1916. *Ottawa, 1916.*

Proposed Uniform Boiler Code. Louisiana Planter. Gift of Frederick R. Hutton.

Some Properties of Vibrating Telephone Diaphragms, A. E. Kennelly and H. O. Taylor. Reprinted from Proceedings of American Philosophical Society. vol. lv, 1916. Gift of Massachusetts Institute of Technology, Electrical Engineering Department. Bulletin no. 11, April 1916.

Specimens of British Minerals, Philip Rashleigh. *London, 1797.*

Technical Vocabulary, English-German, F. J. Wershoven. Ed. 2. *Leipzig, 1885.*

Texas Midland Railroad Company. Valuation of the property of Before the Interstate Commerce Commission. Gift of Clemens Herschel.

Through the Air, John Wise. *Philadelphia, 1873.*

Underground Latrines for Mines. U. S. Bureau of Mines, Technical Paper 132. *Washington, 1916.*

Uniform Boiler Laws, T. E. Durban. Address before the Texas Cotton Seed Crushers Association, May 29, 1916. Gift of Frederick R. Hutton.

Uniform Specifications for Boilers, T. E. Durban. Address before 2d Pennsylvania Industrial Welfare and Efficiency Conference, November 19, 1914. Gift of Frederick R. Hutton.

U. S. Board of Engineers. Appointed to examine and report on plans adopted or designed for machinery of U. S. Vessels. Minutes of the Proceedings of. *Philadelphia, 1863.*

U. S. Bureau of Mines. Annual Report of the Director. 1916. *Washington, 1916.*

U. S. Bureau of the Mint. Annual Report of the Director, 1916, also the Report on the Production of the Precious Metals, 1915. *Washington, 1916.*

U. S. Census Bureau. Census of manufactures, general totals for the United States by geographic divisions, states and industries, 1914, 1909, 1904, and 1899. *Washington, 1916.*

U. S. Isthmian Canal Commission. Annual report of the Governor of the Panama Canal, with maps and diagrams. 1916. *Washington, 1916.*

Vapor Pressures of Various Compounds at Low Temperatures. U. S. Bureau of Mines. Technical Paper 142. *Washington, 1916.*

Victoria Mines Department. Annual Report of the Secretary for Mines, 1915. *Melbourne, 1916.*

Western States Water Power Conference. Call, Resolutions and Official Proceedings. September 21 to 23, 1915. *Portland, 1915.*

What is Preparedness? H. L. Gantt. Reprint from Engineering Magazine, September 1916. Gift of Frederick W. Taylor Co Operators.

Wisconsin Gas Association. Journal of Proceedings. 15th Annual Convention. *Milwaukee, 1916.*

GIFT OF ALBERT F. GANZ

Effect of Electrolysis on Engineering Structures. Paper read at meeting International Engineering Congress, 1915.

Electrolytic Corrosion of Iron by Direct Current in Street Soil. Paper presented at 29th annual convention, American Institute Electrical Engineers, June 25, 1912.

Electrolysis from Stray Electric Currents. Before American Water Works Association, June 6, 1912; and New England Association of Gas Engineers, February 19, 1913.

Report, Investigation for stray electric currents in the City of Winnipeg and in adjoining municipalities, by H. A. Robson. *1915.*

Report on Electrolysis Conditions in Springfield, Ohio. *1914.*

Report on Insulated Return Feeder System for Mitigating Electrolysis installed by the United Railways Company of St. Louis, Mo., in the Ann Ave. substation district. *May 1914.*

GIFT OF INTERNATIONAL ENGINEERING CONGRESS

International Engineering Congress. Transactions vols. 1-11 and Index. *San Francisco, 1915.*

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary and items should be received by February 16 in order to appear in the March issue.

CHANGES OF POSITION

David B. Clark, until recently with the Providence Engineering Works, Providence, R. I., has become superintendent of the American Shoe and Foundry Company, Erie, Pa.

John W. Clark, until recently associated with Hodenpyl, Hardy & Company, Inc., Jackson, Mich., has accepted a position with the Central Illinois Light Company, Peoria, Ill.

Frank E. Bardrof has resigned his position with the Pennsylvania Railroad, and is now connected with the Corning Glass Works, Corning, N. Y., in the capacity of machine designer.

Grandon D. Gates has become affiliated with The Celluloid Company of Newark, N. J. He was formerly connected with the A. Y. McDonald Manufacturing Company, Dubuque, Ia.

P. P. Henshall has accepted a position with the Stokes & Smith Company, Philadelphia, Pa. He was formerly instructor of machine shop practice at Pennsylvania State College, State College, Pa.

Edward W. Norris, recently connected with the Southwark Foundry and Machine Company, Philadelphia, Pa., has accepted a position as sales engineer in the New York office of the Mead-Morrison Manufacturing Company.

F. V. McMullin, formerly affiliated with the Pennsylvania Forge Co., Bridesburg, Pa., has assumed the duties of secretary and treas-

ager of the Richter Machine Company, Philadelphia, Pa., which has succeeded the Domestic Machinery Works.

John O. Heinze, who about a year and a half ago formed the John O. Heinze Company in Springfield, O., to make electric starting systems, has severed his connection with the company and has joined the Simms Magneto Company, East Orange and Bloomfield, N. J. He has been appointed engineer and production manager.

Thos. *R. H.* Murphy, formerly member of John H. Wallace and Company, New York, and recently engineer of the Mattagami Pulp and Paper Company of Toronto, has become chief engineer for the Port Arthur Pulp and Paper Company, Ltd., Toronto. Mr. Murphy will be in charge of building the company's 150-ton sulphite mill and 100-ton paper mill at Port Arthur, Ontario.

James A. Norris has assumed the duties of first assistant superintendent of the Presbyterian Hospital, New York. He was formerly connected with the New York Polyclinic Hospital, in the capacity of superintendent.

Robert Shirley, formerly mechanical engineer for the Pratt and Cady Company of Hartford, Conn., and works manager and engineer for The Chapman Valve Manufacturing Company, Springfield, Mass., for the past seven years, has severed his connection with the latter company. Mr. Shirley expects to take an extended vacation before again assuming manufacturing responsibilities.

ANNOUNCEMENTS

H. G. Brinckerhoff has been placed in charge of the Boston office of The Engineer Company.

Miss Kate Gleason of the Gleason Iron Works, Rochester, N. Y., has been elected vice-president of the Trailer Manufacturers' Association, recently formed at Detroit.

Charles B. Rearick, who has been acting as manager of sales for the Covington Machine Company for the past two years, is now located in Covington, Va., as vice-president and manager of the company.

Hugh M. Wilson, first vice-president of the McGraw Publishing Company, Inc., has tendered his resignation and will devote himself to his personal interests. Mr. Wilson has been vice-president of the company for the last six years.

Frederick W. Gay of San Francisco, Cal., announces that he has opened offices as consulting engineer, and will make reports, investigations, appraisals, and design, construct and operate power plants for public utilities and industrial plants.

Fred Ophüls, Halbert P. Hill and J. Harold McCreery, have incorporated under the firm name of Ophüls, Hill & McCreery, consulting engineers. They will specialize on the design and construction of power plants, ice and refrigerating plants and mechanical and electrical engineering.

George C. Hicks, Jr., vice-president and engineer of the P. H. and F. M. Roots Company, of Connersville, Ind., for the past 15 years, announces his retirement from the company on January 1, 1917. Mr. Hicks will act as consulting engineer for the company for a short time. Before taking up work again, he expects to take a six months' vacation.

Charles R. Courtenay, formerly superintendent and chief draftsman with the Watertown Engine Company and late with the New York Engine Company, and Robert E. Cahill have formed a partnership and will conduct business under the name of the Watertown Engine and Machine Company. The company will make a specialty of repairs and replacements to Watertown engines and boilers and, in addition, will do engineering work along the line of testing and adjusting power plant apparatus.

A. W. K. Billings has returned from Barcelona, Spain, where he has been for the past five years as manager of construction, managing director and vice-president of the Ebro Irrigation and Power Company, Ltd., and allied interests, in responsible charge of extensive hydroelectric construction and other work. Previous to his work in Spain and elsewhere for the Pearson interests, Mr. Billings spent two years in Pittsburgh and ten years in Cuba, principally on electric railway and power plant construction, and two years in New York as engineering manager of J. G. White and Company, Inc. He has opened an office as consulting engineer in New York, and will devote considerable attention to work in Europe and in Latin America.

APPOINTMENTS

Henry L. Barton has been made president of the Northway Motor and Manufacturing Company. Mr. Barton has been an executive of the General Motors Company for several years.

John H. Suter, formerly with the Snow Steam Pump Works, Buffalo, N. Y., the St. Joseph and Doe Run Lead Companies in southeast Missouri, and for the last two years with the Western Gas Engine Corporation, Los Angeles, Cal., as shop superintendent, has been appointed chief engineer and general superintendent of the Western Gas Engine Corporation.

Max E. Cutler, chief engineer of works of the Whiting Manufacturing Company, Bridgeport, Conn., has been appointed supervising engineer for Hamilton, DeLoss, Inc., who will erect a new factory immediately, with the intention of manufacturing metal goods and stamping in various kinds of metals. Mr. Cutler will still retain his position with the Whiting Manufacturing Company.

AUTHORS

F. De R. Furman is the author of a treatise on Elementary Cams.

Reginald Trautschold is the author of an article on Internal Spur Gearing, which appears in the January issue of *Machinery*.

J. C. Bertsch has contributed a paper on The Steam Jet Refrigerating Machine to the January number of *The Electric Journal*.

Gano Dunn has contributed an article entitled Professional Unity Among Engineers to the January 6 issue of *Engineering Record*.

Robert E. Cranston is the author of Gold Dredging in 1916, which appears in the January 6 issue of the *Engineering and Mining Journal*.

Advantages and Future of Electric Ship Propulsion, by W. L. R. Emmet, appears in the January 6 number of the *Electrical World*.

The Treatment of Export Inquiries, by Sterling H. Bunnell, is published in the January 4 number of *The Iron Age*.

Frederick C. Moore is the author of A Cost System for a Small Malleable Foundry, which is published in *The Foundry* for January.

An article on the Design of Oil-Ring Bearings by William Knight is published in the January 9 number of *Power*.

J. E. Johnson, Jr. is the author of Technical Advances in Iron and Steel, in the January 4 number of *The Iron Age*.

W. F. Durand has contributed an article to the January 6 number of the *Electrical World* on Progress and Outlook in Prime Movers.

B. S. Nelson of New Orleans, La., is the author of an article on Flow of Air Through Orifices Against Back Pressure, which is published in the January 4 issue of *Engineering News*.

Arthur J. Slade has contributed a paper entitled, What Motor Trucks Offer to Contractors, to the January 6 issue of *Engineering Record*.

Charles E. Knoeppel has contributed an article entitled How Profit-Sharing has Worked in Foundries, to the January issue of *The Foundry*.

B. A. Behrend is the author of The Signs of the Times in Generating Apparatus, which appears in the January 6 number of the *Electrical World*.

Charles A. Stone is the author of an article entitled Engineer's Relation to Foreign Expansion, which is published in the January 6 issue of the *Engineering Record*.

Harry L. Horning presented a paper on Seeking the Ultimate Tractor Engine, at the New York convention of the Society of Automobile Engineers, January 9 to 11.

Lawrence Addicks is the author of Metallurgy of Copper in 1916, which appears in the January 6 issue of the *Engineering and Mining Journal*.

Frederick Hymans presented a paper on Dynamic Balance of Rotating Parts and Dynamic Balancing Machines, at the convention of the Society of Automobile Engineers, held in New York, January 9 to 11.

Peter Junkersfeld, president of the Association of Edison Illuminating Companies, has contributed an article entitled, The Sale of Electric Service in Larger Quantities, to the January 6 number of the *Electrical World*.

G. R. Tuska presented a paper on Recent Developments in Design of Municipal Waste Disposal Plants, at the convention of the American Association for the Advancement of Science, held in New York, December 26 to 30.

HEAT TREATMENT OF WROUGHT-IRON CHAIN CABLE

An Original Investigation of the Causes of the Comparative Weakness of Power-Forged Wrought-Iron Chain, with Results of Experiments Leading to a Method of Heat Treatment for Their Removal

By W. W. WEBSTER[1] and E. L. PATCH[2]

With Foreword by F. G. Coburn, Naval Constructor, U. S. N.

THE following paper on the thermal treatment of wrought iron is a restatement of the graduation thesis on that subject prepared by W. W. Webster and E. L. Patch, Assistant Naval Constructors, U. S. Navy, at The Massachusetts Institute of Technology.

The subject was suggested by the writer, as a result of experience at the U. S. Navy Yard, Boston, Mass., in the manufacture of chain cables for naval vessels. Prior to July 1, 1914, all chain cables for the Navy were manufactured at that yard, by hand, after the fashion of the old English chain-makers, still followed in other chain shops in this country. Experiments had been under way for several years, looking toward a steam-hammer process, and such a process had, at that time, been developed: satisfactory to the extent that it effectively and cheaply welded the chain, but unsatisfactory in that the chain, apparently perfect, would not meet the breaking-strength requirements.

It became suddenly necessary, in July, 1914, to make the process work in order to supplant hand manufacture. The writer, just at that time, came into direct charge of the work. The process seemed to be good, but it was mystifying, indeed, to see apparently perfect chain snap off under test like cast iron. It seemed as if an *addition* to the process was needed, rather than a change; and heat treatment suggested itself. There was no literature available on the heat treatment of either iron or low-carbon steel. In fact, this thesis appears to

Fig. 1 Heavy Pearlite Structure—from Heavily-Shaded Areas in Fig. 5

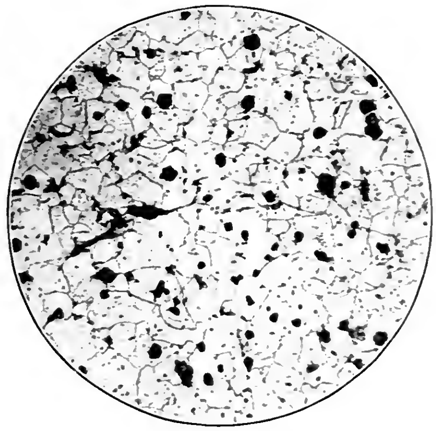


Fig. 2 Pure Iron Structure—from Lightest Areas in Fig. 5

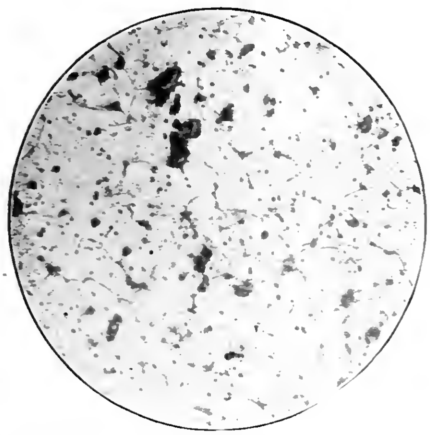


Fig. 3 Ferrite Structure with Traces of Pearlite—from Lightly-Shaded Areas in Fig. 5

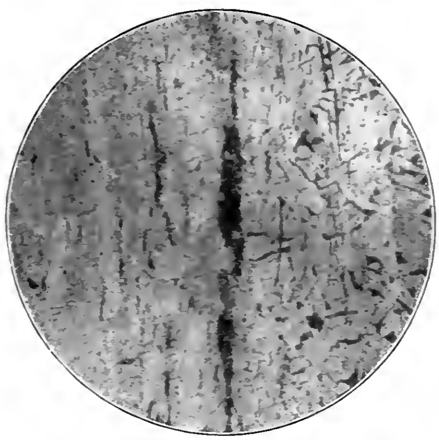


Fig. 4 Adjacent Areas of High and Low Carbon (50 Diameters)

Figs. 1 to 4 Characteristic Microphotographs from Burden Wrought Iron

[1] Puget Sound Navy Yard.
[2] Portsmouth Navy Yard.

Presented at the Annual Meeting of The American Society of Mechanical Engineers, New York, December 1916. The paper is here printed in abstract form. Pamphlet copies without discussion may be obtained; price 15 cents to members, 30 cents to non-members.

be the first work of its kind. A number of engineers familiar with the art of heat treatment were consulted by the writer, but none of them knew of any work having been done which would be of assistance.

It was peculiar that *hand* welded chain was successful under test, yet we knew that it was not so thoroughly welded as the *hammer* welded chain. The latter was very thoroughly hammered, too, and kneaded, so that it should be stiff and strong. In this very stiffness the trouble finally was found.

The distribution of stresses in a studded link under tension is such that there are maxima of bending moment at the ends of the axes of the link and maxima of shear at the quarters. It is well known that iron is weaker in shear than in tension. It was observed that the hammer-welded links always failed in the quarters; that while the hand-welded links stretched freely, the power-welded links would not stretch much prior to breaking.

Fig. 5 Section of Burden Iron Etched 30 Minutes

The following hypothesis was then formulated by the writer, to explain the above phenomena: That the hammer-welded link was so stiff that the shearing stress could build up in the quarters to such a degree that the link would fail by shearing, whereas the hand-welded link was soft and ductile enough to deform under the shearing stress, failure occurring later due to a combination of shear and tension when a higher applied tensile load was reached.

There was no pyrometric equipment available; so in the first experiments, which were necessarily crude, the writer gaged temperatures by eye. Test doublets were heated to a temperature believed to be above the upper critical point, cooled in air, and pulled, giving satisfactory results as regards stretch, character of fracture, and ultimate tensile strength. Heat treatment was plainly the answer to the problem.

The writer therefore proceeded to equip a laboratory and to equip the shop for temperature measurement. After some experimenting, a method of heat treatment was evolved which gave fairly good results. But these results were not always consistent, and while the plant was put on a manufacturing basis, still there were very puzzling questions arising. It was considered very desirable, indeed, to find out really why heat treatment was required for power-forged chain and not for hand-welded chain, what the very best heat treatment should be, how much heat treatment wrought iron would respond to, and, in general, to develop working standards for shop practice.

Messrs. Webster and Patch took up the task as their graduation thesis, being assisted in the work later by J. J. Crowe, Physical Metallurgist, who came to the work from the Bureau of Standards by courtesy of the Director, Dr. S. W. Stratton, and of Dr. G. K. Burgess.

F. G. Coburn.

MANUFACTURE OF POWER-FORGED CHAIN

The various operations involved in the process of power-forging chain are briefly as follows:

Shearing. The bar of round stock is rolled from the storage skids on to rollers which guide it through the shears and against the stop which gages the length of the "bolts." After cutting off, the bolts are packed in special baskets for transfer by crane to the scarfing furnace.

Scarfing. One end of the bolt is heated in a special oil furnace for a distance of about a foot and the end is then bent and upset by a single operation in the upsetting machine. During the same heat the bolt is scarfed under a 2500-lb. steam drop hammer, using special steel dies. The "flash" or web is then removed by a trimming press. The operation is repeated for the other end and the bars are packed in baskets for transport to the bending-machine furnace.

Bending. The scarfed link is heated throughout to about 1100 deg. cent. in a special oil furnace, from which it is swung by a special jib crane to the hydraulic bending press. Here it is bent by wiping it around a mandrel having the shape of the inside of the chain link. This operation leaves the links practically closed and it is necessary to pry apart the scarfs with a crowbar in order to thread the links in the chain.

Welding. The link is first preheated, threaded into the end of the growing chain, and the scarfs closed under a heavy hammer. It is then brought to a welding heat of about 1350 deg. cent. in a special oil-burning chain forge and welded on special "dolly dies" under a light hammer (250-350-lb.). To give the link the proper shape it is brought to welding heat a second time and finished in the dies of the heavy hammer (1800-3000-lb.).

Trimming. The last welding process leaves a "drop-forge flash" inside and outside on the welded end of the link, which is trimmed off by hand.

Studding. The drop-forged chain stud, which is inserted to preserve the shape of the link, increase the strength, and prevent kinking of the chain, is held in place with the link on its side under the steam hammer and pinched in place by a light blow of the hammer.

Heat Treatment. This is accomplished by loading the chain on to a steel flat car, which is run into a long annealing furnace fired by oil burners. The temperature is brought evenly to about 950 deg. cent., well above the upper critical point, as determined by the indications of nine base-metal thermocouples distributed about the furnace, one couple being placed in a bolt of iron under the pile of chain on the car. After the

desired temperature has been maintained for 10 minutes the car is hauled out of the furnace and the chain allowed to cool in the air before proofing.

Proofing. Each shot of chain is given a "proof test" with the hydraulic testing machine up to values given in the chain tables. After proofing, each link of the shot is examined for defects, and if unsatisfactory links are found they are cut out and replaced by the repair crews. In addition to the proof test, a breaking test is made on a "doublet" taken at random during the making of each shot. If this does not equal the tabulated standard others are tried on each side, and if they fail the whole shot is condemned. The proofing load is approximately 60 per cent of the breaking load. The tables of stresses are standard with the Navy Department, being based on both foreign and domestic practice.

Painting. Shots which have been proofed and found satisfactory are coated by hauling through a hot bath of asphalt paint, and are then stowed ready for shipment.

PROPERTIES OF STOCK MATERIAL

At present the iron used for the most important sizes of chain is made by the Burden Iron Company, of Troy, N. Y. The Government requires grade "A" American refined iron, puddled from all-ore pig iron, free from admixture of steel or scrap; phosphorus not to exceed 0.10 per cent and sulphur not to exceed 0.015 per cent.

Chemical analysis of Burden iron, made by the chemical laboratory of the Boston Navy Yard from borings taken from several stock bars, gave the following average results:

Carbon	0.10 per cent
Silicon	0.10 per cent
Phosphorus	0.085 per cent
Sulphur	0.008 per cent

Twelve tensile specimens cut from a 3¼-in. bar gave the results summarized below, which are compared with the Government specification requirements:

	Test results.	Specification.
Yield point, lb. per sq. in.	26,100	24,000
Tensile strength, lb. per sq. in.	49,000	48,000
Elongation, per cent	35.5	26
Contraction of area, per cent	50	40

Charpy impact tests of eight specimens averaged as follows, and indicate the difference of resistance to shock due to the direction of the slag fibers:

Longitudinal, 150 ft-lb. per sq. in.
Transverse, 39 ft-lb. per sq. in.

The appearance of the transverse and longitudinal sections of a stock bar, when polished and etched, is shown in Fig. 1, which brings out clearly the outlines of the different bars and slabs, known as grade "B" bars, which were piled together to make up the finished grade "A" bar. Also each grade "B" bar is seen to be made up of well-defined areas of different shades or depths of color, representing the muck bars from which it was rolled.

Under the microscope the heavily shaded areas have a pearlite and ferrite structure, with numerous slag spots (Fig. 5), showing them to be wrought iron with about 0.20 per cent carbon. The more lightly shaded areas indicate less pearlite (Fig. 2), typical of about 0.05 per cent carbon, and the unshaded areas a pure wrought-iron structure (Fig. 3). Metallographic examination was made of specimens cut from three stock bars all of which displayed the same characteristics of segregated carbon; the line between adjacent areas of high carbon content and of low carbon is frequently very sharp, as in Fig. 4.

HEAT TREATMENT OF BURDEN CHAIN IRON

The thermal analysis of the iron, or the determination of its "critical" points, is quite necessary for an intelligent study of its heat treatment. In Fig. 6 are typical heating and cooling curves for Burden iron, which indicate the positions of the critical points. These are commonly designated as, A_1 (recalescence point); A_2 (lower temperature point of thermal retardation and cooling) on heating and cooling; and A_3 (upper temperature point of thermal retardation and cooling).

Table 1 gives the critical points as determined by the curves. For purpose of comparison, average points are given for pure

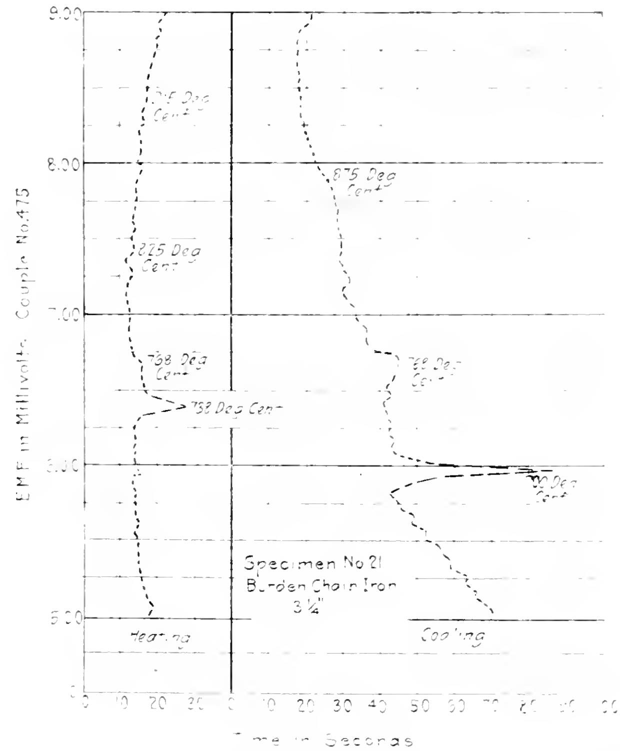


Fig. 6 Typical Heating and Cooling Curves for Burden Iron

iron and for iron of 0.10 per cent carbon and 0.20 per cent carbon, taken from Sauveur's diagram of iron-carbon alloys.

TABLE 1 CRITICAL POINTS FROM HEATING AND COOLING CURVES FOR BURDEN IRON

Critical Point.	Burden stock. Heating, deg. cent.	Burden stock. Cooling, deg. cent.	Average of Heating and Cooling, from Equilibrium Diagram. Pure Iron, deg. cent.	0.1% C, deg. cent.	0.2% C, deg. cent.
A^3	915	875	900	850	800
A^2	768	768	768	768	768
A^1	738	700	690	690	690

In the heating curve, which is the important curve in connection with heat treating, the indication of the upper critical point, A_3, is indistinct and, at first glance, apparently indeterminate.

But the small point shown at 915 deg. cent. was duplicated in size, shape, and position on all of the curves taken; as were also the indications of changes shown by irregularities of the curve from about 825 deg. cent. up to 915 deg. cent. It may therefore be concluded that the upper critical point is not sharp but extends over the range indicated, with a well-defined end at 915 deg. cent. This phenomenon is explained by the unequal distribution of the carbon in the iron, different parts of which vary in composition from pure wrought iron to 0.2

per cent carbon, as was determined by metallographic examination. The second and lower critical points are well defined at the temperature indicated.

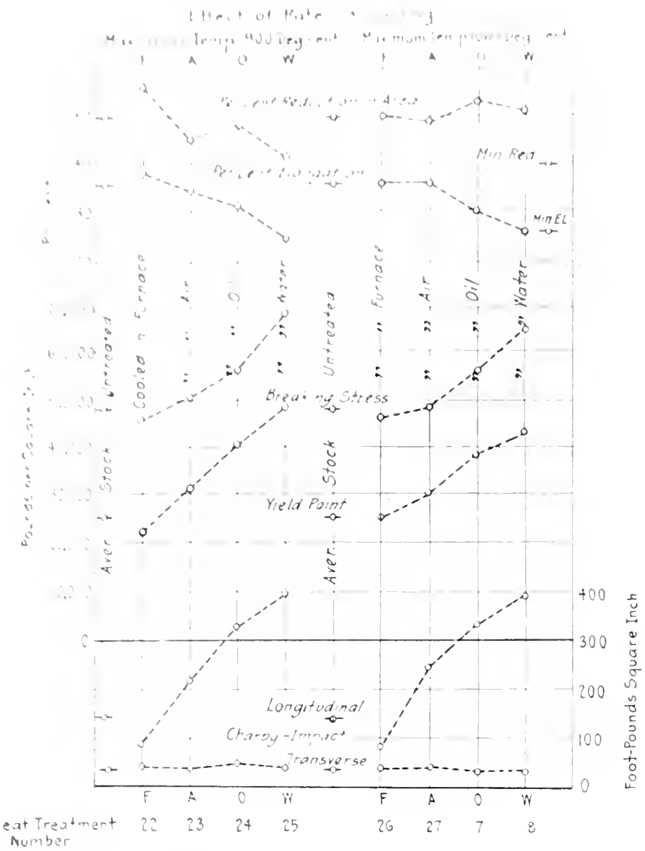


FIG. 7 EFFECTS OF DIFFERENT RATES OF COOLING

Specimens heated to 900 deg. cent. and 1060 deg. cent. cooled in furnace, cooled in air, quenched in oil and quenched in water. Results on untreated material shown vertically at the left and in the center. It may be readily seen: (1) that furnace cooling reduces the Charpy and tensile strength and increases the elongation and reduction of area; (2) that air cooling gives greater strength than the original material with less elongation and reduction of area; (3) that oil and water quenching increase the strength considerably. In the case of heat treatment No. 25 in which the specimens were heated to 900 deg. cent. and quenched in water, the tensile breaking stress was increased from the 49,000 average to 68,700, which is an increase of 40 per cent, and the longitudinal impact resistance was increased from 150 average to 406, which is an increase of 165 per cent. The effect of the rate of cooling on series (*b*), in which the specimens were heated to 1060 deg. cent., was generally less than in series (*c*), in which the heating was carried only to 900 deg. cent.

The practical conclusion from the location of the upper end of the upper critical range on the heating curve at 915 deg. cent. is that to anneal or air-quench the chain from above the critical range it should be heated to about 950 deg. cent., or about 56 millivolts (mv.) on the furnace thermo-couples, instead of 52 millivolts, or 890 deg. cent., as has previously been the practice in the manufacture of wrought-iron chain at the Navy Yard.

LABORATORY EXPERIMENTS IN HEAT TREATMENT

A preliminary study of heat treatment was made in the laboratory for the purpose of securing an indication of the best treatment to be used in the actual manufacture of the chain cable, and the effects of the following variables were studied:

1 Maximum temperature of annealing.
2 Rate of cooling, or quenching.
3 Drawing to different temperatures after heating to maximum temperatures, or after different rates of cooling.
4 Time of annealing, or time material is held at maximum temperature.

The list of heat treatments developed is given in Table 2. Each charge consisted of three tensile specimens and two blocks from which four longitudinal and four transverse Charpy specimens were machined. The furnace was heated to about 750 deg. cent. before specimens were introduced. The temperature was then raised, rapidly at first and slower as the upper limit was approached, to the point where the increase was about 5 deg. in 15 min.

TABLE 2. TABULATION OF HEAT TREATMENTS OF BURDEN IRON STOCK

Series (a): Rate of Cooling.

1 Heat to 900 deg. cent. and cool in furnace.
2 Heat to 900 deg. cent. and cool in air.
3 Heat to 900 deg. cent. and quench in oil.
4 Heat to 900 deg. cent. and quench in water.

Series (b): Rate of Cooling.

5 Heat to 1060 deg. cent. and cool in furnace.
6 Heat to 1060 deg. cent. and cool in air.
7 Heat to 1060 deg. cent. and quench in oil.
8 Heat to 1060 deg. cent. and quench in water.

Series (c): Rate of Cooling before Drawing.

9 Heat to 1000 deg. cent., cool in furnace, reheat to 900 deg., quench in oil and draw to 650 deg.
10 Same as (9) but quenched in water.

Series (d): Maximum Temperature before Cooling.

11 Heat to 800 deg. cent. and quench in water.
12 Heat to 850 deg. cent. and quench in water.
13 Heat to 900 deg. cent. and quench in water.
14 Heat to 950 deg. cent. and quench in water.
15 Heat to 1000 deg. cent. and quench in water
16 Heat to 1050 deg. cent. and quench in water.

Series (e): Temperature of Drawing.

17 Heat to 1000 deg. cent., quench in water, draw to 550 deg.
18 Heat to 1000 deg. cent., quench in water, draw to 650 deg.
19 Heat to 1000 deg. cent., quench in water, draw to 750 deg.

Series (f): Rate of Cooling.

20 Heat to 1000 deg. cent., quench in oil.
21 Heat to 1000 deg. cent., cool in air.
22, 23, 24, 25 Series (*a*) Repeated.
26, 27 5 and 6 of Series (*b*) Repeated.

Series (g): Time of Annealing.

28 Heat to 970 deg., hold 1 min., cool in air.
29 Heat to 970 deg., hold 15 min., cool in air.
30 Heat to 970 deg., hold 30 min., cool in air.
31 Heat to 970 deg., hold 120 min., cool in air.

After the specimens had received their heat treatments as outlined in Table 2, the following tensile and impact tests were made upon the heat-treated specimens:

1 Tensile tests giving
 a Yield point
 b Breaking stress
 c Per cent elongation in 2 in.
 d Per cent reduction in area from 0.20 sq. in.
2 Impact tests giving
 Resistance to shock in ft-lb. per sq. in. of an area of about 0.0785 sq. in. in a bar 10 mm. square by 55 mm. long, with 40 mm. between supports.

All tensile results were within 10 per cent of the average results from the three tensile specimens previously mentioned as having been subjected to heat treatments in each series. The averages are used in all plots.

The Charpy impact results varied greatly; in certain instances as much as 80 per cent from the average. For example, one specimen showed a fine, silky fibrous fracture with 321 ft-lb. per sq. in. resistance, and the next specimen, supposedly from the same bar, a coarse crystalline and dirty fracture with only 39 ft-lb. per sq. in. resistance (heat treatment No. 11).

These variations are probably due to variations in the character of the metal in different sections of the bar, as shown by the metallographic examination. It would be possible even for adjacent specimens to have widely different characteristics, and the probability of this is enhanced by the fact that the breaking sectional area of a Charpy specimen is only about 0.0785 sq. in.

The most important results of the tests are plotted in Figs. 7, 8 and 9.

As a general conclusion from the results of the physical tests, it may be stated that the iron is affected by heat treatment in a manner very similar to low-carbon steel, giving an increase of 40 per cent in the tensile strength and 125 per cent in the longitudinal impact strength when heated to 950 deg. cent. and quenched in water. This was confirmed by microphotographs showing sorbitic and martensitic structure typical of the hardening structure of mild steel.

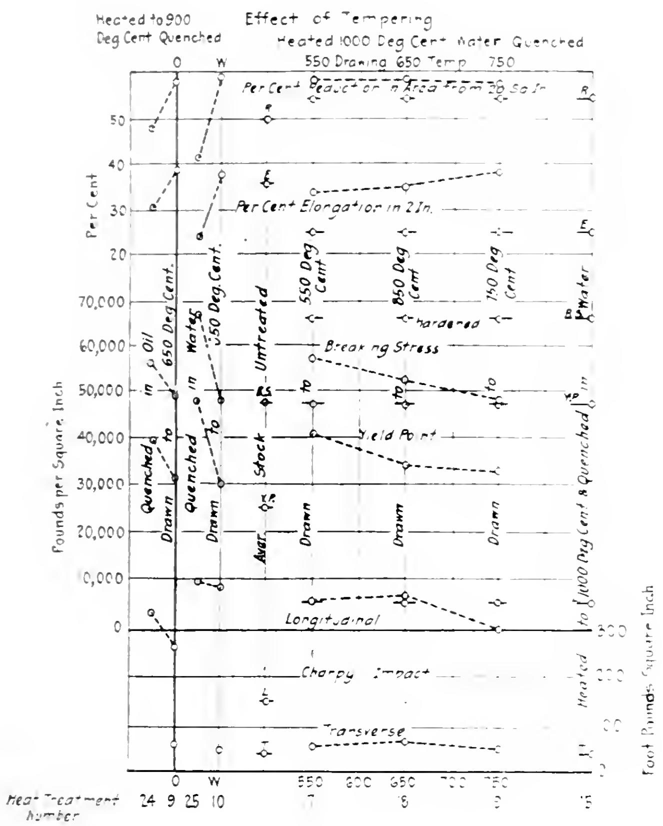


FIG. 8 EFFECTS OF HARDENING AND DRAWING

On the left is shown series (e), the effect of drawing to 650 deg. cent. of specimens heated to 900 deg. cent. and quenching in oil and water respectively. It is seen that the drawing brought the tensile breaking stress and elongation nearly down to the average untreated results, as shown in the left center of the sheet, while the per cent. reduction of area was greatly increased over the average stock results, and the reduction in the Charpy longitudinal strength was very small. On the right is shown series (c) all heated to 1000 deg. and water quenched, the abscissæ being the drawing temperatures, with the results of the undrawn given at the extreme right for comparison. The general effect of increasing the drawing temperature is to reduce the strength and increase the elongation. There is little change in the impact strength and reduction of area, which remain considerably greater than in the untreated stock results.

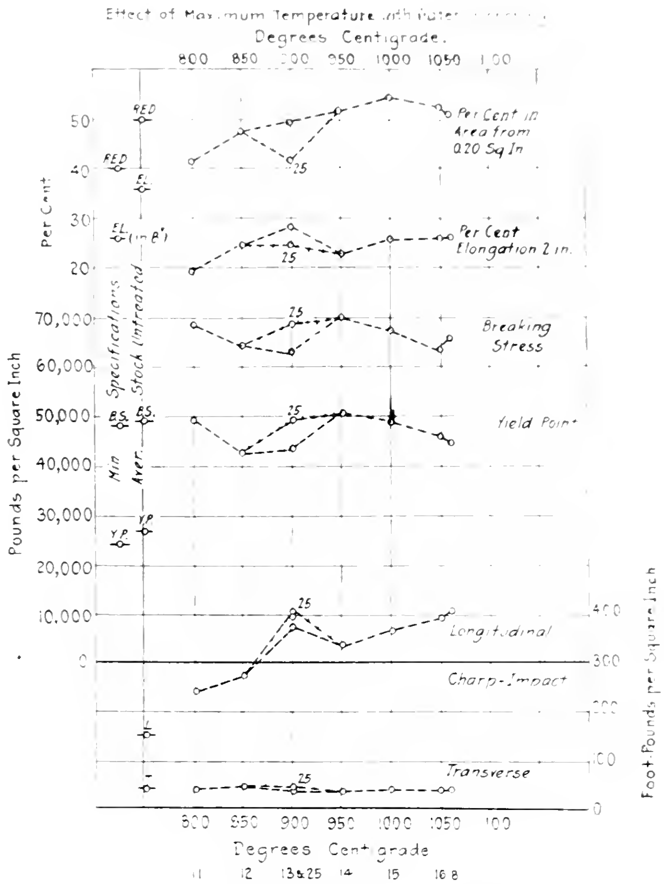


FIG. 9 EFFECT OF MAXIMUM TEMPERATURES OF HEATING WITH WATER QUENCHING

This comprises heat treatments Nos. 11 to 16, inclusive, in which the material was raised to different temperatures and quenched in water; and in addition heat treatments Nos. 8, 13 and 25. The two latter are the same and the difference in the results may be due either to the nature of the material, or to a slight variation in the heat treatment, as apparently there is considerable change near 900 deg. cent. It appears from these results that a temperature of about 950 deg. cent. would give the best results with water quenching and any increase beyond 1000 deg. cent. gives less strength, although the Charpy longitudinal specimens gave best results at 900 deg. cent. and 1060 deg. cent. The data of the oil-quenched and air- and furnace-cooled specimens were not sufficiently complete to warrant plotting.

It is therefore recommended that a further investigation be made of the effect of this heat treatment of chain cable, and the practicability of its application to the manufacture of chain cable.

It was suspected that the length of time during which the specimens remained at maximum temperature in the furnace might have some effect on the results, so a special series (g) was added of heat treatments Nos. 28 to 31, which were all heated to 970 deg. cent. and maintained at that temperature, for intervals of 1 min., 15 min., 30 min. and 2 hr. The results indicated that on specimens of that size the duration of the time of annealing has no appreciable effect.

PRELIMINARY EXPERIMENTS WITH CHAIN LINKS

Two preliminary experiments were performed with full-size chain, (1) to confirm the results of the laboratory experiments as to the best temperature to which the chain should be heated for annealing by air cooling, and (2) to determine the best sequence of annealing and proofing.

It was concluded both from the investigation of the stock material and the laboratory experiments on this subject that the chain should be annealed from about 950 deg. cent. (56 mv.) instead of 890 deg. cent. (52 mv.) as hitherto had been the practice. To confirm this conclusion, 2⅝-in. Burden iron doublets were heated to temperatures corresponding to 48, 52, 56 and 60 mv. The tensile results from the specimens heated to 52, 56 and 60 mv. were not conclusive, but the fractures of the 56- and 60-mv. links, however, were, as a whole, very clean, fine and silky, and much better looking than those of the other links, and the practice has therefore been followed in the

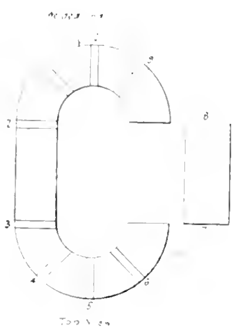


Fig. 10 Location of Test Specimens in Link

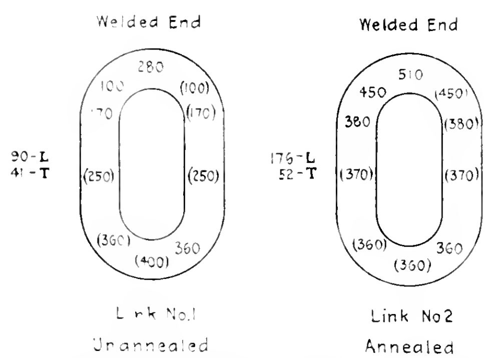


Fig. 11 Grains per Sq. Mm. at Various Sections of Links 1 and 2

manufacture of the chain, of annealing from approximately 950 deg. cent. (56 mv.), with the result that stronger chain has been produced, as determined by the routine test doublets referred to in the second paragraph on p. 193.

The second series of tests, to determine the best order to follow in annealing and proofing, was conducted with 2⅝-in. Burden-iron doublets. Chain may be (1) annealed before proofing, which is the regular practice, (2) annealed after proofing, or (3) annealed before and after.

When chain is proofed, it is strained well over the elastic limit of the link as a whole. For example, 3¼-in. test links are proofed to 367,000 lb., which leaves a permanent set of about ⅜ in. The ratio of proof to pulling load is 367,000: 620,000 = 0.59, while the ratio of elastic limit to ultimate stress of the material is 27,000:49,000 = 0.55.

Proofing therefore strains certain parts of the link above the elastic limit and leaves it in an internally strained condition. If method (1) is used the chain leaves the shop for service with internal strains, but if method (2) is used the internal strains of proofing are relieved by annealing, and from this consideration alone each link should be stronger.

Method (2) appeared to produce the stronger link. On the other hand, it must be noted that four of the six test doublets of method (2) broke by failure of the weld before they were strained to their breaking stress. One of the best men in the shop forged all of the links for this experiment, knowing that they were for experimental purposes. This, combined with the fact that there was only one failure of the weld in the tests made for each of the other methods, indicates that the failure of these four welds was due to the sequence of operations.

The logical explanation is that when a link is proofed before it is annealed there is a tendency to start an opening in the weld due to local strains which may have been produced by forging. Then when the link is subjected to an applied load it will break through the weld before the breaking stress of the material is reached. If the link is annealed before proofing, this condition will be relieved.

After four of the six doublets for method (2) broke through the weld, it was decided to run another series of tests on this method, for which purpose eight 2¾-in. doublets were used. Of these, two broke low with a dull, lusterless fracture, indicating overheating. The average of the other six was 504,000 lb., failing generally across the welded quarter with a fibrous fracture. In spite of the careful welding, the point of the scarf in one link was found not welded when pulled to destruction.

These results were compared with results from tests on 2¾-in. doublets annealed and pulled in the course of regular shop manufacture. These doublets were treated by method (1) by first annealing and then proofing.

The average pulling strength of six of these links was 482,000 lb., which, compared with the 504,000 of the links treated by method (2), shows that the latter process produces the stronger links, provided there is no injury to the weld due to the action of proofing on local strains.

Because this tendency to injure the weld does exist where method (2) is used, the conclusion was reached that method (1) of annealing before proofing should be followed and not method (2). Theoretically, method (3) would seem to be much preferable to both (1) and (2), since it combined the advantages of each, but the average breaking load was the same as for method (1). The fractures, however, were remarkably clean, pure, and silky. There would probably be a small advantage in using method (3), but it is not practical to go to the great additional trouble and expense of two annealing processes for the slight advantage to be gained.

DISCUSSIONS OF WELDING AND ANNEALING

In order to explain the failure of these power-forged, unannealed links and the way in which annealing restored their strength, it is important to understand the essential differences between hand and power forging.

The use of the steam hammer in forging enables a much greater reduction in area to be made at the weld, and hence produces a much greater amount of internal work. It also permits the use of a longer scarf, which necessitates a welding heat further around on the quarter of the link. In power forging, therefore, the link is brought up to a white heat around on the quarter, and then shades off through light orange, dark orange, and bright red, to a dull red at the bent

end. In hand forging the white heat does not cover so large an area and shades down to a dull red on the side of the link, and to black on the bent quarters and end.

It would be expected that these conditions would permit a greater crystal growth of the power-forged chain, except under the hammer at the welded end. Since the welded end of the power-forged link receives a much greater amount of work from hammering, it should have a much smaller grain size than the hand-welded link at the finishing temperature. On the other hand, the power-forged link has a greater cooling range during which the crystals may grow, since its finishing temperature is higher; but most probably this effect is small in comparison with that of hammering. The net results should be an appreciably smaller grain size at the weld of the power-forged link.

In comparison with the other parts of the same link, the grain size at the weld should increase from the middle to the end of the weld as the hammering effect decreases, and then should decrease from the weld around to the bend and in proportion to the maximum temperature to which the part was heated.

Hammering also deforms the crystals at the weld, but this effect should be obliterated by the crystal growth during cooling from 1200 deg. cent. down through the critical range, after hammering has ceased, and there should be no resultant "strain hardening."

The effect of the carbon content should further be considered. Above the critical range, carbon is present in the solid solution of iron, or austenite. As the metal after forging cools slowly in air through the critical range, all the carbon should separate freely from the austenite crystals in the form of pearlite. Therefore, carbon should have little hardening effect in either hand- or power-forged chains; and, since there is no practical difference between the cooling conditions of the two, it should cause no difference between them in hardening.

The only remaining difference between the structures of the hand-forged and power-forged links which could cause the greater stiffness of the latter, is in the grain size. In the side of the link where most of the stretching takes place, the grain size is probably somewhat greater in the power-forged link, while in the welded quarter, where the first power-forged links broke, the difference is probably not appreciable. According to Rosenhain, coarse structure generally does not affect tensile strength or ductility to a marked degree, although it does greatly decrease resistance to shock.

Therefore, from a theoretical consideration of the material as an alloy of iron and carbon only, we can find no apparent cause for stiffness in the power-forging process. In the tests which are hereafter described, however, it developed that in the power-forged link there was an overheated, distorted structure, which was relieved by the recrystallization in annealing. The stiffness of the link was undoubtedly removed primarily by relieving this condition, but also to some extent by the lessened hardening effect of carbon and the refinement of grain size caused by annealing.

TESTS OF FULL-SIZE LINKS BEFORE AND AFTER ANNEALING

For the purpose of testing, a shot of five $3\frac{1}{4}$-in. Burden iron links was forged in the regular manner and four of these were annealed. Specimens were cut from the unannealed link (designated as No. 1) and from one of the annealed links (designated as No. 2). The remaining three links were pulled. Ten sections were located around links Nos. 1 and 2, as shown in Fig. 10. Piece 7-8 was used for tensile specimens and Charpy specimens were cut from the straight section 2-3 and from the curved section 0-1.

A slice $\frac{3}{4}$ in. thick was cut from each of sections 0 to 6, and from 9, for metallographic examination. Eight specimens $\frac{3}{4}$ by $\frac{3}{4}$ by $\frac{1}{2}$ in. were cut from each of these slices, numbered from 1 to 8, and their faces polished as required.

At the time the tests were started it was the practice to heat the chain to about 890 deg. cent. (52 mv.) and this value was used throughout. The present practice, as previously stated, is to heat to 950 deg. (56 mv.). The effect which this change might be expected to have on the results will be discussed later.

It should be noted that the tensile specimens, cut as they were from the side of the link, give a test of the material in that place only, and not of the material in other parts, nor of the strength of the link as a whole. It was impracticable to cut tensile specimens from the curved ends of the link, where the characteristics of the metal are modified by forging and where, also, the links usually fail.

Of the three links which were pulled, one broke across the welded quarter at a stress of 683,000 lb. The requirements for these links are: proof test, 376,000 lb.; and breaking load, 620,000 lb.

The results of the physical tests of the specimens are given in Table 3. In the third column are entered for comparison the results of tests on untreated stock material previously given. However, only a rough comparison can be made between these results and those from link 1, for the reason that in the link specimens there is a curvature of the slag grain with respect to the axes of the specimens, due to the curvature of the link. This curvature probably renders of no significance any difference under 10 per cent. The only marked difference is in the longitudinal Charpy tests, which gave results 45 per cent lower in the case of those cut from the side of the link, due to a combination of the effects of carbon and overheating in addition to curvature. The longitudinal specimens from the quarter gave somewhat lower results than those from the side, due to the effects of greater overheating, greater grain curvature, and larger grain size. The results of transverse specimens, as shown by the laboratory heat treatments, are generally contradictory and unreliable, and are therefore neglected.

TABLE 3 TEST OF UNANNEALED AND ANNEALED LINKS

	Average Results.		
	Link No. 1.	Link No. 2.	Stock Material.
Yield point, lb. per sq. in.	27,900	26,600	26,100
Tensile strength, lb. per sq. in.	47,600	45,500	49,000
Elongation, per cent	37	38	36
Reduction of area, per cent	51	55	50
Charpy tests, ft-lb. per sq. in.:			
Longitudinal, quarter	85	122	150
Longitudinal, side	90	176	
Transverse, quarter	48	41	39
Transverse, side	41	52	

In comparing the results of links No. 1 and No. 2, the question of curvature is of course eliminated, as the specimens from both links were in the same condition. Link No. 2 gives a small decrease in yield point and strength, and a small increase in ductility, which shows that annealing in air has lessened the hardening effects of carbon. Although annealing has also relieved the overheated condition and refined the grain size, these conditions do not have an appreciable effect in increasing the strength as shown by static tests.

In link No. 2 the longitudinal Charpy tests, side and quarter, were increased respectively from 90 to 176 ft-lb. per sq. in. (practically 100 per cent), and from 85 to 122 (almost 45 per cent), showing that annealing has greatly increased the resistance of the metal to shock, due mostly to relieving the

overheated condition and refining the grain size, which have a decided effect on ability to resist shock.

Comparing the results of link No. 2 to those of the laboratory experiment on Burden iron, which received the same heat treatment (No. 23), it is seen that the yield point, tensile strength, and Charpy results are smaller, and the ductility greater in the case of the link specimens. This indicates that a heat treatment applied to actual chain will not have as great an effect in changing the physical properties of the metal as it does when applied to laboratory specimens, on account of the much greater cross section of the link, and of the mechanical treatment which it has received.

Fig. 12 Link 1. Welded End. Ferrite with Traces of Pearlite, Large Grain Size, Slight Distortion

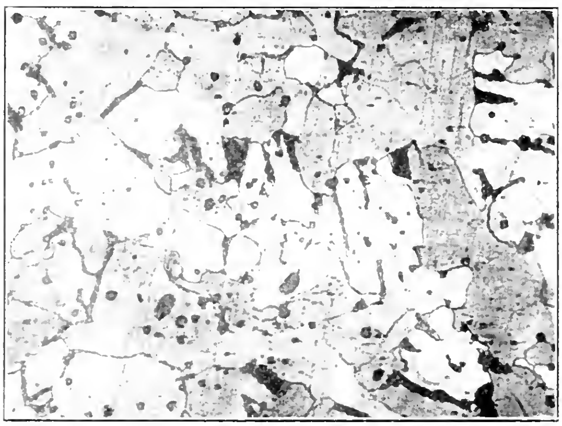


Fig. 13 Link 1. Welded End. Ferrite and Pearlite (0.1 Per Cent C). Medium Grain Size, Slight Distortion

The foregoing tests lead to the conclusion that the present heat treatment of cooling in air slightly decreases the yield point and tensile strength, increases the ductility, and greatly increases the resistance to shock of the metal of the forged link.

GRAIN SIZE OF ANNEALED AND UNANNEALED LINKS

It was desired further to study the effect of the heating and hammering processes and of annealing upon the grain size of different sections of the links.

The average grain size for four of the metallographic sections of the link was estimated by the method of counting grain size which was described and recommended by Jeffries, Kline and Zimmer.[1] The results from links 1 and 2 are as follows:

Section	Link No. 1.	Link No. 2.
0	280 gr. per sq. mm.	510 gr. per sq. mm.
1	100 gr. per sq. mm.	453 gr. per sq. mm.
2	169 gr. per sq. mm.	388 gr. per sq. mm.
6	359 gr. per sq. mm.	365 gr. per sq. mm.

It is not contended that these results are exact. In fact, they are probably not good to within 10 per cent, but it is stated with confidence that they give a very good rough comparison of the grain size of the various sections.

In Fig. 11 are sketches of links Nos. 1 and 2, showing the

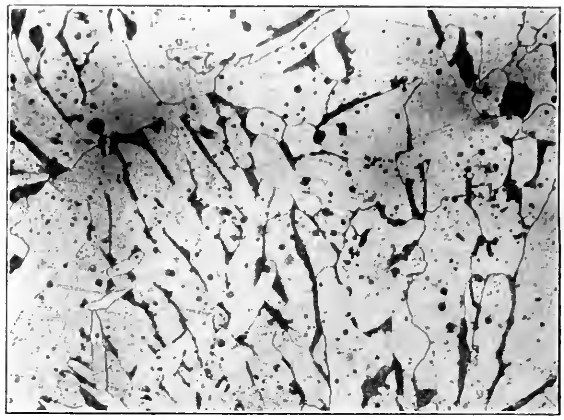


Fig. 14 Link 1, Welded Quarter. Ferrite and Pearlite. Medium Grain Size, Marked Distortion

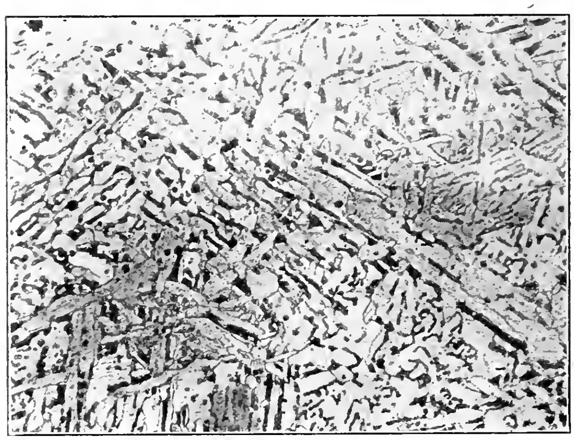


Fig. 15 Link 1. Welded Quarter. Ferrite and Pearlite (0.15 Per Cent C). Medium Grain Size, Marked Distortion with Elongated Ferrite and Pearlite Bands

grain size at the various sections. The determinations in the preceding table are indicated to the closest ten, without parentheses. The other figures, in parentheses, were obtained by induction as follows:

Since both sides of the link are in the same condition by similarity, section No. 9 should be the same as section No. 1, No. 8 the same as No. 2, and No. 4 the same as No. 6, and they are so indicated. The middle of the side of the link should have a grain size about half way between that of the welded and bent quarters, or about 250 gr. per sq. mm. for link No. 1, and 370 gr. per sq. mm. for link No. 2. From the decrease in

[1] The Determination of the Grain Size in Metals: Trans. A.I.M.E., Dec., 1915.

grain size toward the bent end of link No. 1, its grain size at the bent end is probably about 400 gr. per sq. mm. Since there is practically no variation in grain size away from the welded end of link No. 2, the grain size at its bent end is probably about the same as at the quarters, or 360 gr. per sq. mm.

In link No. 1 the grain size is fairly small right at the middle of the weld, but increases rapidly toward the quarter, since the effect of hammering on crystal growth then decreases faster than the effect of heating. But from the welded quarter to the bent end the grain size decreases again; since there has been no hammering and the temperature resulting from heating the link decreases as the distance from the weld.

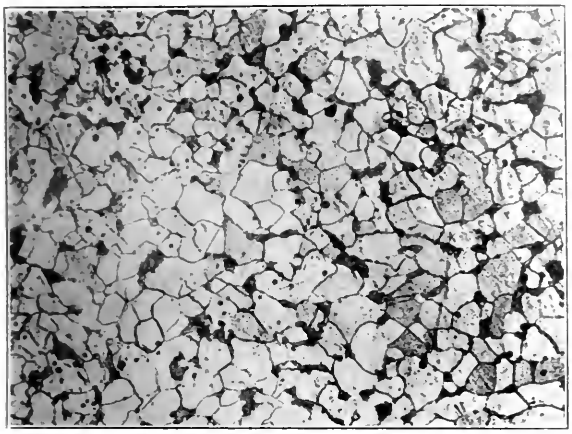


Fig. 16 Link 2, Welded Quarter. Ferrite and Pearlite (0.1 Per Cent C.) Very Small Grain Size

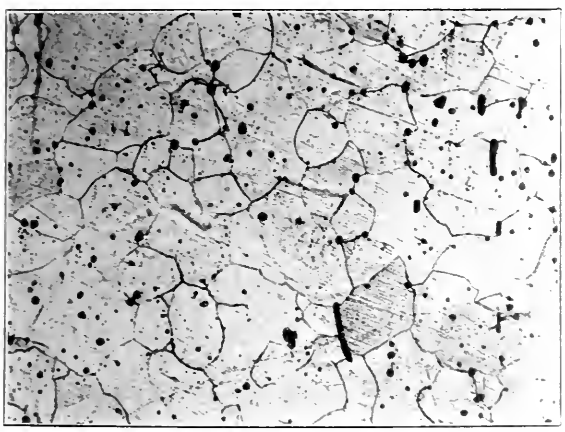


Fig. 17 Link 2, Welded End. Ferrite Structure. Medium Grain Size

Comparing link No. 1 with link No. 2, it is seen that annealing has the effect of refining the grain size of the link, especially at the welded end. This gradation to a smaller grain size at the welded end shows that some effect from the smaller grains in that part before annealing still remains to produce a somewhat smaller grain after annealing, in spite of recrystallization.

CHARACTER OF STRUCTURE OF UNANNEALED LINK (NO. 1)

A microscopic study was made of the structure of the metal and its variation in different sections, and for this purpose both transverse and longitudinal faces of specimens from all parts of each link were examined.

In no section of link No. 1 is the carbon distributed homogeneously; it appears in segregated areas, except that near the boundaries of such areas the carbon has become somewhat diffused into the neighboring ferrite areas due to the various heats which the link had received during manufacture. The proportion of pearlite areas containing greater than 0.05 per cent carbon in different specimens varies from about 15 per cent to about 50 per cent, the average being about 30 per cent.

Typical areas from the welded end containing varying percentages of carbon are shown by Figs. 12-15. The notable feature is the distortion of the ferrite grains into elongated bands with angular bands of pearlite between them. This distortion is proportionate to the amount of pearlite in the area.

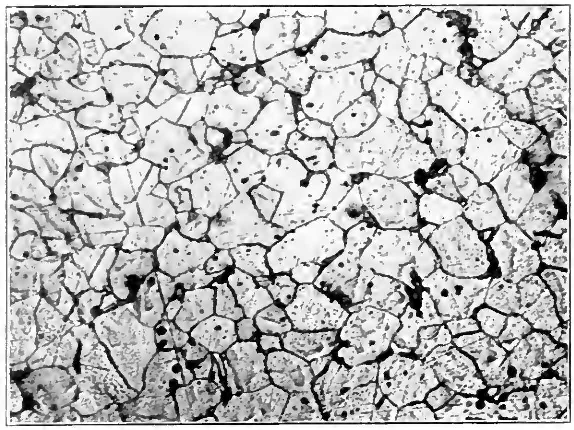


Fig. 18 Link 2, Welded End. Ferrite and Traces of Pearlite. Small Grain Size

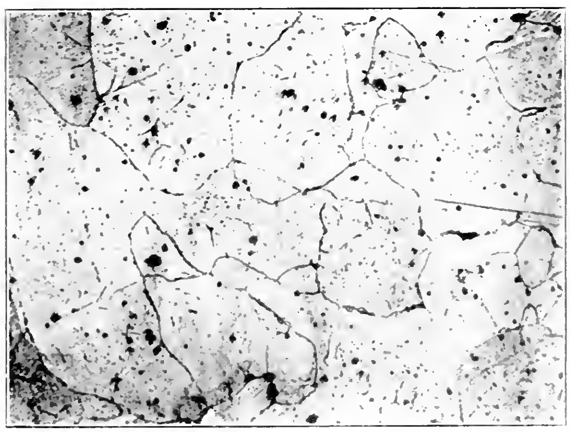


Fig. 19 Link 2, Welded Quarter. Ferrite Structure. Very Large Grain Size

It does not, however, extend through all parts of the welded end. A large number of the specimens at this end show a normal or only slightly distorted structure, and in certain of them signs of slight burning were observed in the vicinity of the weld.

In the other sections of the link, away from the weld, there were no signs of distortion of the grains, and the pearlite had separated from the ferrite crystals in a perfectly normal manner. The smaller average grain size in the bent end of the link was clearly brought out by this examination.

CHARACTER OF STRUCTURE OF ANNEALED LINK (NO. 2)

In the annealed link the same unhomogeneous distribution of carbon was found, as would be expected. Around the

welded end, however, pearlite areas were relatively fewer than in link No. 1, other parts of the link were about the same as link No. 1. The possibility of this non-uniformity between the two links should have been avoided by insuring that both links were made out of the same bar, but the difference was not appreciable enough to affect any of the general conclusions which might be drawn from the experiment.

Typical areas from this link, with varying percentages of carbon, are shown by Figs. 16 to 19. The important point brought out is that there are no signs of distorted structure in any part of the link. The pearlite has separated and segregated around equi-axed grains in the normal manner. The average grain size is fairly uniform but is smaller in pearlite than in pure ferrite areas. Near the weld itself the structure was often very fine, as in Fig. 18, but away from the weld it would grow rapidly coarser, often to a grain size as large as that shown in Fig. 19.

EFFECT OF HEAT TREATMENT

From the foregoing examination, the conclusion is reached that the stiffness of the unannealed link is largely due to the overheated distorted structure in the welded end.

The fact that the metal of the forged link does not return to its normal condition during slow cooling after forging, even if it has been "overheated" to 1350 deg. cent., is probably to a large extent due to the effects of slag and other impurities. Annealing relieves this condition by the process of recrystallization, which practically wipes out all former structure and gives a finer and more normal grain size.

In regard to this overheating, Rosenhain says:[1] " . . . We find that by 'overheating' steel, i.e., by exposing it to unduly high temperatures, or for too long a time at any temperature above Ac, the growth of a very coarse iron structure results, and this, on cooling down, gives rise to a corresponding coarse ferrite-pearlite structure. Not only this, but the arrangement and forms assumed by the pearlite which is formed from such steel is characteristic; there is a strong tendency for the ferrite to take the form of straight bands with elongated and angular patches of pearlite between them, the ferrite bands frequently crossing one another, at angles of 60 deg. Such a coarse, sharply angular structure is, of course, extremely undesirable; there is a minimum of interlocking between ferrite and pearlite, and the straightness of the arrangement facilitates the propagation of slip or cleavage through the crystals. Such structures are, in fact, frequently met with in steel objects which have failed in service. Under test they generally exhibit some degree of weakness as regards shock and alternating stresses, but their tensile strength and elongation are frequently quite satisfactory. The most typical feature, however, is a decided drop in the yield point as compared with that of the same material in a more normal condition."

The above description fits exactly the structure which has been found in the carbon areas of the welded end of the unannealed link. In the results of the physical tests, it was seen that the shock-resisting quality of this link was actually low, but it appears that the tensile strength and elongation are not "quite satisfactory" as indicated in the foregoing quotation.

[1] Introduction to the Study of Physical Metallurgy, pp. 281-282.

CONCLUSIONS

For heat treating, Burden iron should be heated to about 950 deg. cent. (56 mv.) instead of 890 deg. cent. (52 mv.), which was the former practice.

There is no apparent relation between character of fracture and character of structure.

Heating to 950 deg. cent. (56 mv.) for cooling in air gives stronger and better chain than heating to lower temperatures, and heating to higher temperatures gives no improvement.

The present procedure of annealing before proofing should be continued.

Stiffness of the unannealed link compared with the annealed link is mainly caused by overheated distorted structure at the weld.

Annealing removes stiffness of the forged link by relieving overheated distorted structure. It decreases the tensile strength and yield point, and increases the ductility and resistance to shock, of the metal; but it increases the strength, as well as the ductility and resistance to shock, of the link as a whole.

The laboratory experiments indicate the following conclusions:

(1) *Rate of Cooling.*

Cooling in furnace:

Reduces tensile strength from 49,000 to 47,000.
Reduces impact resistance from 150 to 90.
Increases elongation and reduction of area.

Cooling in air:

Increases tensile strength from 49,000 to 50,500.
Increases impact resistance from 150 to 240.
Reduces elongation and reduction of area.

Quenching in oil:

Increases tensile strength from 49,000 to 57,000.
Increases impact resistance from 150 to 340.
Reduces elongation from 36 to 31 per cent.

Quenching in water:

Increases strength from 49,000 to 67,000.
Increases impact resistance from 150 to 400.
Reduces elongation from 36 to 25 per cent.

(2) *Temperature from Which Cooled or Quenched.* Increase of temperature above 950 deg. cent. slightly decreases tensile strength, increases elongation and reduction of area, and does not appreciably affect impact resistance. Temperature of 950 deg. cent. gives best results.

(3) *Drawing Effect.* The higher the drawing temperature, the greater the decrease in tensile strength and increase in elongation. Drawing has little effect on impact resistance.

(4) *Increased Time of Annealing* slightly decreases tensile strength, and slightly increases elongation, reduction of area, and impact resistance.

SIX YEARS' DEVELOPMENT OF THE WERKSPOOR MARINE DIESEL ENGINE

By THOS. ORCHARD LISLE, NEW YORK, N. Y.

Member of the Society

THIS company has completed 37 propelling engines for 24 sea-going mercantile ships, representing about 36,000 hp. Werkspoor was one of the first firms to build Diesel-type engines on an extensive scale. Our first attempt at building the machinery of motorships was most modest. It was recognized that problems would arise which no ship tests or stationary-engine experience could foresee. Throughout we have remained steadfast adherents to the four-stroke cycle and have no reason to regret it. We also decided that unless an engine can be repaired in any port where steam engines can be repaired, it is of no use for ocean-going ships; consequently there is nothing fantastical about our designs, they are exactly similar to an ordinary steam engine.

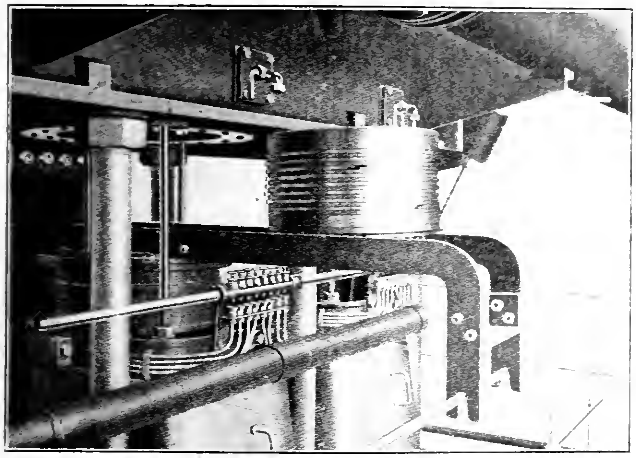


Fig. 1 Improved Method of Removing and Replacing Piston (Patented)

It was the *Vulcanus* that gave us the real experience, as this was the first sea-going full-powered ship, and her engine was the first Diesel to have short pistons, crossheads and guides. She is a ship of 2080 tons displacement and 1235 tons deadweight capacity fitted with a six-cylinder direct-reversible Werkspoor crosshead engine of 450 b.hp. at 160 r.p.m. Her fuel consumption did not exceed two tons per day, or one-fifth of the coal consumption of a steamer of similar cargo capacity. She was placed in service in 1910. At the beginning, trouble was experienced partly through lack of experience of the ship's engineers and partly through her air compressors, but the engines gave very little trouble indeed, wear and tear of the moving parts being very slight, and less than is usually found with marine steam engines. After two years' wear the cylinders were opened up and gaged as shown in Table 1.

On one occasion a high-pressure air reservoir burst while the engines were being overhauled at Amsterdam. Bad welding had left a fracture and the top part of the compressed-air bottle blew off. The indirect cause was the accumulation of water in the air retainer, which had not drained owing to a cracked internal pipe. This mishap taught us to dispense with the welded-type air bottles, also to suspend high-pressure bottles with covers and valves downward, thus effectually preventing any unknown accumulation of water.

TABLE 1 GAGING OF MAIN MOTOR CYLINDERS OF THE "VULCANUS" AFTER TWO YEARS' WEAR

Original Size 400 mm. (15¾ in.)

Cylinder No.	Top.	Middle.	Bottom.
1	400.5 mm.	400.4 mm.	400.1 mm
2	400.6 mm.	400.4 mm.	400.1 mm.
3	400.8 mm.	400.6 mm.	400.6 mm.
4	400.7 mm.	400.4 mm.	400.5 mm.
5	400.6 mm.	400.4 mm.	400.2 mm
6	400.4 mm.	400.3 mm.	400.15 mm.

For several years we have not tested our high-power engines in the shops, but since the war the engines of new ships have had about three hours' running at the wharf and about four hours' at sea. This may surprise some Diesel engineers and probably many will hardly agree with me that a fictitious value has grown round the tests made on the floors of builders' works.

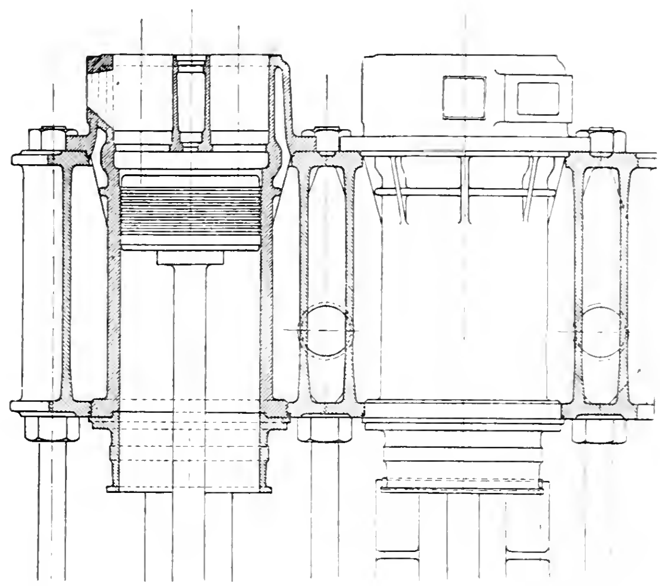


Fig. 2 Section of Cylinder, Illustrating How the Water Cools Hottest Part of Combustion Chamber

Certainly, some of the faults of a new design can be made to appear by shop trials, but when the design has been standardized, the tests are but little more than a check upon the quality of the machine and fitting work.

For years the detachable-cylinder-head design has been the standard practice with virtually every make of Diesel engine both marine and stationary, and still is the recognized standard practice. At the cylinder head, just level with the combustion, that is to say, where cooling is most needed, there are few or no cooling water passages. In the design adopted after the *Vulcanus*, there is therefore a complete water passage round the sides as well as on top of the combustion chamber. Expe-

From an Illustrated Review given at the Annual Meeting of The American Society of Mechanical Engineers, December 1916.

rience with the *Vulcanus* also showed that when using a very heavy oil the rings are apt to become gummed and then stick. So in our next engine, overhauling the pistons was greatly facilitated by the introduction of a patented device by which a piston can be dismounted from below in about 30 minutes, piston rings replaced, and the pistons remounted in about 1½ hours without disturbing any pipes or operating mechanism.

Radical changes in design were made with the engine in the tanker *Juno* in 1912. The frames for supporting the cylinders were entirely dispensed with, and forged-steel columns substituted, stiffening being obtained with and lateral stresses absorbed by diagonal steel rods. The load of tension that these rods have to take is over 130 tons per cylinder, or about 750 tons for the sixteen rods of the whole engine. Although there are cast-iron columns at the back of the engine, they are not secured to the cylinders, but have a sliding-surface fit and carry the crosshead guides; also, being hollow, they are utilized as intercoolers for the air compressors. They allow an up-and-down movement of the cylinders, but side pieces prevent lateral motion.

The open-column construction has been so successful that all our stationary engines are now designed in this manner.

With the later models the fuel-injection valve is offset from the center, and there is at least a space of 4 in. for cooling water everywhere in the cylinder head. Offsetting this valve, in contradiction to all theories, is proving entirely successful in actual practice. As the supporting webs of the cylinders occasionally cracked, our designers dispensed with them entirely in later designs and also improved the shape of the cylinder head. Since these various alterations in cylinder design have taken place, absolutely no cracks have occurred. This engineers will be glad to learn, and it will do much to allay the prejudice that still exists in some quarters against the marine Diesel.

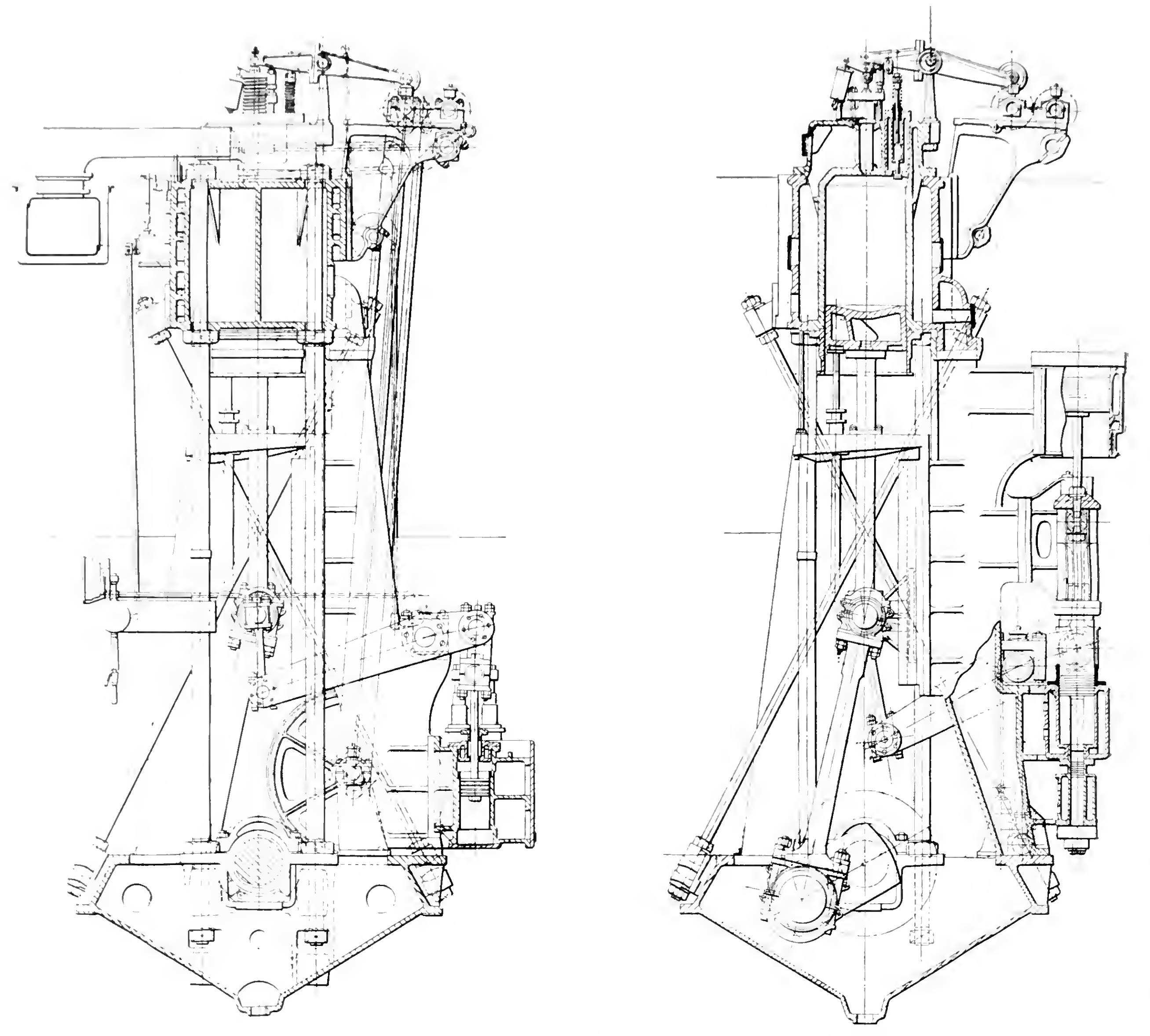


FIG. 3 ENGINE OF THE EMANUEL NOBEL. THIS IS THE TYPE BEFORE THE LATEST IMPROVEMENTS, AS STATED IN THE TEXT, WERE MADE

With regard to piston cooling, all our ships now use sea water for cooling the cylinders, pistons and bearings, there not being sufficient troubles to necessitate a change to fresh-water cooling. With sea water below 100 deg. fahr. practically no scale is deposited. When it is below 70 deg. fahr. it is as good as fresh water. But pistons and cylinders must allow of no

pockets; once scale or dirt starts to deposit, it quickly accumulates and so causes local temperatures.

Our present system consists of a jet of water forced up through clearance tubes, having no rubbing parts, but moving up and down with the piston to prevent splashing. The piston is never more than about half-full of water, the broken surface of the water being far better for the cooling than a solid mass. By means of a simple sight system a chokage of water supply at any point can be detected instantly.

So far as our company is concerned, the trouble with air compressors is absolutely a matter of past history. In the air-compressor system that has replaced the type recognized, the link-and-beam-operation motion is still retained, as this has proved efficient with all the ships. The high and middle stages are arranged side by side, each having its own piston rod, while the first stage is directly below and also has its own piston rod; thus every piston can be separately dismounted. All valves are interchangeable.

In the earlier ships some crankshaft failures have occurred, and crankshafts constructed by the same makers and installed in other ships gave out in the same manner. As a precautionary measure we have lately increased the size of bearings and have installed forced lubrication for the main bearings. For some vessels now building, built-up crankshafts are being adopted.

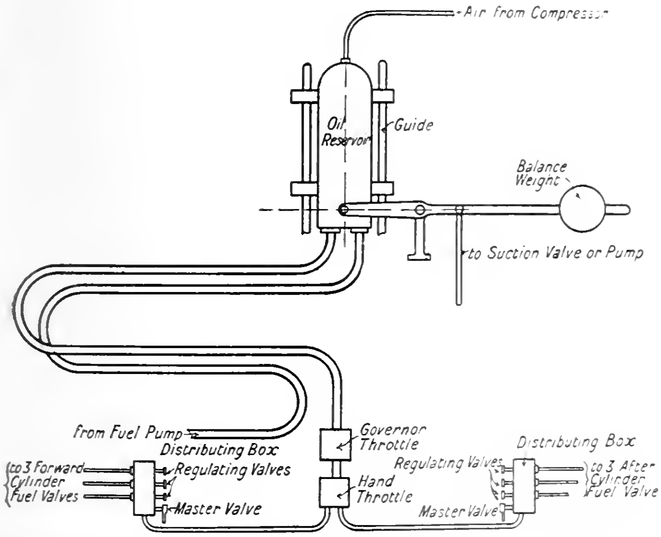


Fig. 4 Fuel-Oil Controlling and Distributing System

A smart ship's engineer can reverse in 5 seconds a 1000-hp. engine from full ahead to astern, but 7 to 10 seconds is the usual time occupied. For the purpose of obtaining the reverse motion there are two camshafts, one for the ahead running and one for the astern movement, and the astern camshaft is driven by means of a spur gearing from the ahead camshaft. These two shafts are mounted on sliding brackets or saddles. When maneuvring, these brackets, by sliding to and fro, bring the ahead or astern cams under the rolls of the valve rockers. By making the rockers unusually large, the angle of the face of each roller, where it meets its cam, is never steep, and this produces smooth and silent running. Thus reversings are rapidly and quietly carried out. The cams and cam rollers are of cast iron, and never have I seen the slightest sign of wear in them, even with a four-year-old ship. The steel tubes have a saw cut down through the center, the two halves being held apart by cross-struts to eliminate vibration.

Most Diesel engines have a separate fuel pump to each cylinder. This method requires too delicate adjustment to supply exactly the quantity of fuel to each cylinder. So a single pump is fitted which supplies two distributing boxes, each box having feeds to three cylinders and every feed its own adjuster. To the exhaust branch of each cylinder is fitted a thermometer by which the engineer can instantly see if any one cylinder is receiving more or less fuel than the others. As a stand-by, an extra pump with a single change-over device is fitted. The fuel pump feeds a reservoir in which an air pressure is maintained, thence the oil passes through a governor-controlled throttle, a hand throttle, and through master valves, and finally into the distributors. The receiver holds enough fuel to run the engine for 15 min., so that in case of a breakdown of the fuel pump the spare pump can be connected up before the engine stops. The distributing boxes are quite close to the indicator cocks, so that adjustment can be made by the engineer in charge while he is reading the cards and thermometers. The plunger fuel pump is made from a solid steel forging; the valves are simply steel balls, and the gland runs in an oil bath. This system was adopted with the earliest ships and has been retained with all since built.

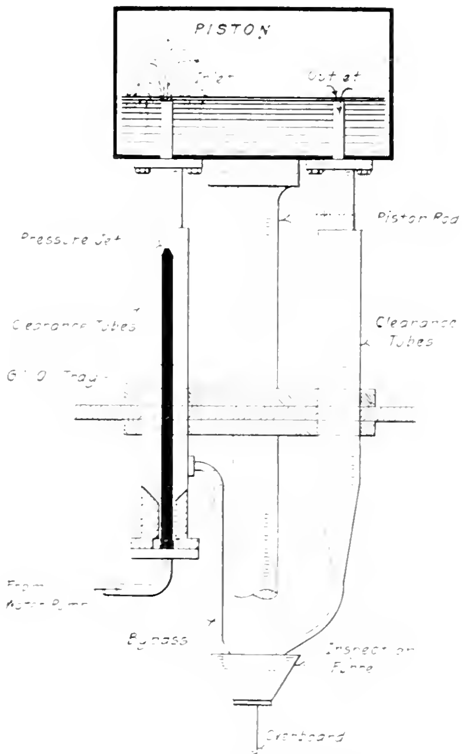


Fig. 5 Piston-Cooling System

At sea the waste exhaust gases of the main engines are utilized to fire a donkey boiler for the ship's auxiliary machinery. This has been most successful and we have since been followed by other shipbuilders. Specially large heating surfaces must be given to the boilers, the temperature being 700 to 800 deg. fahr. compared with 2000 deg. fahr. in the furnace flues of an ordinary oil-fired steam boiler. On the *Emanuel Nobel* and *Elbruz*, sister ships of 6500 tons d.w.c., on a displacement of 9000 tons and with cargo capacity of two million gallons of oil, the auxiliaries are a steam-driven dynamo, a steam-driven spare compressor set, a 7-hp. semi-Diesel, Brons type oil-engine-driven dynamo, and the usual steam-operated pumps. The donkey boiler has two furnaces and the exhaust gases from the two main engines are led

[illegible] furnace and supply sufficient steam for operating the auxiliaries, including the steam gear. The other furnace is used at night for oil-fired burners as, more work being required of the dynamo, not so much steam is available for steering. In the daytime at sea no oil firing is required, for as much as 120 lb. pressure can be maintained with the exhaust gases alone, but usually about 100 lb. is the average pressure maintained. With the *Emanuel Nobel* the recorded fuel consumption for all purposes per 24 hr. day is 9 tons of gas oil — $8\frac{1}{4}$ tons for the main motors and $\frac{3}{4}$ ton for the boiler. This gives 0.29 lb. per indicated horsepower per hour under average running conditions. The total consumption, including auxiliaries at night, works out at 0.32 lb., per indicated horsepower per hour. An oil-fired steamship of the same power would have a consumption nearly four times as great, while an oil-fired steamship of the same cargo capacity and of the same speed ($11\frac{1}{2}$ knots) would have a total fuel consumption five times as great, because her engines would have to be of greater power, owing to the required displacement being about 800 tons greater. Under present abnormal shipping conditions, by the way, the greater carrying capacity of a motorship on a given displacement is even of greater importance than its fuel economy.

With slow-speed, heavy-duty crosshead engines of 200 to 500 hp. at 160 to 200 r.p.m. we have taken a bold step that may make many marine steam and oil engineers shake their heads; but the machinery with which this step has been taken has resulted in being among the most successful of all our installations.

The reversing propeller has been developed and used with four recent full-powered ships, including the *Poseidon*. Several objections may be raised but they will be founded mostly on the prejudice formed by the indifferent services given by reversible propellers, cheaply built and poorly constructed, for the operation of small motorboats. Our mechanism is entirely different. Power to reverse and actuate the mechanism is furnished by the engine itself. By interconnecting the throttle directly with the propeller mechanism, the strokes of the fuel pumps are automatically reduced and increased by the mere act of throwing the blades into the central position, or by reversing them respectively. One important advantage is that the ship can go ahead and astern a hundred times in an hour without the use of compressed air, so that the engine will not be *stalled* at the critical moment owing to lack of starting air. How important this is with a harbor tug can be easily understood. Besides, the navigator on the bridge is given complete control of the ship's movements by a small handwheel installed on the bridge. The reasons for such a radical step may be enumerated as follows:

1 Simplification of main engine due to absence of reversing features
2 Reduction in power and quantity of auxiliary machinery
3 Rapid and independent maneuvring
4 Reduction in first cost of machinery.

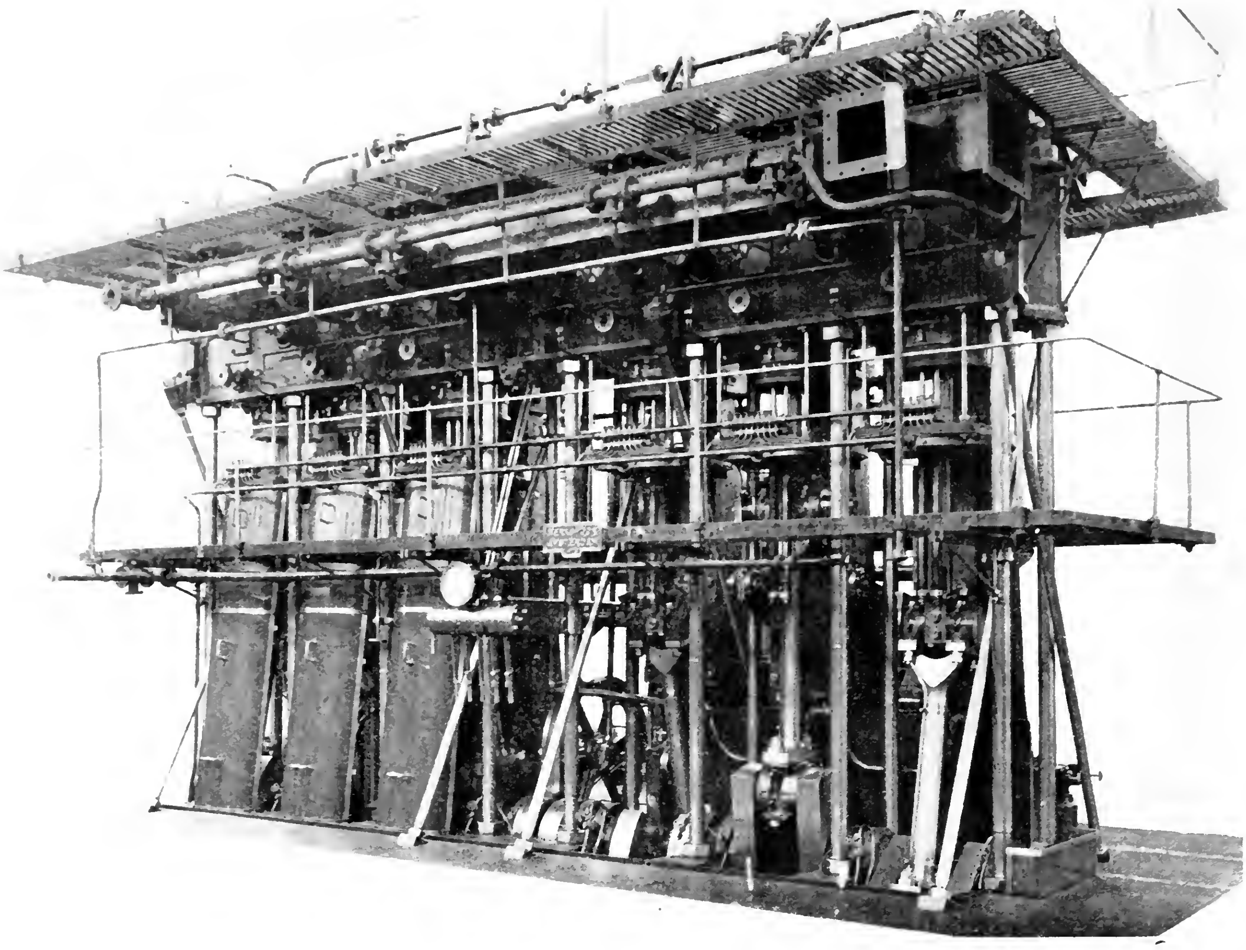


Fig. 6 Four-Cycle-Type Reversible Marine Diesel Engine (1020 b.hp., 1360 i.hp. at 120 r.p.m.). Weight 122 Tons. Fuel Consumption Under 4½ Tons per 24-Hour Day

Because of the strain thrown on the machinery by reversing the direction of a large ship, the tackling of the reversible propeller is by no means a simple matter; but every part, being massive, has proved more than capable of handling the power, without showing noticeable wear. The fact that the owners of the *Poseidon* ordered other similar ships after it had been in service for some time, is evidence that the reversible propeller is satisfactory in practice.

Since this paper was written I have received cabled permission to give drawings and details of our new submarine engine. The motor shows a remarkable advance in design and construction and is perhaps the most simple Diesel engine ever built. On the test bed at Amsterdam there is now a six-cylinder set designed to operate at 400 to 450 r.p.m. on the four-cycle principle. It can develop 500 b.hp. when running at 400 r.p.m., and is capable of a considerable overload. It only weighs about 12 tons without flywheel, which, I believe, is lighter than any existing two-cycle Diesel submarine engine of similar power. An entire cylinder may be removed and another substituted in about two hours, while a piston can be taken out and inspected in about 15 min. It has very few cast parts, the only castings of note being the cylinder boxes, the cylinders, the pistons and the air-compressor cylinders. Instead of cylinders of the ordinary type there is a long cast iron box running the length of the engine into which the cylinders are placed from below and held in position by a flange, the cylinder and cylinder head being in one, which gives a very large water-cooling space over and around the combustion chamber. This cylinder box is connected to the bedplate by steel rods 3 in. in diameter, thus taking all strains from the bedplate, and consequently each bearing is suspended directly from the cylinder, which enables the bedplate to be made from light cast-steel bearing blocks connected by cast-steel girder beams along the engine, thus dispensing entirely with cast-steel, iron or bronze bedplate. To collect the oil from the working parts, the bottom of the engine is enclosed by a steel plate 1⅛ in. thick. The running gear is entirely enclosed by steel plates which are easily detachable. Each working

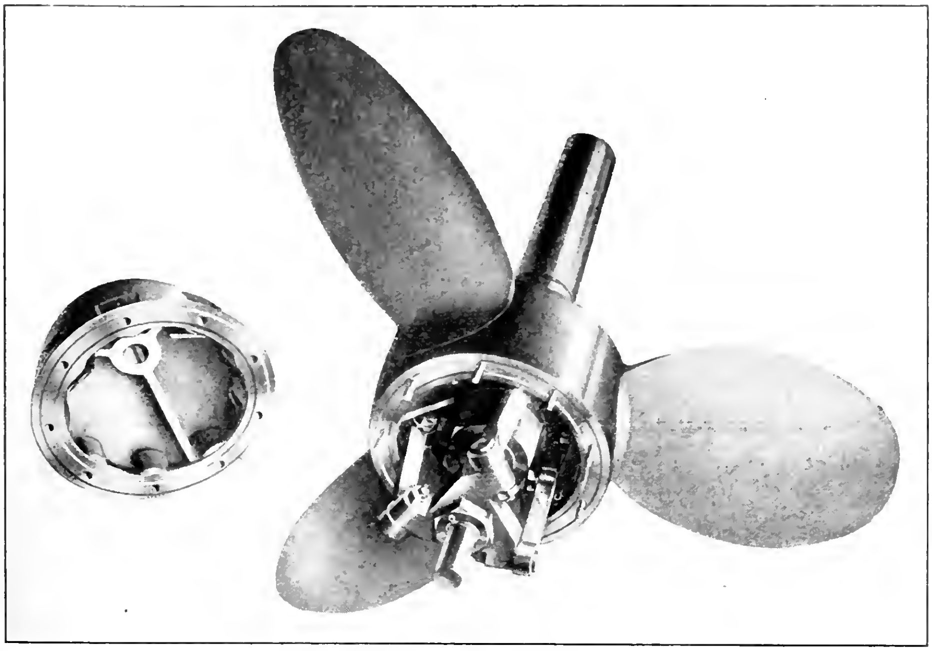


Fig. 7 Reversing-Blade Propeller

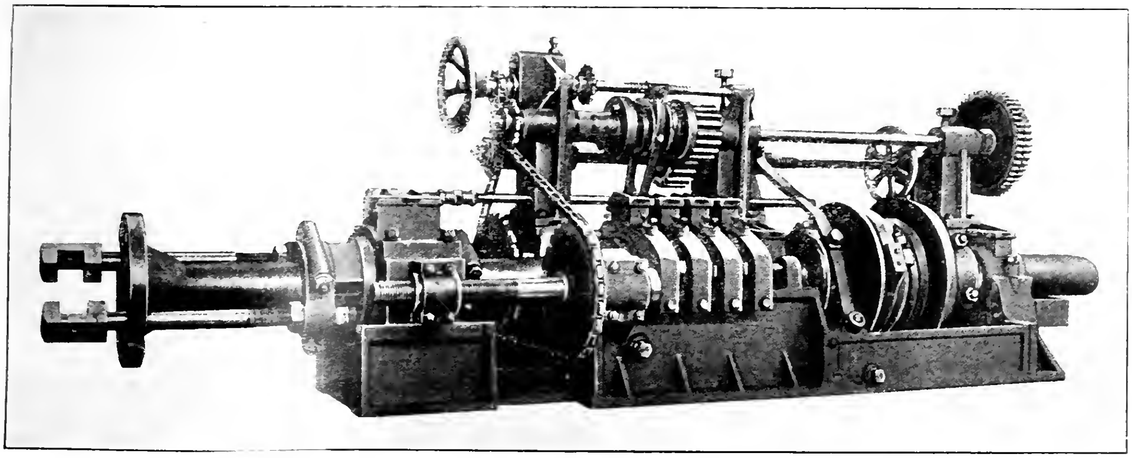


Fig. 8 Mechanism and Thrust Block for Operating Reversing-Blade Propeller

cylinder is made in two parts, the upper part being cast in one piece with the cylinder head, while the lower part is detachable and enables the pistons to be removed very quickly. This extension also is water cooled, a sheet metal band being placed entirely around it. An innovation is to be seen in the blade steel springs for closing the valves, which give less vibration and take less height: and only three springs are required for two cylinders. It is not necessary to water-cool the pistons with this size of engine; but some sort of cooling device is advisable, so the air aspired by the down stroke of the main piston is drawn by suction through the cylinder box from the upper part of the crank case and is replaced by cool air blowing through the bent pipes. In order to overcome the valve difficulty sometimes experienced with air compressors, we designed a special valveless three-stage compressor, and this is situated at the forward end of the engine. The three stages are driven by three cranks having angles of 120 deg. to each other. Each cylinder has inlet ports at the bottom, and the low-pressure and middle-pressure cylinders have an outlet hole at the end, while the high-pressure cylinder has an outlet valve at the top where it can easily be taken out if necessary. Thus there is only one valve in the entire compressor.

My personal opinion is that in six or seven years every new cargo ship of under 10,000 tons displacement will be equipped with internal-combustion engines of the crude-oil type, except in a few rare instances where special circumstances of service will cause steam engines to be the only suitable machinery. The advantage of the Diesel-type engine will be appreciated most during normal times. When low freight rates return, it will not be possible for steamers to compete with motorships on many routes, particularly where long distances have to be covered, and especially where tramps are concerned. In hard times shipowners will be forced to use the most economical propulsion. Other methods of steam power cannot be made as efficient and as economical as the crude-oil engine, unless the price of oil should rise to phenomenal figures.

DISCUSSION

A. J. Wood said that with regard to the author's remark that one particular type of four-cycle Diesel engine was lighter per horsepower than the same capacity unit of a two-cycle, he would like to ask whether there was any particular design followed to effect the result, and whether there were other types of engines that had effected the same results. Mr. Lisle replied that in marine work the four-cycle engine was lighter, owing to the additional parts necessary for the two-cycle, particularly the scavenging pumps. Theoretically the two-cycle should be much lighter, but on those put to service the two-cycle engines had been heavier than the four-cycle. That included the compressor of the engine. There were no scavenger pumps with the four-cycle engine, and that saved an immense amount of weight.

Julius Kuttner, with reference to reversible propellers, asked about the fact that the blades on solid propellers frequently broke, and separate solid blades were always carried on the deck of the ship. If the solid one broke off, were not the chances of breaking in the reversible propeller much greater? Mr. Lisle replied that he did not see why it should be so. They might break off if they hit anything, of course, but they could be replaced just as easily, and it was possible to make them just as strong, this being a question of design more than anything else.

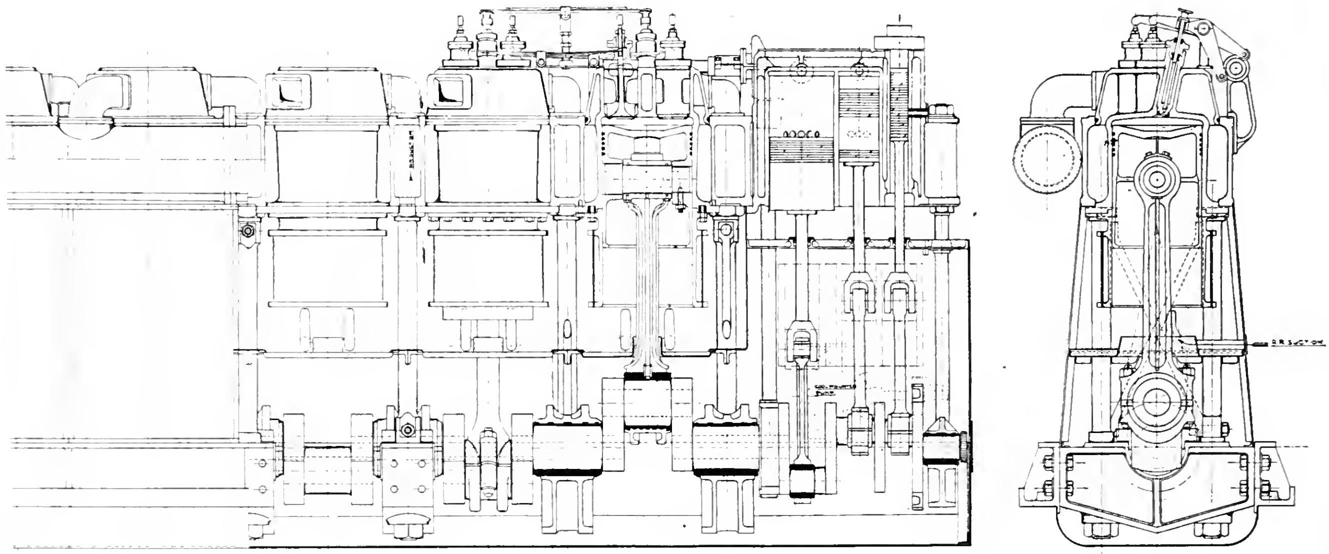


Fig. 9 Submarine Diesel-Type Engine. There is also a Design of Smaller Power in Which the Weight Has Been Reduced to 31.5 lb. per b.hp.

THE DOWNFLOW TYPE OF STEAM BOILER

By JOHN CLINTON PARKER, PHILADELPHIA, PA

Member of the Society

THE downflow principle is shown diagrammatically in Fig. 1. The reservoir has separate compartments for water and for steam, with a swinging valve between, which automatically forces water into the tubes to replace that which is discharged by each drop in pressure. The straight water tubes are arranged in the form of flattened-coil elements leading downward from the water compartment with direct connections from the bottom ends to the steam compartment. A check-valve at the water-inlet end of each element prevents reversal of the flow.

The water is maintained at a given level in the lower compartment of the reservoir through a feed connection in the regular way. It flows downward by gravity into the elements and seeks the same level in the upcast. When heat is applied, the water in the upcast is soon discharged into the reservoir by the expansion of the steam formed in the lower tubes. The water then runs down from the reservoir to regain its level in the upcast. This is frustrated by continuous evaporation, mainly in the lower tubes. The more the fire is forced, the greater is the proportion of steam in the upcasts, the larger is the unbalanced head of water, and the more rapid is the flow through the tubes.

A 20-hp. downflow boiler enclosed in a steel casing was built in 1899 at Roach's shipyard in Chester, Pa. There were three drums 10 in. outside diameter, 3 ft. long, 160 tubes 1 ft. outside diameter by 3 ft. long, and 36 firebox tubes $1\frac{1}{2}$ and $1\frac{3}{4}$ in. The headers consisted of a pair of cored tube sheets with cored cover plates which when bolted to the tube sheets formed return bends, the idea being that the one large outside joint would obviate a lot of inside ones, a steam-tight joint not being essential between the inside ribs. Experience with this boiler, however, led to the development of the two-tube junction box and the use of larger tubes.

STANDARD DOWNFLOW BOILER

Fig. 2 shows a standard design. The drums are constructed in accordance with the best practice, using high-class material and workmanship. The longitudinal seams are butt-strapped and triple-riveted, giving very high efficiency.

The diaphragm of $\frac{1}{4}$-in. steel plate is riveted to the shell and arranged to form a pocket at the front to collect the scale discharged from the tubes. The anti-priming valve is hinged to the diaphragm head and serves as a manhole for the lower chamber. The bottom of the drum below the level of the nipples leading to the elements forms the sediment pan or mud drum. An inverted angle with closed ends is placed over the blow-off opening, making the blow-off effective over considerable area.

The elements are formed by expanding the tubes into the junction boxes which hold two tube ends, with a handhole opening opposite each.

The tubes in the upper pass form the feed element or economizer, which in this unit is 16 tubes wide and three tubes high. The top end is connected to the drum with an expanded nipple, and the feed connection is in the junction box at the front end of the first tube in the element. At the rear end of the tube is placed a non-return valve, which prevents the feed going the wrong way and entering the drum through the inlet connection.

The flow in the economizer element is forward and back alternately through each tube in the top row, then down to the next row, and so on, finally discharging through a vertical upcast into the rear drumhead above the diaphragm. When the feed is shut off, the drum connection furnishes the economizer element with a circulation.

The lower or evaporating elements are two tubes wide, passing the water twice across the furnace at each level. The connection from the drum to the upper or induction end is made by an expanded tube entering an "inlet" box which supplies two elements. Each element has a non-return valve, located

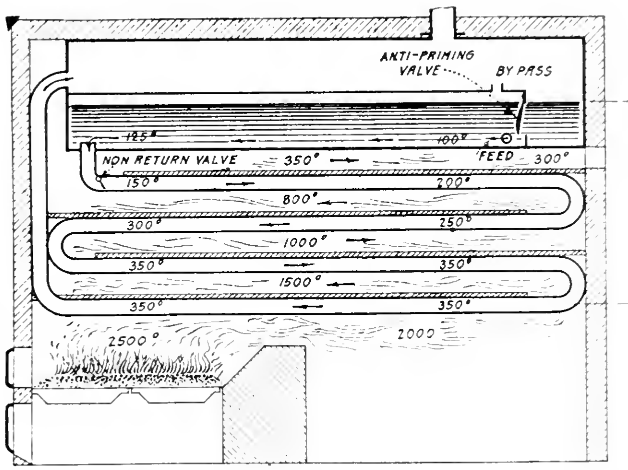


Fig. 1 Evaporation Diagram Illustrating Downflow Principle

in the inlet box. The valve fits into the tube end and is held in place by a loose pin, which forms a positive stop when the handhole is closed. The valve is loosely hinged with plenty of clearance, and is easily removed through the handhole for cleaning. The lower end of each element is connected to the steam chamber by an independent upcast. The arrangement of the tubes permits the free and independent expansion of every tube without strain on any joint.

The large swinging valve at one end of the water compartment closes as often as steam is withdrawn through the steam opening with sufficient rapidity to lower the pressure. In practical service, pressure changes are more or less frequent, sudden and pronounced, according to the irregularity of the service and the severity of the demands for steam. In such service as supplying steam hammers, rolling-mill engines, electric-power plants, subject to sudden heavy peak loads, or warships which may require full speed on a moment's notice, the steam pressure may be suddenly lowered 10 or 15 lb., or even more, in a very short space of time. In every such case a quantity of water, proportionate to the drop in pressure and the speed with which it takes place, is discharged from

Abstract of paper presented at the Annual Meeting of the American Society of Mechanical Engineers, December 1916. Pamphlet copies of complete paper may be obtained. Price 10 cents to members; 20 cents to non-members.

tubes of any type of water-tube boiler by the sudden evaporation due to the lowering of the boiling point along with the pressure.

Under conditions of a drop in pressure causing displacement of water from the tubes, a bypass controlled by a float-operated double-beat valve equalizes the pressure.

The double valve just referred to may be seen in Fig. 2 over the swinging valve. It is balanced and operates without touching the sides of the bypass openings through which the disks move. Sufficient clearance is provided as a vent to allow the water compartment to fill to the water level under normal conditions. When a pressure drop occurs with sufficient suddenness to affect the circulation, the anti-priming valve closes. The excess pressure forces water into the tubes until the float opens the bypass. This releases the pressure and allows the

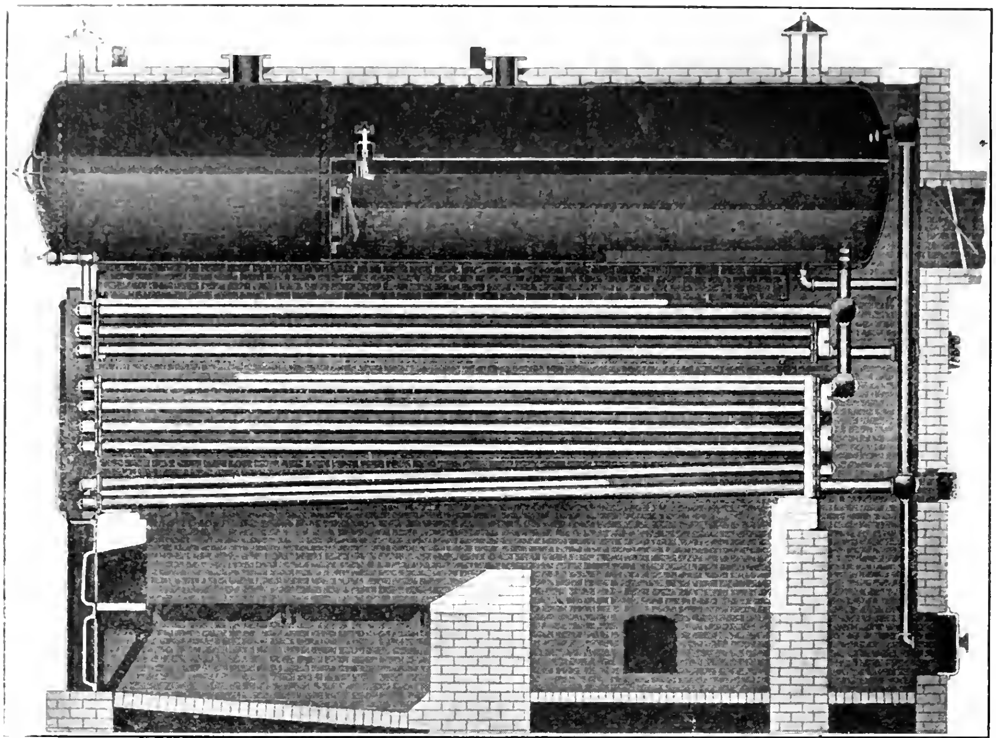


FIG. 2 SINGLE-ENDED DOWNFLOW BOILER, STANDARD DESIGN

water compartment to fill, and the operation is repeated intermittently as long as the pressure continues to fall. The prompt replacement of the desirable quantity of water in the tubes after each pressure drop can be provided for in the design by proportioning the water compartment to hold between the upper and lower levels at which the anti-priming valve closes and opens, the quantity of water required to meet the severest conditions.

Following are some of the new ideas embodied in the latest cross-drum design of downflow boiler.

a The diaphragm is omitted. The front drum serves as the water compartment. The steam drum drains into the water drum through a three-tube connection controlled by the anti-priming valve. One 4-in. tube connection serves as a bypass. The cross drums are more convenient for inlet and upcast connections. The drums are free from unequal strains, and are more accessible.

b The feedwater-heating coiled element is swung so that it can be moved 2 in. sidewise at either end when necessary to remove and replace a junction box, or when access to the handholes, entirely clear of the inlet or upcast tubes, is desired for cleaning or replacing tubes. It is not necessary to move the tubes to insert a tube cutter, expander or cleaner, but it may sometimes add to the convenience.

c The bottom row of tubes go through a crossbar at the rear end which supports the tubes above it. The whole bottom row can be moved 2 in. sidewise to bring the upcasts entirely clear of the junction boxes or handholes when desired. The bar is carried on ¼-in. rollers. It is made in box shape to form an air trap to prevent leakage of hot gases from the combustion chamber into the rear casing. This box has small holes to admit sufficient air to direct any leakage *into* the combustion chamber in place of the reverse direction. This keeps the bar and rear casing cool and prevents gradual deterioration from excessive heat. The movable box joints and openings where the tubes pass through are made fairly tight so that the leakage is small. What does get through aids combustion.

d In the new downflow design, the entire bottom row of tubes operates on the inclined-tube principle. The flow through the two bottom tubes of each element is now parallel in place of serial. These two tubes now discharge directly into one 4-in. upcast like the two staggered bottom tubes of a Babcock & Wilcox section. None of the other tubes above the bottom row discharge into this upcast. The steam is discharged above the water level. It does not have to pass through water and is entirely free to escape into the steam compartment without interference under all conditions of operation.

ANNUAL MEETING DISCUSSIONS

Written Discussions of the Papers Presented at the Thirty-Seventh Annual Meeting of The American Society of Mechanical Engineers, New York, December 5 to 8, 1916

BELOW are the remaining written discussions of the papers presented at the Thirty-Seventh Annual Meeting of The American Society of Mechanical Engineers, held in New York City, December 5 to 8, 1916. One half of these discussions were published in the last issue of The Journal, supplementing the full account of the meeting which appeared in the January issue.

The discussions are printed substantially in full, and will be found to contain a large amount of valuable material supplementing the subject-matter of the papers. Following the discussions are given the authors' closures, which refer also to the oral discussion abstracted in the January number.

WATER FOR STEAM BOILERS—ITS SIGNIFICANCE AND TREATMENT, ARTHUR C. SCOTT AND J. R. BAILEY

M. F. Newman. The authors seem to be unaware of the fact that the most highly efficient water purification is carried on without dependence upon heat. The main factors in boiler-water purification are not heat, soda ash and blowing off, with possible filtration, but accurate softening and purification carried out independently of the variables encountered in the irregular flow of water through the heater and the uncertain degree of precipitation within the heater.

The causes assigned for corrosion include the presence of sodium chloride (evidently the authors have confused magnesium chloride with sodium chloride, since it is a well-known fact that sodium chloride within the boiler is a neutral salt). If sodium chloride were an active corroding substance, then the majority of the boilers in operation in this country would be constantly showing evidence of corrosion.

The authors assign as cause of foaming and priming a concentration of alkali salts, giving secondary place to silt, organic matter, loosened scale, lubricating oil, etc. This belief is commonly held, but it has been found that in the absence of substances in solution which form precipitates upon concentration, water containing alkali salts can be concentrated to a very great degree without any appreciable effect on the steaming quality of the water. The foaming is not due primarily to the alkali salts but to the accumulation of lime, magnesia, iron, etc., that are forced out of solution, thus befouling the water in the boilers with suspended matter, which, by ebullition, is carried to the surface of the water, interfering with the liberation of steam.

The authors' classification of water containing less than 8 grains per U. S. gallon of scale-forming matter as very good, water of from 8 to 15 grains as good, and water with 15 to 20 grains as fair, is altogether fallacious, because no distinction is drawn between temporary hardness and permanent hardness. In any water supply where permanent hardness is present all of the hardening substances become scale-forming substances due to the cementing action of the salts of permanent hardness. Under present-day practice of boiler operation, where the rate of evaporation is carried as high as 300 per cent of rating, any water containing permanent hardness rapidly concentrates to the point where scale formation results, and under such high evaporation any scale formation is quickly followed by tube failure.

The authors' statement that all water softening consists of lime alone, or lime and soda ash, and that no chemicals other than lime and soda ash are ever used under conditions of water softening, is erroneous, there being few water supplies where the precipitation of lime and magnesia can be carried to the proper minimum with these two reagents alone. The adherence to theoretical calculations of the laboratory for requirements of lime and soda ash to precipitate hardening substances is responsible for many failures to obtain from water treatment the results anticipated. There are more factors than the calcium and magnesium salts to be taken into consideration, and each water supply presents a separate problem in itself.

The authors' statement that, after a water-softening plant is in proper working order, the adjustment of chemical feed to raw water, as a rule, will not necessitate any considerable change in the amount of lime and soda ash to be used, can scarcely be reconciled with the facts, when it is known that many of the river-water supplies pass through a seasonal range of from 500 to 700 per cent variation. It is scarcely to be expected that such variations could be met with "a practically constant feed of reagents."

It is quite true that it is not necessary nor desirable to remove all of the calcium from boiler feedwater, but the result obtained in reducing the hardness with different water supplies should and must be brought to a definite standard so that the softened and purified water will contain approximately the same amount of lime and magnesia under all conditions, regardless of the varying quantities of sodium salts or other impurities. The reduction of hardness to entirely eliminate permanent hardness and keep the remaining lime and magnesia compounds within a total of two grains per gallon, is the result obtained in correctly softening a water supply from any source. This degree of softening must be constantly maintained, and on such uniform softness depends the success of water purification for boiler feed.

The statement that large amounts of sodium chloride tend to make water corrosive is erroneous. It is the various substances in solution, notably magnesium chloride, which, under boiler conditions, produce the corrosive effects. Waters containing large amounts of alkali salts, especially sodium carbonate and sodium chloride, have a tendency to foam, not because of the presence of these salts alone, but because with these salts present, much lime or magnesia is precipitated, due to concentration and heat, and the suspended matter thus formed produces a foaming tendency.

The foaming resulting from the use of soda ash is mostly due to forcing calcium and magnesium out of solution, or to the soap-producing effect from grease and oil.

The relative terms *high* and *low* as applied to alkali salts do not determine the suitability of water for softening and purifying for boiler feed, for with the reduction of calcium and magnesium to a minimum and with an elimination of oil and grease, waters containing as high as 200 grains per gallon of sodium salts are frequently used for boiler feed without any difficulty being experienced with foaming and priming, and when using such water the controlling factor is to avoid too

great concentration of the residual calcium and magnesium salts.

The dependence placed upon the empirical soap test for determining hardness, and the reliance on lime and soda ash, or upon heat and soda ash alone, give a false impression of the true procedure required to soften and purify boiler feedwater from any source. Neither heat and soda ash alone, nor lime and soda ash treatment alone, will meet all conditions so generally as to permit of the statement that such procedure includes all of the requisites for purifying boiler feedwater.

F. F. VATER. I would like to ask why the hot process of water softening is classed in the paper with such devices as live steam purifiers and boiler compounds. The cold process would be more appropriately classified with these than the hot process.

Any chemical reaction will be more thorough and quicker with heat applied than without. This being true, the treatment of water hot offers possibilities of efficiency not attainable in a cold process. Treating water at 200 deg. fahr. will enable one to begin with a water containing 25.59 grains of incrusting matter per gallon and deliver it into boilers with a hardness of 2 grains per gallon with a causticity of from 0.4 to 0.5 of a grain per gallon and an alkalinity of 3½ to 4 grains per gallon, not occasionally, but constantly.

Again, treating water at 200 deg. fahr. will enable one to begin with a water containing 17.97 grains of incrusting matter per gallon and deliver it into boilers having zero hardness as determined by soap solution, causticity 1.8 and alkalinity 6.7 grains per gallon.

A gravimetric analysis of the treated water shows but 85/100 of a grain of incrusting matter per gallon.

I would suggest that the authors compare labor cost of operating a cold process, either intermittent or continuous, with the records made by the hot process, which is $35.00 per month for a plant handling 80,000 gallons of water an hour, operating 24 hours a day. Plants of this size are in continual operation, and there is no reason why one cannot be built to handle any quantity of water.

There are advantages in plant operation obtained by treating water hot other than chemical and labor costs, but space will not permit bringing these out here. Only one plausible criticism of the hot process is in existence, and that is the possibility of heat losses. Hot-process machines can, however, be placed in open air, 10 deg. below zero, and covered, so that the loss in temperature between the heated water and the water as it comes from the machine will not exceed 0.5 deg. fahr.

GEO. H. GIBSON, whose discussion of this paper was publsihed in full last month, appended to this discussion the description of an apparatus by means of which the softening reagents used in hot-process systems are fed with great accuracy and sensitiveness. The description follows:

This flow proportioner is of the type in which the secondary flow, the chemical reagent in this case, is discharged through an orifice under a pressure proportional to the velocity head of the raw water entering the softener. Referring to Fig. 1, *A* is a perforated diaphragm inserted in the raw-water supply pipe. From each side of the diaphragm small pipes lead to the sides of the differential piston in cylinder *B*. The piston rod extends through both ends of the cylinder, to avoid unbalanced areas, and its lower end carries a flat valve disk covering an opening through which chemical solution is pumped constantly by the circulating pump *C*. The differential pressure forces the valve disk against the escaping fluid, and a pressure is therefore maintained upon the latter proportional to the differential head due to the flow of raw water past the orifice at *A*. The bulk of the chemical escapes under the edges of the valve and returns to the chemical tank, but a portion discharges through a small orifice into the open funnel *D*. Due to the proportionality of pressures this flow is at all times proportional to the flow through the raw-water orifice. The chemical-proportioning orifice, not being in contact with the atmosphere, does not accumulate scale or sediment. From the funnel the measured portion of the chemical descends to the chemical feed pump *E*, by which it is lifted to the top of the sedimentation tank, there encountering the heated raw water from the open feedwater heater.

It is found that in actual practice the accuracy of feeding of reagent is within 2 per cent: in fact, a pressure gage com-

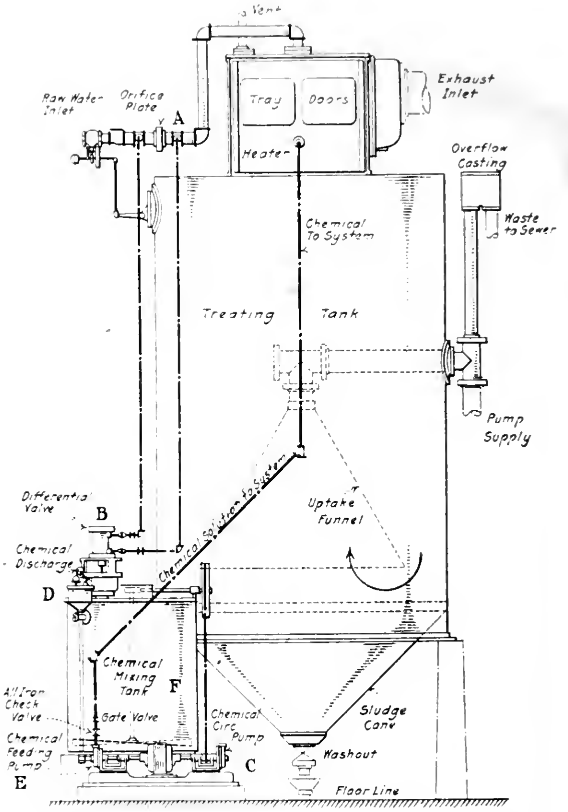


FIG. 1 CHEMICAL-FEEDING APPARATUS FOR USE WITH HOT-PROCESS WATER SOFTENERS

municating with the solution pressure chamber makes a very good flow meter for the raw water, and the total amount of raw water used can also be determined from the amount of chemical removed from the chemical tank.

The main supply of the chemical reagent is kept in constant agitation in the tank *F* by paddles driven by the same motor which operates the two pumps. This tank is located on the ground, avoiding the lifting or hoisting of chemicals, and the whole chemical feed apparatus is in the open and readily inspected. The positive feed of the reagent renders the action of the apparatus entirely independent of any back pressure carried in the softener.

The combined softener and feedwater heater, because of its small size, due to the more rapid reaction and sedimentation,

can ordinarily be placed within the boiler room, without requiring special housing or foundations. There is also usually a considerable saving in piping and other installation costs.

CLOSURE BY MR. BAILEY

J. R. Bailey. Mr. Fowler deplores the skipping over, in the paper, of "the ingredient which occurs in almost all boiler waters—organic matter," but the following extracts from the paper indicate that this criticism is not justified: "Waters low in mineral content but high in organic matter, though perfectly clear, may be troublesome, because a part of the organic matter precipitates. Peaty waters are harmful to boilers by reason of the vegetable acids they contain. The bad effect of mineral or vegetable oils finding their way into the boiler-feed water is well understood."

Mr. Newman takes exception to our belief that "large amounts of sodium chloride also tend to make waters corrosive," overlooking the fact that, where the hypothetical combinations in a water analysis show magnesium chloride, all the sodium is reported as chloride. Under such conditions it would be expected that a heavy concentration of chlorine ions, reported in the main as sodium chloride, would necessarily increase the corrosive action. He further objects to the classification of a water as *good* that contains less than 8 gr. per gal. of scaling salts, because "no distinction is drawn between temporary and permanent hardness:" on the contrary, this distinction is emphasized in the paper with utmost clearness.

Mr. Newman also points out that "the adherence to the theoretical calculations of the laboratory for requirements of lime and soda ash to precipitate the hardening substances is responsible for many failures to obtain from water treatment the results anticipated." My thorough accord with this contention is attested by the statement in the paper that "the best results can be obtained in water softening by controlling with chemical tests the successive batches of water treated." Mr. Newman's statement that there are "few water supplies where the precipitation of lime and magnesia can be carried to the proper minimum with lime and soda ash alone," is challenged by the satisfactory results the process has given in the hands of thousands of operators.

I wish especially to take exception to the comment by Mr. Newman that "the authors' statement that after a water-softening plant is in proper working order the adjustment of chemical feed to raw water, as a rule, will not necessitate any considerable change in the amount of lime and soda ash to be used, can scarcely be reconciled with the facts, when it is known that many of the river waters pass through a seasonal range of from 500 to 700 per cent variation. It is scarcely to be expected that such variations could be met with a practically constant feed of reagents." It is to be observed that we say that *as a rule* no *considerable* change in the chemical feed will be necessary. Why did Mr. Newman not quote this statement in the paper: "It is impossible to regulate automatically the feed of chemicals to compensate fluctuations in the scaling ingredients of water"? If there is any one point that is stressed in the paper, it is that without chemical control the lime-soda-ash process will probably prove unsatisfactory. Mr. Newman asserts that a concentration of alkali salts cannot be assigned as a cause of foaming, but that foaming is brought about by the accumulation of lime, magnesia, iron, etc. The question arises why, if this be the case, certain waters in alkali countries cannot be used in boilers? It is a very common observation in laboratory practice that solutions, after attaining a certain viscosity through concentration of salts of any nature, bump and foam, and such a condition is certainly analogous to that which may arise in a boiler, where the water used is high in alkali content.

Mr. Kent minimizes the waste heat that is due to boiler scale, but I think the coal bills of many steam users will offer mute protest to his contentions.

What Mr. Applebaum says about the Permutit process demands attention, but the fact remains that Permutit softeners have not yet been generally introduced in this section of the United States.

Mr. Vater and Mr. Gibson contribute some very interesting data on the very satisfactory results obtained in the hot-process softeners, of the efficiency of which there is no question. The fact should not be lost sight of that a great many operators of small steam plants cannot afford the investment required for the installation of a patented water softener. Their only hope lies in a home-made water softener, and in using the cold process of treatment with lime and soda ash. All large steam users should install a standard softener with mechanical features that will demand a minimum of supervision and yield maximum efficiency.

THE IMPACT TUBE, SANFORD A. MOSS

Victor R. Gage. Work done on blower testing in the Sibley College laboratories verifies some of the conclusions drawn by Mr. Moss. We have found that the impact tube gave reliable and consistent results, not subject to error from slight misalignment or from stream lines not parallel to the pipe walls. Difficulty has been encountered in obtaining a satisfactory method for determining the pressure head, i.e., the so-called "static pressure" of moving fluids.

It is our custom to use as small an opening as is possible, without rounding the corners, but with all burrs removed, and with the pipe carefully smoothed, for measuring pressure head. Our laboratory experience has led us to this. In one case, using a large hole, the pressure head was of a considerably different value than when the manometer was connected to another and exactly similar hole about nine inches away. By greatly reducing the size of the holes, the values became practically the same. Further investigations indicated the existence of eddies and standing waves. The conclusion was drawn that a large opening was subject to more danger of receiving some (positive or negative) impact from currents of fluid not parallel to the pipe wall, and that the skin-friction effect would protect a small hole to some extent. The smaller the hole the more the protection. This conclusion is tentative. With ordinary or higher velocities the flow is always turbulent, and care must be exercised in obtaining measurements of pressure head, both as to the means used and the place where the instruments are located.

With air at very high velocities (about a mile a minute) it was once found that the pressure head was not constant across an 8-in. pipe, and was actually less than atmospheric pressure although the blower was discharging into atmosphere through the pipe. The discharging steam was convergent after leaving the pipe.

For several years the arrangement shown in Fig. 8 of Mr. Moss' paper has been used in place of a pitot tube, as being more satisfactory, in the regular students' laboratory experiment upon testing of blowers.

In regard to the use of a thermometer, we have used one first bare and then protected, placed in the jet of steam in a throttling calorimeter to illustrate the direction of the changes in the adiabatic conversion of heat into kinetic energy, and

back again to heat. The bare thermometer bulb only partially checks kinetic energy, there is a very perceptible temperature rise upon furnishing a more complete checking of the velocity, although the bare bulb indication is considerably higher than the temperature corresponding to isentropic expansion.

JOHN L. ALDEN. An impact tube with properly made static pressure holes in the pipe wall will give as accurate a determination of velocity as the best pitot tube. In addition, the tube itself is much less delicate and is more easily manipulated because of the absence of the tiny static-pressure orifices. However, it is extremely doubtful whether the large static openings in the pipe, as described by Mr. Moss, are not a source of error. Holes ¼ in. to 1 in. in diameter are very likely to be influenced by the velocity, and will probably give a combined reading of static and velocity pressure. If anything, the error is greater by using a large hole and getting velocity influence than by using a small hole and having a slight possibility of leakage. This leakage trouble is one not ordinarily encountered, I think, and it would seem that a lower static reading should be attributed to the measurement of the true pressure with the small hole rather than to leakage. The tests by W. C. Rowse at the University of Wisconsin, recorded in Vol. 35 of the Transactions, show pretty conclusively the effect of large static holes in recording velocities lower than the actual. The same conclusions apply in a considerable degree to static orifices in a pipe wall. The piezometer ring is unreliable, for the reason Mr. Moss has given. It does not correctly average the static pressures around the pipe.

The impact-tube law as stated in the paper is merely a restatement of the law of conservation of energy. In other words, the kinetic energy of the jet may be transformed into potential energy in the impact tube with only the immeasurable loss in the tube itself. Such a conclusion should be expected, as the impact tube is primarily an instrument measuring energy.

Testing a fan by the use of a single impact tube in the discharge pipe, as shown in Fig. 10, does not give a true indication of the output of the fan. Two tubes must be used, or the static vacuum at the inlet must be measured, for otherwise the fan is not credited with the negative pressure which it is producing. This suction is used in creating flow through the inlet. Part of it is shown in the form of velocity and the rest is lost in overcoming the resistance of the inlet. Where the inlet and outlet areas are equal, the pressure not credited to the fan is the entry loss referred to. The method shown in Fig. 11 is the correct one for fans and blowers as well as centrifugal pumps.

The writer believes that the orifices shown in Fig. 18 would give very doubtful results if the velocity of approach were appreciable. From the standpoint of smooth stream flow these nozzles are very bad. At high entrance velocities, 3000 feet per minute or greater, the contraction of the jet at the throat would probably be great enough to prevent filling of the mouth of the orifice. In other words, the condition of Fig. 12 would be greatly increased, and the expansion of the jet to the size of the orifice would not take place until the end of the orifice was passed. If this condition actually occurred, the area of the orifice could not be used in calculating the volume. Unless each orifice were calibrated for all high velocities, it would seem unsafe to use this form. If the approach were more gradual and the fillets were large to smooth out the stream lines, an orifice might be made which would cause no contraction whatever.

CLOSURE BY MR. MOSS

SANFORD A. MOSS. Mr. Alden refers to Mr. Rowse's paper in Vol. 35, Trans.Am.Soc.M.E., as showing that large static holes give error in static pressure. In all cases the errors reported by Mr. Rowse in measurement of static pressure were in the static pressure in a pitot tube. The reason they were in error is due to the fact that the flow was not parallel to the surface. Mr. Gage also notes error due to large static holes when there were eddies. I believe, that with proper length of straight pipe, or other arrangement for insuring that flow along the surface is parallel to it, the size of the static hole is unimportant. However, there is no objection to a small hole if any one prefers it and has tight piping.

Mr. Alden has some fears regarding the shape of the orifices illustrated, but actual experience with these orifices for many years shows that Mr. Alden's fears are groundless and that the mouth is filled in all cases, even for extremely high velocities. The essential point of an orifice is a large fillet or gradual curve just preceding a parallel portion. A long gradual approach is not necessary. In steam-turbine nozzles, where very high velocities are used, this has also been found to be the case.

The errors in the theoretical adiabatic perfect-gas formula to which Mr. Buckingham alludes are negligible for all engineering work. The validity of the use of the theoretical formulae has been justified by a great deal of experimental work.

In The Journal and pamphlet editions of the paper, owing to an error, the term *down stream* was used instead of *up stream* in a number of cases.

THE PROPORTIONING OF SURFACE CONDENSERS, GEORGE A. ORROK

WILLIAM D. ENNIS. In their present forms, Mr. Orrok's several papers would all of them need to be consulted to obtain a definite program for procedure in condenser design. The following is offered as a summary and amplification of his method.

Let W = maximum weight of steam to be condensed, lb. per hr.

t_s = temperature of steam

Q = weight of condensing water, lb. per hr.

t_0 = inlet temperature of condensing water

t_1 = outlet temperature of condensing water

S = aggregate external surface of condenser tubes, sq. ft.

U = coefficient of transmission

t_m = mean temperature difference

L = latent heat of vaporization of steam at temperature, t_s

x = dryness of the steam at temperature t_s.

Then

$$WxL = Q\ (t_1 - t_0) = SUt_m \ldots\ldots\ldots\ldots [1]$$

The following rules will fix values to be taken in the above:

If H' denotes the B.t.u. in 1 lb. of steam at throttle conditions, h_s the heat of liquid corresponding with the temperature t_s, and B the steam rate of the engine, lb. per i.hp-hr., then

$$xL = H' - h_s - \frac{2545}{B} \ldots\ldots\ldots\ldots [2]$$

This rule is on the safe side, since it assumes all heat not converted into work to be still present in the exhaust.

For t_1 use a value 5 deg. to 10 deg. below that of t_s.

The steam temperature t_s is that corresponding with the absolute steam pressure p_s at the exhaust nozzle. If v denotes the vacuum at the condenser, in. of mercury, and v_n the loss of vacuum between condenser and exhaust nozzle (also in. of mercury), then, ignoring the influence of any air present,

$$p_s = 14.696 - 0.493\ (v - v_n) \ldots\ldots\ldots [3]$$

For good design, Orrok uses $v_n = 0.2$.

The value of U that is now recommended by Mr. Orrok is $325\ V^{0.6}/t_m^{\frac{1}{8}}$, where V = water velocity in tubes, ft. per sec., which water velocity varies from 7 to 10. In usual practice, this is equivalent to a value of U around 800, or about four times the value once employed. The expression given for U is sufficiently applicable for any standard material in a new tube. (Foul tubes may decrease U 50 per cent.) The effect of the steam-richness ratio is now thought to be represented by $(p_s/p_t)^2$ rather than by $(p_s/p_t)^5$ as in Vol. 32, Page 1162. With tight condensers and good vacuum pumps, (p_s/p_t) may be expected, according to Mr. Orrok, to lie between 0.95 and 0.97. The constant in the expression for the value of U has been made to contemplate such values. Safe values of U for commercial design are further considered below.

The mean temperature difference, assuming that the exponential law holds (see Trans. Am.Soc.M.E., Vol. 32, Page 1211), is

$$t_m = \left[\frac{\frac{1}{8}\ (t_1 - t_0)}{(t_s - t_0)^{1/8} - (t_s - t_1)^{1/8}}\right]^{8/7} \ldots\ldots\ldots [4]$$

The arithmetical mean is $t_s - \dfrac{t_1 + t_0}{2}$. The logarithmic mean is

$$\frac{t_1 - t_0}{\log_e \dfrac{t_s - t_0}{t_s - t_1}} \ldots\ldots\ldots [4a]$$

(See Trans. Am.Soc.M.E., Vol. 32, Page 1211.) This gives a value close to t_m.

The expanded equation for design is then

$$Q\ (t_1 - t_0) = \frac{325\ V^{0.6} S}{t_m^{1/8}} \cdot t_m = 325\ V^{0.6} S\ t_m^{7/8}$$

$$\text{or, } S = \frac{Q}{40.63\ V^{0.6}} \left\{ (t_s - t_0)^{1/8} - (t_s - t_1)^{1/8} \right\} \ldots\ldots\ldots [5]$$

Let d = outside diameter of tubes, in.
t = thickness of tubes, in.
n = number of tubes in each pass of condenser
l = aggregate length of passes, ft.

Then area per tube for passage of water $= \dfrac{0.7854\ (d - 2t)^2}{144}$ $= 0.00547\ (d - 2t)^2$ sq. ft. Water velocity = cu. ft. per sec. ÷ aggregate area per pass

$$= V = \frac{Q}{62 \times 3600 \times 0.00547\ n\ (d - 2t)^2} = \frac{Q}{1220\ n\ (d - 2t)^2},$$

$$\text{or, } n = \frac{Q}{1220\ V\ (d - 2t)^2} \ldots\ldots\ldots [6]$$

$$\text{Also, } S = \frac{\pi d}{12}\ nl, \text{ whence } l = \frac{3.83\ S}{dn} \ldots\ldots\ldots [7]$$

As an example, assume a unit of 2000 maximum i.hp. at 226 lb. throttle pressure and 27.68 in. vacuum, using 12.725 lb. of dry steam per i.hp-hr. Take the inlet water at 70 deg., outlet water at 95 deg. and water velocity at 8 ft. per sec.

By Equation [3], $p_s = 14.696 - 0.493\ (27.68 + 0.2) = 1.0$, whence t_s (from the steam table) is 102 deg. Then by Equation [4] the mean temperature difference is

$$t_m = \left(\frac{\frac{1}{8} \times 25}{32^{1/8} - 7^{1/8}}\right)^{8/7} = 16.64 \text{ deg.}$$

(Note that the arithmetical mean is 19.5 deg. and—by Equation [4a]—the logarithmic mean is 16.5 deg.)

At 226 lb. throttle pressure, $H' = 1200$. Since $h_s = 70$, Equation [2] gives

$$x\,L = 1200 - 70 - \frac{2545}{12.725} = 930 \text{ B.t.u.}$$

Then by Equation [1], $WxL = 12.725 \times 2000 \times 930 = 23,$-

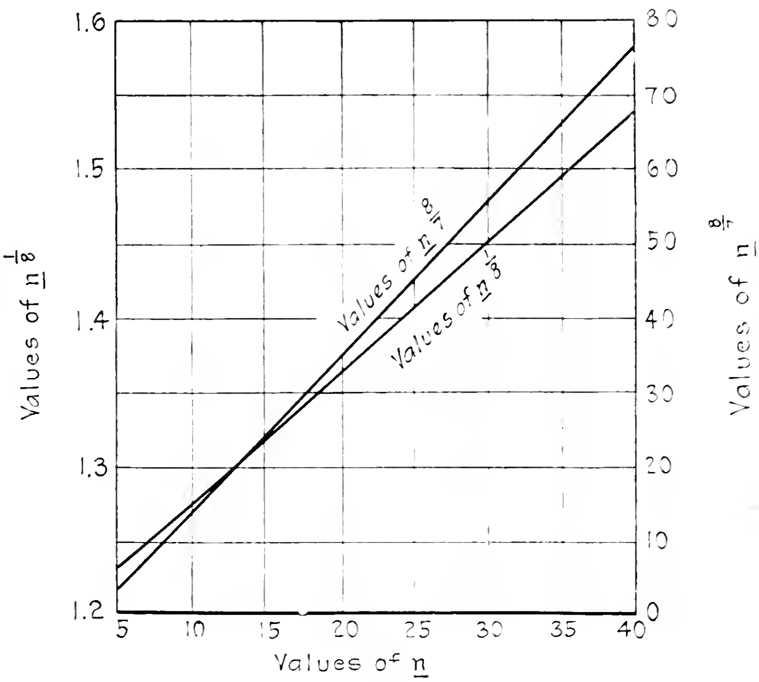


Fig. 2 Graph for Evaluation of Equations [4] and [5]

668,500 B.t.u. per hr. Setting this equal to $Q\ (t_1 - t_0)$, the weight of circulating water per hour is

$$Q = \frac{23,668,500}{95 - 70} = 946,740 \text{ lb.}$$

Equation [5] now gives the surface directly:

$$S = \frac{946,740}{40.63 \times 8^{0.6}} \left\{ (102 - 70)^{1/8} - (102 - 95)^{1/8} \right\}$$

$$= \frac{946,740 \times 0.2669}{40.63 \times 3.485} = 1780 \text{ sq. ft.}$$

If 1-in. No. 18 B.W.G. tubes are used, Equation [6] gives

$$n = \frac{946,740}{1220 \times 8\ (0.902)^2} = 119$$

as the number of tubes per pass. From Equation [7]

$$l = \frac{3.83 \times 1780}{1 \times 119} = 57.3 \text{ ft.}$$

This is the aggregate length of all passes. In the absence of certainty as to values of U and t_m, no effort is here made to choose a *best* ratio of l to d. Usual ratios are between 30 and 50, indicating that two passes will be desirable in this condenser.

(The value of U for these conditions works out $325 \times S^{0.8} \times 16.6 V^{0.5} = 796$.)

It is perhaps unreasonable to expect that definite and generally satisfactory values of U will ever be established. The transmission will inevitably decrease in service, the air richness influence is doubtful and the question of steam circulation has not been (perhaps cannot be) included. The rate of heat transmission in a surface condenser is a variable quantity, like the rate of transfer in a steam boiler. For safe design to meet anticipated operating conditions U should probably be taken at about 400, with due allowance for factors known to influence its value. Perhaps Weir's relation, $U = 250 V^{0.5}$, may be found safe if divided by a *hedging* factor of 2.

The mean temperature difference, which is only a slight factor in the determination of U, is itself a nearly linear factor in the total transfer. Accurate knowledge of its value is therefore of first importance. The weight of evidence points toward an exponential law for the rise of water temperature in the tube, but the logarithmic mean given by Equation [4*a*] represents very closely the result of such law for any ordinary conditions. Moreover, in Equation [1], exact values of the exponents are not fully settled.

A quick method for evaluation of Equations [4] and [5] is afforded by Fig. 2.

CLOSURE BY MR. ORROK

George A. Orrok. I am greatly pleased with the form which the discussion of the paper has taken. Professor Ennis has amplified the suggested method given in the paper by introducing factors which are usually slurred over. In the actual tests N was always known by the weight of circulating water times its temperature rise, and the steam was rarely wet, as it nearly always is in an actual condenser.

Mr. Stuart's discussion emphasizes some points which perhaps have not been brought out in sufficient detail. Mr. Kothny referred to my paper on Air in Surface Condensation (Trans.Am.Soc.M.E., vol. 34, p. 713) for data on air leakage, and I wish to reiterate again my statement that eternal vigilance is the price of freedom from air leakage. From 1 to 3 cu. ft. of free air per min, is very good practice with any commercial condenser, and this result can be obtained with condensers of the largest sizes.

Mr. Gibson mistakes K for U, and U is the coefficient of heat transmission in the fundamental formula $N = SU\theta$, while K is the reduced coefficient as given in Par. 10 $\left(K = \frac{U\theta^{.8}}{V_w^{0.5}} \right)$ with a further reduction for air richness.

A reference to Trans. Am.Soc.M.E., vol. 32, p. 1210, where the "three-dimensional" diagrams are shown, should make this distinction clear as well as Professor Ennis' question about the exponent (.8).

Mr. McBride brought up the very interesting point that frequently it is necessary to assume primarily the tube length and diameter in some commercial designs. I have met this case in my own practice a number of times, but have always solved it by trial and error instead of using the arithmetical mean.

Mr. Bancel has again brought up the question of the depth of the tube bank, and incidentally the velocity of the steam among the tubes. This is a very complicated subject, being mixed up with the prevalence of the water film on the steam side of the tubes. There has been some little mathematical work along these lines, but in our experiments the results were negative, as was also the case with the observed results on commercial condensers. At the present time, however, there seems to be no reason to doubt the statements regarding this subject in Trans.Am.Soc.M.E., vol. 32, p. 1160. Since writing the paper John E. Bell has read a paper on this subject before the Engineers' Society of Western Pennsylvania, in which he shows that a definite relation exists between the transfer rate and the cube root of the water condensed per hour per square foot divided by a function of the film temperature. More work is being done along these lines, but all I can say at present is that it is probable that we may be able to show a physical basis for the exponential formula of temperature rise.

A PROPOSED PLAN FOR THE ACTIVITIES OF THE MACHINE SHOP PRACTICE SUB-COMMITTEE OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, H. K. HATHAWAY

L. C. Brooks. While heartily indorsing Mr. Hathaway's attitude, I would point out that the electrical problem received no mention except in the fourth paragraph, where Mr. Hathaway advised a certain condition where the motor was overloaded. The policy of electric drive is becoming more and more prominent and is considered as a part of the installation. With proper investigation the following subjects would give valuable information to the public: The question of belt vs. electric drive, the advantages and limitations of individual drive or group drive, the horsepower required to drive, the relative advantages of individual drive for special machines, as planers, car-wheel lathes, etc.; in connection with electric drive, drum-type manual control vs. automatic control, dynamic brake as applied to electric control for certain machines, safety-first protection to the operator. In connection with Mr. Hathaway's tentative classification provision should be made for the question of operation, which is of vital importance.

CLOSURE BY MR. HATHAWAY

H. K. Hathaway. It is very gratifying that my suggested plan should have aroused so much interest, and that it should have been received so favorably. The Sub-Committee on Machine Shop Practice should, I believe, give careful thought to the utilization of existing committees, and in fact should take into account any existing agencies, either within or without the Society.

Mr. Pigott is right in pointing out that to accomplish results the committee must be handled more like an operating company than a council of advisers. To make this practical necessitates, as stated in my paper, a secretary who can devote his entire time and attention to the affairs of the committee, seeing that the program is carried out.

While it is desirable that ultimately the codified data on machine-shop practice should cover not only current practice but its development, it would, as Mr. Eberhardt suggests, be wise not to spend too much time in the beginning on the collection of data from papers and articles that have been published in the past, but to give particular attention to new material as it appears.

I regret that there should have been so much discussion as to the form of classification adopted, as while it is no doubt important that the best method of classifying be used, it is not nearly so important as that some form of classification be adopted, and it is still more important that some action be taken toward the carrying out of a definite plan leading to the further development of machine-shop practice as a science.

RELATION BETWEEN PERPETUAL-INVENTORY VALUE AND APPRAISAL VALUE, CHARLES PIEZ

HARRY BARKER.[1] The fundamental term "depreciation" has become so involved in a maze of differing definitions that even when engineers endeavor to use it quite technically it conveys different ideas to different persons. If we could agree on an acceptable vocabulary which we would employ in our discussions, a great gain would be made. Fallacies would be more quickly exposed and truths better comprehended.

I first endeavored about a year ago (in the proceedings of the Philadelphia Valuation Conference, held under the auspices of the Utilities Bureau) to harmonize some of these differences, and I desire here to draw attention to much the same ideas as then advanced.

The meanings which have been given to the term "depreciation" are seen to fall into two general classes: (*a*) losses in value of physical property, and (*b*) sums secured from earnings to offset loss in value of property.

The first group of definitions of "depreciation" can be further divided into: (1) aggregate actual or estimated loss in value from all causes; (2) the loss in value due to wear- and age-deterioration as distinguished from the loss of value from liability of obsoletion or inadequacy: and (3) the loss in value due to loss of ability to render full service or to decreased efficiency.

The second group is seen to be split into: (4) an annual accounting figure representing the depreciation for the year, or any other given period, deducted from gross earnings in computing probable true net earnings; (5) an annual sum used in making up the amount of necessary income to be secured by the rates. (This last is often an annual amount to be set aside out of the earnings to help create a reserve which will equal the cost of the several items of plant when they are retired from service and will pay for the renewals to the extent of the cost of the items retired. It might well be a direct repayment out of earnings of investment, equal to the annual loss in value of property due to depreciation.)

There is finally a sixth definition of depreciation as: Various aggregates of the annual sums secured from time to time to compensate for loss in value through deterioration or obsolescence, or both.

The several shades of meaning indicated in these definitions are sufficiently different to make our discussions run on diverging tracks. They show the need of greatly restricting our use of the word "depreciation." Our language is not so lean that we have to use one word in so many senses. Therefore I have a few propositions to advance.

The first definition—as the aggregate loss in value from wear-deterioration, inadequacy, supersession, antiquation, dilapidation, etc.—is probably the most used and the original one. This can well be adhered to, and a few available terms employed to carry the other meanings given.

The idea involved in the second definition makes a most useful distinction, which should be preserved, but it is more definitely indicated by "wear-deterioration," "age-deterioration" or "wear-and-age deterioration," according to the precise shade of meaning needed.

The third definition—loss in value due to diminished power to function or to decreased efficiency—has no real place in depreciation discussions, for mere ability to render the original service does not indicate lack of depreciation, and percentage of service ability (which is not the "serviceability" of the dictionary) alone does not measure value. (It indicates relative value only when the duration of that percentage of service ability is considered; if one machine can yield certain service for 10 years and a second machine can yield the same service for 20 years, their real values are not equal.) Instead of speaking of this loss of service ability as depreciation, it should be called "service-ability drop," or some equivalent.

The fourth definition has sprung up to give a short expression equivalent to "deductions for depreciation expense," or something like that. If there were not so many definitions in the field needing weeding out, its abbreviation to "depreciation" would be excusable. But, because of the confusion induced, the longer phrase should be reverted to.

Similarly in the case of the fifth definition, it is advisable to say "allowance for depreciation expense," or, more briefly, "depreciation allowance," and not merely "depreciation." Between speed of speech and accuracy of expression there should be no question of choice. Depreciation allowances correspond to what some engineers call a "theoretical depreciation" in contrast with what they designate as "actual depreciation" (meaning wear-deterioration) found by examination.

Definition five conveniently reduces to "renewal allowance," and for further simplicity to the coined word "renewance," which the speaker has found generally understandable. The first and the fifth definitions are perhaps the ones most used, so that it is a great advance to agree to speak of "depreciation" as the actual lost value, and "renewance" as one year's part of the compensation therefor.

However, it is little more than a convenient fiction to speak of building up reserves for renewals, since those funds have no relation to the amounts spent for the new equipments. Electric railways have been known to scrap generating stations and purchase power from central-station companies. In general, replacements are made with radically different equipment. What the business must be made to yield, in line with the Supreme Court's dictum, is full compensation to the utility concern for the loss in value of property from all the various causes already outlined. That is to say, the rates must cover the liability for retiring plant rather than the cost of renewing it.

"Retirance," therefore, has been substituted for "renewance." Retirance, then, is the annual amount to be repaid the corporation to compensate it for each year's depreciation. Retirance is a definite factor in rates, and in its nature is a repayment of invested capital. Unit retirance may be spoken of as a subdivision of retirance, as it has been apportioned over rates. Wear-retirance, age-retirance, obsoletion-retirance, etc., become useful special terms which can be accurately employed. The place of aggregate retirance is obvious.

By such a restriction as outlined on the employment of the terms "depreciation," "wear-deterioration," "depreciation-allowance," "retirance," etc., discussion is not appreciably encumbered and a fundamental cause of exasperating confusion is removed[2].

ROBERT J. HEARNE. The entire subject of physical valuation is bound up with proper cost-keeping and a perpetual inventory, and the greatest of these is the last. Properly kept, a perpetual inventory is a time saver and a daily corrector

[1] Associate Editor, Engineering News, 10th Ave. and 36th St., New York.

[2] Since this discussion was presented, the Valuation Committee of the American Society of Civil Engineers has made its final report; and in this the further useful distinction is drawn between "decretion" (reduction of service life), the cause, and depreciation (reduction of money value), the effect. Attention also should be here directed to the recent report of the Valuation Committee of the American Electric Railway Association in which a standardized list of 21 valuation terms, comprehensively defined, are recommended for use in place of the 300 odd terms now largely employed. (These terms were reprinted in Engineering News, Oct. 26, 1916.)—H. B.

on values and costs, and keeps everything up to date. It takes some trouble to install and some thought to keep going, but it pays.

I have had experience for nearly 15 years with a method that is adapted to almost any business. The business to which the method has been applied was established over 25 years ago, and includes importing, manufacturing small machinery, and dealing in supplies, so that the problems were numerous. To apply this method to a new business is very easy, and it can be applied to an old business a little at a time.

The inventory begins with the receipt of goods, either through purchase or manufacture, and a written invoice from the factory should be treated just as an invoice for purchases. Sales are deducted from inventory, of course, and so should be all tools and equipment which are worn out and junked. A written invoice for all goods junked is vital.

The proper classification of every article must be decided on in advance, and this should be done, as far as possible, in such a manner that each article will fall *naturally* into its class.

There are several grand divisions or classifications, namely:

(*a*) Furniture, Fixtures and Machinery. (Subject to deterioration.)

(*b*) Work in Process. (A proper shop-cost record is required to take care of this.)

(*c*) Merchandise, Supplies and Raw Material. (Generally figured at cost.)

Each grand division can be subdivided as often as experience shows it to be desirable.

In practice it has been found best to number each section. Symbols should be avoided. At first they seem helpful; in the end they are a nuisance. A numerical index is also essential, and it is easily kept. A number once used should never be used for another thing. Numerical and alphabetical indexing answer all purposes.

Physical control of stock is essential. Nothing should be received or given out without a voucher. If one is allowed to help himself to stock, without control, it is useless to attempt to keep a perpetual inventory.

The inventory items should all be on cards. Books are not practical, and a loose leaf is practically the same as a card, and not so serviceable.

A perpetual inventory is very helpful because it shows how goods move, and at what dates they sell, and will generally be more accurate than an actual counting of the goods. Nevertheless, a constant check is kept on the inventory by the simple method of actually counting stock on hand and reporting in writing on a "Goods Wanted Memorandum" before replacing any stock that is low. Any error in the inventory is thus discovered. In practice we have found that the inventory is the more reliable.

Keeping track of merchandise presents no serious difficulties, although most people still rely on the annual inventory. While it is true that Machinery, Fixtures and Tools must be appraised, yet an accurate description, accurate count, and accurate cost must be furnished before an appraisal can be made that is anything more than a guess.

Proper classification is very essential here. It is very wrong to attempt to value line shafting, belts and pulleys as a whole. Every pulley and belt belongs to some machine or to a line shaft, and should be so described in detail, not by guesswork. A separate inventory card should be kept for each line of shaft. The pulleys for driving machines, either directly or through countershafts, and the belts, are part of the driving equipment of each machine. This method simplifies the shafting, pulley and belting problem, as each belt pulley should be accurately described and priced on the inventory card for the machine it belongs to.

In classifying Machine Tool Equipment, only such equipment should be included with each machine as can be used only on that particular machine. For instance, if a number of screw machines exactly alike are used, then the spring chucks should be classified separately, and not as part of the equipment of any one machine. For the same reason milling cutters are not part of the equipment of any one machine.

Drills, taps, reamers and similar tools should always be separately classified. The more subdividing there is done, the easier it is.

Each machine tool should be listed in detail on a separate card, with a list of its equipment as originally bought, with dates and costs. New equipment can be added as bought or made. A proper addition is for freight, cartage and cost of installing, and of the pulleys and belts.

If costs are kept, say, on the right-hand side of the card, they can be totaled up, and the entire original cost shown at a glance. Estimates of present value can be written down, say, annually on the left side of the card in a column headed "Present Value," and dated.

Appraisal of present value can only be made by a competent, honest person who knows all the facts and is familiar with the business. Appraisals by outsiders are of little value. Taking off a fixed percentage per annum is unreliable. A simple test is to ask for how much cash would you be willing to part with the machine. Honestly applied, this test will give an accurate value. If we cannot assume intelligence and honesty, any appraisal is valueless.

In valuing small tools, such as reamers, taps, cutters, etc., no hard and fast rule can be laid down, but a few general principles will apply. In general, a stock of reamers and cutters in a shop will all be in use, hence all will be depreciated, but as worn-out tools are replaced it is a fair assumption that all are serviceable. A flat depreciation of, say, one-third would probably cover. With taps, drills and files, however, there would always be a large percentage, possibly one-third, which were unused, therefore a depreciation of, say, one-fourth would perhaps be correct. Equipment such as tote boxes and case-hardening boxes is subject to very great deterioration, and probably a depreciation of one-half would be right.

As to count of such items, it should not be guessed at. The rule should be that no tool should be junked until it is reported in writing to the office. The actual throwing out of junked tools should be done periodically, not daily, and no new equipment should be bought or made until an accurate count of that item is reported in writing to the office, for the purpose of checking off inventory.

For instance, if some number-size drills are wanted to replace stock, it is a simple matter to send a memorandum of tools on hand to the office. Inventory is then checked off. A new lot is ordered, and when they are received they are added to the corrected inventory. The worn-out tools are not generally charged to expense. This is taken care of by charging the replacement to expense. If no replacement is made, then the junked tools are charged to expense.

It is easy enough to keep track of the cost of a drawing, but the constant changes are difficult to analyze. It would be very wrong to keep all drawings and divide up the total cost among them. It is impossible to appraise their value. The best method is to keep them constantly weeded out. The inventory can be arranged numerically, using the same number for the drawing as for the part or machine. The same number

should also be used for patterns and special tools and jigs. Our practice is to keep track of original cost of drawing, and add 100 per cent. All drawings on inventory are priced. Drawings in actual use are carried at full price on inventory. Drawings which are not much used are carried at no value; if revived, the full value is restored; if obsolete, they are destroyed.

Patterns are kept track of numerically, a separate card for each. Patterns in general use are carried at full price. Those little used at no value. Obsolete patterns are destroyed. The pattern card is also made to serve as a record of cost of castings, and it is also noted if the pattern is in storage or at the foundry. In figuring the cost of patterns it is proper to figure all cost of making the first patterns. For instance, if a metal pattern is wanted, the first cost of the wooden pattern is figured in the cost of the final metal pattern, even though the wooden pattern is no longer of any use after the metal pattern is made. Alterations in patterns to get good castings are also considered a proper part of cost, but alterations in design are not.

Work in process is controlled by the fact that work is always started in lots or jobs, and time, material and overhead take care of this. Every piece of shop or repair work should be on a separate job ticket, unless very trivial. In this way all changes in equipment are kept track of.

Pipe, fittings and wiring in buildings can be classified and separated into mains and branches, just as suggested for shafting, belting and pulleys. Dead lines should be so marked and valued at practically nothing, but as dead lines are sometimes revived, it is well to keep track of them, unless they are actually abandoned.

In conclusion, it is important to have means of getting rid of all records, drawings, tools, etc. For this purpose a slip is used in which all possible places where there is a record are named, and all obsolete records are thus systematically destroyed. This includes patterns, jigs, drawings, catalogues, etc. If anything is discarded, but there is a possibility of revival, all records, tools, jigs, etc., are put in one box, and marked, for instance, "No. 1364—Section 13—obsolete," and stored away. In time actual junking will occur.

CLOSURE BY MR. PIEZ

Charles Piez. No schedule of depreciation, no matter how carefully and intelligently framed, will cover all possible conditions and provide for all possible contingencies. A fixed schedule is always lacking in that elasticity which would render it universally applicable, and must on that account be supplemented in unusual cases by exceptional treatment born of intelligent analysis and experience.

In discussing allowances to be made out of profits to cover loss or shrinkage of value, it is well to bear in mind that relatively few manufacturers regularly make such allowances for depreciation, and that even these few have never adopted, or even discussed any standard set of rates.

That loss of value from any one or all of the causes enumerated by Mr. Barker does occur is universally acknowledged. Academic definition of the generally used term depreciation does not stay its inroads on profits nor make the method of providing for these inroads any clearer. Why add such new terms as "retirance" and "renewance" to an already overburdened industrial vocabulary?

What is needed is a presentation of records and experiences, so that out of these we may develop a schedule of rates which can be looked upon as a standard for determining annual allowances against loss of value due to wear-and-age deterioration and obsolescence.

The loss of value is legitimately a part of the cost of the output, a fact which is at present overlooked in many business enterprises; and to correct this omission or oversight, it is to my mind much more effective to start with a sane schedule of rates of depreciation than to start with a definition. I realize, of course, that Mr. Barker's discussion pertains more particularly to the valuation of public-utility properties, where the allowances to be made on individual units may be so large as to justify division into several classes or causes; but in the mechanical industries the terms "annual depreciation" and "total depreciation" contracted from "annual depreciation allowance" and "total depreciation allowance," are so widely understood as to require no further definition.

What is needed is to have some association of the importance and prestige of this Society investigate this subject and recommend a schedule of rates of annual depreciation for adoption.

With the administration proposing a further tax of five per cent on all profits in excess of eight per cent on the investment, isn't it necessary that the engineering societies shall define what so important a factor in the expense of production as depreciation amounts to annually and how provision for it shall be made out of profits?

Mr. Hearne has outlined very clearly a system by means of which a perpetual inventory of work in process, as well as of the other assets of a manufacturing plant, can be introduced and maintained.

I am a strong advocate of the value of running or perpetual inventories for work in process and materials in stores, as well as for buildings and equipment, and Mr. Hearne's discussion is valued because it outlines the possibilities in these directions. In the valuation of small tools I believe it safer and nearer to the truth to assume that this equipment averages about halfway between new and worn out, and to charge off a flat depreciation of 50 per cent instead of a third. I believe his method of valuing active patterns at full cost is dangerous, and the same must be said of his practice in respect to drawings.

I have never heard of purchasing drawings at anything more than a merely nominal sum upon the liquidation of an industry, and patterns in the average industry are subject to such marked deterioration in value through obsolescence as to justify the flat rates of depreciation named in the schedule.

MECHANICAL DESIGN OF ELECTRIC LOCOMOTIVES, A. F. BATCHELDER

George Gibbs. I take it that Mr. Batchelder's paper is not intended to be more than a very general statement of certain features which must be taken into account in the design of an electric locomotive, together with certain conclusions which he is led to make from his study of the problem. It may therefore be in order for me to give briefly some opinions of my own, and in so doing I am sorry if I must disagree with the conclusions in some respects.

A complete presentation of the subject of electric-locomotive design has yet to be made; all we can do at present is to chronicle experience with various types and classes in different services. Unfortunately the total number actually in service is quite limited and the period over which our experience runs is also in many cases short.

In the first electric locomotives built not so many years ago the chief consideration was to get a machine which would run and pull a train without continually breaking down through some electrical defect; this is the first step in a young art.

When these conditions were satisfied, it then became a question of obtaining the best design from the standpoints of safety, efficiency and low maintenance cost. This second stage is still under way and the end is by no means yet attained, nor can this be expected any more than has been the case with the steam locomotive, in which there has been a tremendous improvement during the last ten years in increased capacity and efficiency.

Many years' experience in testing work for railroads has brought me into very close touch not only with the design of locomotives but of track. I early became impressed with the importance of high center of gravity in steam locomotives and with the importance of reducing the dead weight below springs to the lowest consistent amount. The track structure does not present a perfect and unyielding plane surface; it has defects, both in alignment and surface, and it is elastic. Its elasticity is a saving characteristic as regards safety and the low maintenance cost of track and equipment. Therefore, a locomotive in running over the track has set up in it oscillations and movements, the effects of which become important not only to the locomotive structure but to track, as regards safety and cost of maintenance.

These conditions are well understood in steam-locomotive practice but, unless we are careful, are likely to be lost sight of in designing electric locomotives, where the radical difference in the application of the motive power suggests or permits a variety of wheel arrangements, weight distribution, etc. I cannot here go into a full discussion of this important point, but I can say generally that the elimination of reciprocating parts from the locomotive, a result accomplished in electric locomotives but impossible with steam, does not warrant us in abandoning some of the very important principles well demonstrated in steam practice, namely, that for safe and successful operation under average track conditions, high center of gravity, least dead weight below spring supports and an unsymmetrical wheel and weight distribution give best results. The above applies especially to high-speed operation; for low speeds similar arrangements are also desirable but not so essential.

A word more about the height of center of gravity. There seems to be a tendency to consider that the center of gravity of the machine as a whole is the only consideration of importance, and some electrical designers have been content to secure a fairly high center of gravity by the combination of heavy apparatus in the cab of the locomotive (this being above the springs), with heavy weights carried on the axles or below the tops of the wheels. This arrangement does not give the equivalent of a given height of center of gravity in a steam locomotive (where the bulk of the weight is above springs), as regards the effect on track. A steam locomotive has dead weight only of the driving wheels, axles and boxes; all other weights are spring-borne and thus are not only eased from vertical shock on the track but by the rolling of the mass on the springs tend to effectively relieve lateral rail pressures and convert them into vertical, a condition which conduces greatly to safety and reduction in maintenance both of locomotives and track structure.

The writer, a number of years ago, in taking up the design of electric locomotives for the Pennsylvania Terminal in New York, suggested a method of making an extensive series of experiments to determine the riding qualities of different types of locomotives. The procedure took the form of tests on an experimental stretch of track which was made movable transversely by having the rails mounted on rollers and the transverse motion restrained by stops consisting of hardened-steel points or balls set up against steel strips which, by indentation, register the tendency to displace the track laterally. It was intended by this means to measure the tendency of certain wheel arrangements in locomotives to set up rhythmic side motion and also to register the throw sidewise by defects in track surface. As the result of these tests we obtained much valuable information regarding design of electric locomotives confirmatory of the general principles I have mentioned above, showing the value of an unsymmetrical wheel base for an electric locomotive with a high spring-borne center of gravity and low dead-weight component. I believe a more extensive series of these tests, and an acquaintance with the results by electric-locomotive designers, would accomplish a valuable purpose in clearing up many existing differences of opinion.

Mr. Batchelder speaks of wheel arrangement and height of center of gravity as affecting locomotive design; I am unable to follow his reasoning and, if I understand him, I do not agree with his conclusions. He appears to be trying to make out the case that high center of gravity is unnecessary if you have leading trucks for the locomotive, and that the presence of leading trucks makes it immaterial where the motors are mounted; with these conclusions I disagree. Furthermore, he appears to conclude that a leading truck is essential for high-speed operation by stating that steam locomotives cannot be safely operated backward at high speed. It is common in steam practice abroad, and not unusual in suburban practice in this country, to run steam locomotives backward without leading trucks, i.e., the American type of locomotive. In such service steam locomotives are frequently run at quite high speeds on roads having much curvature. Abroad, especially in England, it is not unusual practice to so operate them over long distances at high speeds. The real objections to the operation of steam locomotives backward are, in the first place, that the view of the enginemen is not good, secondly, that the tender is a short-wheel-base structure having a variable and shifting load, and thirdly, that coal dust which is thrown about becomes very disagreeable to the enginemen. However, I believe that leading trucks are useful in locomotive practice, and favor them, but I simply mention the above to indicate that they are not a necessity for safety.

Mr. Batchelder appears to conclude that simplicity, adaptability, reliability and efficiency require that electric locomotives must be standardized in design in the direction of placing the motive power on the trucks, either geared or gearless motors, and would obtain the requisite power by coupling trucks with short wheel base together, also that this type of locomotive can be used in either high- or low-speed service by simply changing the gear ratio. This procedure is doubtless desirable from the manufacturer's and also from the user's standpoint, if it can be done, as it results in one type of locomotive for any service, but there is no indication, from my experience, that electric motive power puts us any nearer this desirable end than does steam motive power. It certainly seems a mistake for engineers in this early stage of heavy electric-railroading development to come to the hasty conclusion that one standard type of electric locomotive must be advocated for every service, especially when experience in the operation of steam as well as electric locomotives seems to indicate the desirability of combining the elements as I have before indicated to obtain best tracking results.

It must be remembered that track maintenance is a very large item in the cost of operating the railroad, and that track on the average railroad is not always in the best physical condition; therefore the locomotive designer should coöperate

with the track department and not proceed independently in developing the best type of locomotive for any particular local conditions. I should put the prime considerations in determining the serviceability of an electric locomotive as follows:

It should have capacity for the given service.

Electrically and mechanically it should be operative.

It should be least destructive to track, especially when track is not usually kept in perfect surface.

Simplicity and low cost of maintenance.

Low first cost.

For high-speed service especially I would reverse the order which Mr. Batchelder gives under the heading Power Efficiency, for the different manners of mounting motors and connecting them to the driving axles.

In concluding, Mr. Batchelder suggests that it would be interesting to "see a complete investigation of different types of locomotives that are now operating in the same kind of service of different railway terminals in New York City, etc." This certainly would be interesting and should be valuable. I have repeatedly urged such a comparison and suggested that it include not only a comparison of the actual upkeep of the locomotives but should be made to bring out the relative overall upkeep of the railroad. The experimental form of track I have before alluded to could probably be made available for experiments by the coöperation of the various railroads interested if we could secure some concerted action looking to the inauguration of a series of tests. We know now, from figures obtained over a number of years, that there is practically no difference in the cost of locomotive upkeep between such widely divergent types, for instance, as the New York Central and the Pennsylvania Terminal locomotives, and it would therefore be useful to bring out clearly by test what other differences, if any, there are in overall adaptability to influence the future design of a form of motive power of growing importance.

C. H. Quereau.[1] In the main I agree with the conclusions reached. However, it seems to me very unfortunate that this paper, as well as others recently presented, is a general statement of the conclusions of the author rather than a statement of accomplished results. There should now be available accurate figures based on actual operation, which should not be held back because of mistaken ideas on the part of those who have the facts or those who have the authority to make them public. That Mr. Batchelder appreciates this, is shown by the last paragraph of his paper.

In Mr. Batchelder's paper, in the list of features arranged in the order of their importance, I would add "Maintenance" under Item 4. It would then read "Convenience of Arrangement as Affecting Safety, Efficiency of Operation and Maintenance." It is quite probable that convenience of maintenance was in the author's mind, but it seems to me of sufficient importance to be mentioned specifically.

In the discussion under the heading "Safety of Operation," I must confess that I cannot quite follow, probably because I do not clearly understand what was written, or have not the information on which the author bases his discussion. For instance, in describing the action of a locomotive having two driving axles guided by a two-axle swivel truck when entering a curve the statement is made that "The flange of the leading wheel gradually comes in contact with the outer rail, giving the guiding truck an angular motion about its outer rear wheel." I have believed that the angular motion of a four-wheeled truck was about its inner rear wheel, the fact being that when a truck is on a curve the outer-forward-wheel flange and the inner-rear-wheel flange are against the rail, the other two flanges not touching the rail. I do not see, however, that this difference is of particular moment and bring it up only that the matter may be discussed and clearly understood.

I believe it will be generally agreed that the operating advantages gained by having electric locomotives designed to operate in either direction is of so great importance that means must be found to provide satisfactory designs to meet this condition, notwithstanding the fact that the effect of the trailing engine truck contributes to unstable riding of the engine. The paper proposes to prevent this oscillation by the introduction of resistance against swiveling. This is practicable and has been so demonstrated, but results in increased flange wear, at least when the center of gravity is low.

As to reliability in service, we have had a number of papers describing the operation of electric locomotives on steam railroads, the design of the locomotives and the description of power plants and transmission lines, but reliability in service usually has been overlooked. In eastern territories, especially around the large cities, a delay of a very few minutes will upset the smooth operation of the railroad for hours and the effect of it reach back on the line for 150 miles. The prevention of such delays is worth considerable increase in first cost, and the maintenance methods should be such as to prevent delays practically regardless of cost; it is decidedly poor policy to reduce maintenance costs if by so doing the result is increased delays.

Mr. Batchelder very wisely considers the cost of maintenance of permanent way of more importance than cost of maintenance of locomotives. It is extremely difficult to state definitely what, if any, effect the electric equipment has on the cost of maintenance of permanent way. If the cost of maintenance of way is no greater under electric than under steam operation, such a condition would undoubtedly not be used as an argument against electrification.

As to the cost of maintenance of electric locomotives, the difference in cost-of-maintenance charges at the rate of 3.5 cents a mile and seven cents a mile may be safely figured as not less than $1000 per engine per year. This saving, capitalized, represents a considerable sum, and would warrant an appreciable increase in first cost to secure it.

In discussing a paper on the mechanical design of electric locomotives we must recognize the fact that there is no common fund of experience or knowledge from which to draw evidence in reaching conclusions, as there is concerning steam locomotives. Opinions and theories are essential in designing radically new electric equipment, but only conclusions based on extended service results are authoritative. No one has had the advantage of experience with more than one type, therefore, one's conclusions as to other types are based on opinions and theoretical considerations rather than actual results as shown by service records.

So far as I know the published data on service results are very limited, either as to first cost or maintenance or reliability in service as shown by train-delay statistics, and therefore each person will place the emphasis on some particular feature, rather than considering results as a whole. If it were possible for this Society, as a neutral, to obtain statistics covering the main points as to results in service, extending over several years, and make them public, it would be of very decided value.

[1] Superintendent of Electric Equipment, N. Y. Central R. R., New York.

The New York Central electric locomotives are all equipped with bi-polar, gearless motors mounted directly on the driving axles. The operating results have been completely satisfactory to the officials of every operating department affected. This statement does not include the net financial returns from the investment, which must take into account the item of fixed charges. With the usual maintenance these locomotives ride satisfactorily and without undue effect on the track structure, and are perceptibly more comfortable than steam locomotives. In order to secure these results it is necessary to keep the total lateral motion, both in the boxes and center pins, within three-quarters of the allowable lateral motion on steam locomotives. Table 1 contains statistics which will permit a personal conclusion as to the reliability of these locomotives in service, which will probably be more satisfactory than any expression of opinion.

TABLE 1 TRAIN DETENTIONS DUE TO DEFECTS IN ELECTRIC LOCOMOTIVES

	Miles Per Detention—All Locomotives		
Year	Mechanical	Electrical	Grand Total
1912	48271	103967	32965
1913	27873	86716	21093
1914	35625	57395	21981
1915	53720	107440	35813
	Type S Locomotives		
1915	59583	187260	45201

NOTE: All detentions of two minutes or more included. In 1913 and 1914 there was a total of sixteen Class T locomotives placed in service. In 1912 there were 47 locomotives in service. Since the middle of 1914 there have been 63. Detentions due to man failure, or delays to following trains, not included.

In this connection I wish to enter a strong plea for the use of Miles per Detention instead of Miles per Minute Detention as the unit in the preparation of statistics by which to judge the reliability of equipment in service and the efficiency of the organization responsible for maintaining it. Including the time element leads only to confusion.

TABLE 2 INSPECTION AND REPAIRS OF ELECTRIC LOCOMOTIVES

	Cost, Cents per Mile		
Year	Labor	Material	Total
1912	1.888	1.460	3.348
1913	1.982	1.454	3.436
1914	2.155	2.134	4.286
1915	1.901	1.379	3.280

NOTE: The above statistics were compiled in accordance with the requirements of the Interstate Commerce Commission. In the year 1914 it was necessary to replace all driving-wheel tires because of unsuitable material, regardless of the extent to which they had been worn. The costs of maintenance have been essentially as above since 1907, omitting 1914.

The figures in Table 2 include the cost of inspection and maintenance of all the electric locomotives, both road and switch. In 1912 and 1913 approximately half the total engine mileage and in 1914 and 1915 approximately one-third was that of engines used in switching service. The cost of maintenance of engines in switching service is about twice that of those used exclusively in road service. It follows that the cost of maintaining the road locomotives has been about 2.5 cents per mile and that of the switch engines about 4.8 cents per miles. These engines were not designed for switching service; bearing this in mind, they have given remarkable results.

For the first ten months of 1916 the average cost of maintenance of all the electric locomotives has been 2.73 cents per mile. This gives a cost of approximately four cents per mile for the locomotives in the switching service and approximately two cents per mile for those in road service. I expect these costs will not be exceeded for the entire year 1916, but very much doubt that we will be able to keep the maintenance costs permanently at this level.

CLOSURE OF MR. BATCHELDER

A. F. BATCHELDER. One point I want to bring out is the desirability of having more weight on the rail at the place of the thrust. That place, by actual test, is at the rear truck. That is not from guesswork, or from theory, or from calculation, but actual fact, tested and observed for 50,000 miles of running, for the particular purpose of finding out the effect of a double-end locomotive on the track. I have witnessed rails displaced three-quarters of an inch by the rear truck when the leading truck did not appear to move the rail at all. The speed at this time was in the neighborhood of 80 m.p.h.

The double-end locomotives I have seen run did not oscillate from side to side when running on curved track, but would hug one side or the other and ride steady; on tangent track, however, they would oscillate from side to side, except when the truck was held from swiveling in the track, in which case the locomotive would run steady just as it did on the curves.

Regarding Mr. Fowler's tests, they seem to agree with the paper, as the steam locomotive with its rigid frame carried directly on springs and with its center of gravity the same height as the car carried on low center pins, did not give as great a thrust. The car would give the effect of a low center of gravity because the side thrust was taken first against the center pin which was relatively low, resulting in less vertical pressure, while the locomotive has a greater vertical pressure due to the side thrust being taken directly and down through the side springs to the rail.

I have never seen any trouble on a curve with double-end locomotives except where too large resistance was used against the trucks curving. A double-end engine, according to my experience, is absolutely smooth and good running on a properly elevated curve.

In regard to Mr. Quereau's remarks as to the pivot point of a truck, I would say that I have not made tests to determine this, but as the outer wheels are heavier, due to the centrifugal and curving forces applied at the center pin, I have assumed that it would pivot about the heavier wheel.

I am gratified to note that Mr. Quereau has furnished figures which bear witness favoring locomotives of the simple and efficient design, and hope that these figures and what Mr. Quereau has to say about the operation and maintenance of these locomotives will have careful consideration by those interested. Mr. Quereau has spoken about the resistance tending to prevent the guiding trucks from oscillating results in increased flange wear, and I believe that Mr. Quereau is right. With the engines Mr. Quereau has in mind, there is a frictional resistance of an amount that once the truck has taken a position some external force is required to put it into another position, and it might therefore run cock-eyed on the track and cause flange wear. In that particular case flange wear is much preferable to oscillation.

Mr. Katte has spoken of coil springs on the journal boxes, and I would add that my experience with them has been gratifying.

Mr. Young has understood me to say that a locomotive will not run backward safely. I would rather modify that statement and say that it is not desirable to run it backward. For that matter, I do not know of any locomotives of the American type operating at 80 m.p.h. backward.

Mr. Eveleth has been associated with me throughout a large portion of his experience with electric locomotives, and his discussion favors the conclusion of the paper.

Replying to Mr. Gibbs's written discussion, I would say

that Mr. Gibbs seems to agree with me as to the importance of the high center of gravity in steam locomotives; however, it seems to be an inherent condition in steam locomotives, and if it were not desirable it would be difficult and expensive to reduce it any considerable amount.

It is also desirable to have the dead weight below the springs as little as possible, especially in steam locomotives where the unbalancing, due to reciprocating parts, adds relatively large values to the vertical impact. It is not uncommon in well-designed high-speed steam locomotives to have the dead weight on some axles 13,000 or 14,000 lb., and to this is added the effect of the unbalancing, due to the reciprocating parts. A careful analysis of this will show that these values are considerably in excess of the dead-weight values on high-speed electric locomotives of the design suggested in the paper as best adapted for this service, which has been built up to the present time. The last locomotives of this type built for the New York Central R.R. to handle 1200-ton trains at 60 m.p.h. has a maximum of 6310 lb. dead weight per axle.

Again Mr. Gibbs agrees with me in that we should not abandon any of the important principles that have been found good in steam practice. I would add, however, providing it is possible to retain the principle in its desirable form. I believe the paper has made it clear that the high center of gravity cannot be used to the same advantage in double-end-operating locomotives with trailing trucks as with a single-end steam locomotive, unless special provision is made in the design of the truck, in which case it matters not whether the center of gravity is high or low.

Relative to the unsymmetrical wheel and weight distribution in double-end-operating locomotives, I am unprepared to agree or disagree with Mr. Gibbs, but, offhand, I would say that within the possibilities of locating the weights, the effect would be slight and could be easily overcome by the design of the guiding trucks.

As to Mr. Gibbs's "A word more about the high center of gravity," and how electrical designers secure the high center of gravity, I wish to repeat that it does not make any difference whether the center of gravity be high or low, or how it is obtained, if the locomotive is provided with guiding trucks at each end (the locomotive is guided at its ends and not in the middle), and, as stated in the paper, the trucks can be designed to obtain the results required.

The testing device that Mr. Gibbs describes is extremely interesting and very valuable in determining certain characteristics, such as the transverse movement required in the trucks and measuring the transverse pressures tending to displace the rail, but it does not determine whether or no the locomotive is destructive to the track or safe to operate, as it makes no record of the vertical pressure which affects the adhesion between the rail and tie, which Mr. Gibbs apparently deems important and which I believe is one of the most important features to be obtained.

It is not the intention of the paper to convey the idea that it is necessary to have leading trucks for the successful high-speed locomotive, but to say that with leading trucks the desired results can be obtained.

Relative to the desirability of operating single-end locomotives backward, I am quite content to leave this with those who have had experience in operating.

Relative to gearing locomotives to obtain satisfactory results for high- or low-speed service, I would say that this is done very effectively on several roads, and the results indicate that it is very good practice.

THE FLOW OF STEAM AND AIR THROUGH ORIFICES, HERBERT B. REYNOLDS

G. B. UPTON. Inspection of the paper as to conditions of measurement shows (1) that pressures were taken in the dead eddies close to the orifice plate, above and below; (2) that orifices were small compared to pipe diameter, the largest ratio being with a ½-in.-diameter orifice in a 2-in. pipe; (3) and that pressure drops were large, generally all or nearly all of the excess of pressure P_1 above atmosphere being used to cause flow. The author did not touch, nor intend to touch, on the experimental case of a thin-plate orifice, large compared to pipe and pressure drop small compared to initial pressure, that is, the conditions which would make the thin-plate orifice a competitor of the venturi tube as a measuring device.

The usual formula for flow of gases or vapors through a venturi is

$$W = C F_2\left(\delta_0\frac{T_0\, 2gy}{P_0(y-1)}\right)^{1/2}\left(\frac{P_1}{T_1^{1/2}}\right)\left\{\frac{(1-x)^{2/y}-(1-x)^{(y+1)/y}}{1-a\,(1-x)^{2/y}}\right\}^{1/2} \quad [1]$$

In this equation the units are in the foot-pound-second system. W is the flow in pounds per second; C the "coefficient" of the venturi; F_2 the area of the throat of the venturi; δ the density in pounds per cubic foot; y the ratio of specific heats at constant pressure and constant volume for the gas or vapor; x the ratio of the "venturi head" (or drop in pressure from entrance to throat of the venturi) to the driving pressure at entrance, or $x = \Delta P/P_1 = (P_1 - P_2)/P_1$; and a the square of the area ratio F_2/F_1. Subscripts 0 refer to standard conditions for the gas; subscripts 1 and 2 to entrance and throat of the venturi, respectively.

In an article by the discussor in the *Sibley Journal of Engineering* for December, 1914, pp. 90-95, it was shown that the venturi formula [1] could be replaced by

$$W = C F_2\left\{\frac{2g\ \delta_0\, T_0}{P_0(1-a)}\right\}^{1/2}\left\{\frac{P_1\cdot\Delta P}{T_1}\right\}^{1/2}\left\{1-\frac{3+a}{4y(1-a)}\cdot\frac{\Delta P}{P_1}\right\} \quad \ldots [2]$$

or

$$W = C F_2\left\{\frac{2g\ \delta_0\, T_0}{P_0(1-a)}\right\}^{1/2}\left\{\frac{P_1\cdot\Delta P}{T_1}\right\}^{1/2}\left\{1-\frac{(3+a)}{2y(1-a)}\cdot\frac{\Delta P}{P_1}\right\}^{1/2} \quad [3]$$

The accuracy of this simplified formula was shown to be within one per cent, even for the largest values of $\Delta P/P_1$, if we remember the "critical" value of P_2 with regard to P_1 for gas expansion, and the variation of nozzle coefficients with flow when ΔP is large compared with P_1.

To compares equation [3] with that of Reynolds, we must change to the same units. W of [3] changes to Q of Reynolds' formula by multiplication by 60 δ_0. P and ΔP values of [3] change to corresponding values of Reynolds' formula by multiplication by 144. F_2 of [3] must be multiplied by 144 to reduce to inches. C may be taken as unity. δ_0 for air = 0.0807: T_0 = 492 deg. fahr.: P_0 = 14.7, and $\sqrt{(2g)}$ = 8.02. Hence the reduced formula obtained from [3] is

$$Q = \frac{816\, F_2}{\sqrt{1-a}}\left\{\frac{P_1\cdot\Delta P}{T_1}\right\}^{1/2}\left\{1-\frac{(3+a)}{2y(1-a)}\cdot\frac{\Delta P}{P_1}\right\}^{1/2} \quad \ldots [4]$$

The orifices used by Reynolds ranged from ⅛ in. to ½ in. in diameter, in 1½-in. or 2-in. pipes. Taking a 3/16-in. orifice in 2-in. pipe as typical, the ratio of orifice area to pipe area is $(3/32)^2$. There is a contraction of area of the flow beyond the thin-plate orifice, on the low-pressure side, with a "contraction coefficient" (K) which most probably lies near 0.60, and must be between 0.60 and 1.00. The reason that we cannot take K as 0.60 is that when the pressures are measured, as Reynolds did, close up to the orifice plate, the pressure drop

is slightly less than it it were taken exactly at the section of minimum area of flow below the orifice. This smaller pressure drop we compensate for in our calculations by using a value of K larger than its true value, which is somewhere near 0.60. The effective value of K may be 0.70 or 0.80.

It is the contracted flow beyond the thin plate orifice which really corresponds to the throat of a venturi. The area ratio from pipe size to throat size is $K(3/32)$; and assuming $K = 0.75$, the factor a in the venturi formula is $0.75^2 (3/32)^4 = 0.000043$. This is so near to zero as to be negligible. The value of γ for air is 1.40, under ordinary pressures and temperatures. On account of the contraction of flow beyond the orifice the value of F in the venturi formula is KA, A being the area of the orifice. With these values inserted in formula [4] it becomes

$$\left.\begin{aligned} Q &= 816\,KA\left\{\frac{P_1\,\Delta P}{T_1}\right\}^{1/2}\left\{1-\frac{3.00}{2\times 1.40}\cdot\frac{\Delta P}{P_1}\right\}^{1/2} \text{ or} \\ Q &= \frac{816\,KA}{\sqrt{T_1}}\left\{P_1(P_1-P_2)\left(1-1.072\,\frac{(P_1-P_2)}{P_1}\right)\right\}^{1/2} \text{ or} \\ Q &= \frac{816\,KA}{\sqrt{T_1}}\left\{(P_1-P_2)(-0.072\,P_1+1.072\,P_2)\right\}^{1/2} \end{aligned}\right\} \quad \ldots[5]$$

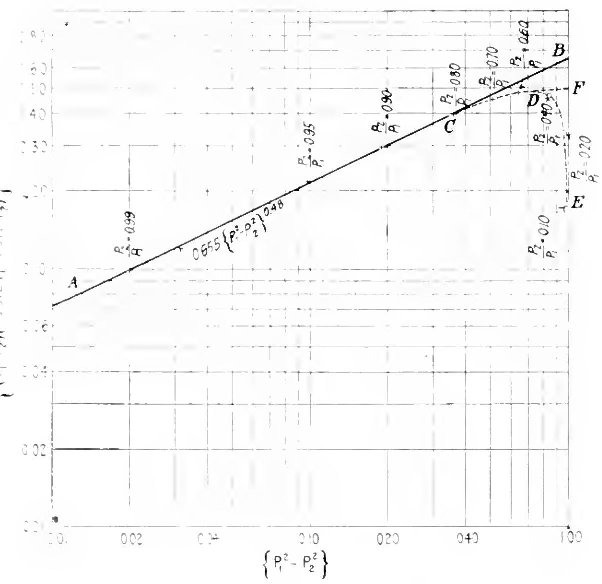


Fig. 1 Comparison of Reynolds and Venturi Formulae

The expression $\{(P_1-P_2)(-0.072\,P_1+1.072\,P_2)\}^{1/2}$ is obviously not convertible by algebraic transformation into anything much like Reynolds' expression $(P_1^2-P_2^2)^{0.48}$, which may be written for comparison as $\{(P_1-P_2)(P_1+P_2)\}^{1/2}$. Dropping the attempt to make a direct conversion of one formula into the other, we may test to see whether there is some constant ratio between the two expressions $\{(P_1-P_2)(-0.072\,P_1+1.072\,P_2)\}^{1/2}$ and $(P_1^2-P_2^2)^{0.48}$. Table 1 and Fig. 1 show the comparison and its results.

The figures in Table 1 are plotted in Fig. 1. The line AB has the equation $0.655\,(P_1^2-P_2^2)^{0.48}$. Up to the point C it fits nicely the values calculated from the modified venturi equation. The venturi values then go down CDE; but the venturi equation is here wrong because the values of P_2 are below the critical. The actual values would follow out the general direction CDF rather than CDE. If we remember that the contraction coefficient of the orifice is a function of P_1 and (P_1-P_2), it will be evident that the expression $0.655\,(P_1^2-P_2^2)^{0.48}$ may be a very good fit to experimental values of flow throughout the entire range of pressure and pressure-drop values.

Putting the expression $0.655\,(P_1^2-P_2^2)^{0.48}$ in place of $\{(P_1-P_2)(-0.072\,P_1+1.072\,P_2)\}^{1/2}$ in equation [5], there results

$$Q=\frac{0.655\times 816\,KA}{\sqrt{T_1}}\left\{P_1^2-P_2^2\right\}^{0.48}=\frac{534\,KA}{\sqrt{T_1}}\left\{P_1^2-P_2^2\right\}^{0.48} \quad \ldots[6]$$

Reynolds' expression makes the coefficient of A to be 405. For this to be so, it is necessary that K have the value $405/534 = 0.758$, which, as has been pointed out above, is both possible and reasonable. The conclusion is that Reynolds' empirical formula agrees as well as can be expected with the mathematical calculations of the flow of air under the circumstances of his measurements.

TABLE 1 COMPARISON OF REYNOLDS AND VENTURI FORMULAE

Argument, P_2 (P_1 taken as unity)	Values of expressions		Ratio	Remarks
	$[(P_1-P_2)(-0.072\,P_1+1.072\,P_2)]^{1/2}$	$(P_1^2-P_2^2)^{0.48}$		
0.99	0.09945	0.1526	0.652	
0.95	0.2175	0.3271	0.665	
0.90	0.2971	0.4506	0.659	Above
0.80	0.3964	0.6122	0.647	critical
0.70	0.4512	0.7238	0.623	pressure
0.60	0.4780	0.8072	0.592	
0.40	0.4627 (0.490)	0.9187	0.504 (0.533)	Below
0.20	0.3375 (0.495)	0.9806	0.344 (0.499)	critical
0.10	0.1780 (0.500)	0.9951	0.179 (0.503)	pressure

CLASP BRAKES FOR HEAVY PASSENGER EQUIPMENT CARS. T. L. BURTON

O. C. Cromwell. In about 1912 the Baltimore & Ohio Railroad, along with other railroads, began to replace wooden passenger-equipment cars with all-steel cars of greater length and heavier weight, and with these cars more or less difficulty was experienced in the proper controlling of the speed and braking of the trains, necessitating very close and frequent adjustment of the brake apparatus on the trucks.

In 1914 the Baltimore & Ohio Railroad again purchased a number of passenger-equipment cars, including 60-ft. steel smokers with 4-wheel cast-steel trucks, steel coaches, passenger and baggage, baggage and mail and baggage cars with 6-wheel cast-steel trucks and weighing about 135,000 lb., and 73-ft. dining cars weighing about 157,000 lb. Clasp brakes were applied, and the clasp brake is now considered the standard brake for this class of equipment.

As passenger equipment cars become larger, the question of increasing the size of cylinders and the brake apparatus has become quite a serious one. Relief has been found in the use of clasp brake, in that while an 18-in. diameter cylinder may be used on cars with maximum weight of 143,000 lb. with single-shoe brake-beam type of truck, however, with clasp brakes a maximum weight of 153,000 lb. is allowed.

The clasp brake prevents the rapid accumulation of piston travel and consequently enables a larger-diameter cylinder to be used. The old-style brake with a standing piston travel of 6 in. has a running travel of 7½ in., a difference of 1½ in.,

while the clasp brake with a standing travel of 6 in. has a running travel of 6¾ in., a difference of ¾ in.

The location of the shoe of the clasp brake in relation to the wheel, namely on the horizontal center line, prevents the rapid accumulation of slack, and consequently piston travel, while the old-style brake beam with the single shoe located some distance below the center line caused rapid wear and accumulation of slack which was reflected in the piston travel.

With the single-shoe brake beams on the heavier trains on long grades, when the brake shoes were wearing thin, the shoes have been found fused to the heads due to the heat generated by the long application of brakes. This condition does not obtain with the clasp brake.

With the clasp brake journal bearings wear more uniformly and do not crowd to the side, as in the case of single-shoe brakes. It has also been found with the clasp brake that there is less wear on the pedestal jaws and the journal boxes and the shoes, and when starting out from a terminal shoes can be permitted to go on a run worn as much as ¼ in. thinner than in the case of the single-shoe application. We feel that on the heavier-passenger-equipment cars the clasp brake will shortly be found in almost universal use.

The reduction in the number of hot boxes on passenger-train cars which has taken place since the application of clasp brakes is not claimed to be due wholly to the clasp brake, but it has contributed its share to the improvement.

B. P. FLORY. The conclusions which are arrived at in the paper are borne out by practical experience of roads which have cars equipped with clasp brakes in service. On the New York, Ontario & Western Railway we have 12 all-steel cars weighing 106,000 lb. with four-wheel trucks equipped with clasp brakes since May, 1914. There has been no trouble experienced in the operation of the brakes on these cars and we have noticed all of the things to which Mr. Burton calls attention. These cars run in train with other cars which have the single brake, and the difference in riding of the cars when stopped is very noticeable.

As to hot boxes, we find that for a period of 30 months, the cars making in that time a mileage of 1,873,500, there have been 10 hot boxes, mostly due to new wheels and axles. During the same period the balance of our passenger cars had 88 hot boxes with a mileage of 11,507,200, or an average of 130,769 miles per hot box against an average of 187,350 miles for the cars equipped with clasp brakes.

Mr. Burton's conclusion concerning the use of clasp brakes in order to stop trains in a short distance should be in the mind of every railroad official when the question of new equipment is raised. This is recognized, for in 1915 the Master Car Builders' Association adopted as recommended practice, the rule that all passenger cars with four-wheel trucks weighing 96,000 lb. and over, and all passenger cars with six-wheel trucks weighing 1[illegible]6,000 lb. and over should be equipped with clasp brakes.

C. H. SMITH[1]. The subject has been so thoroughly covered by the author, who is the "father of clasp brakes," as to leave little either to criticize or add. To the advantages which the author has stated it might be added that the clasp brake has accomplished more successfully that which was previously sought for by the adoption of the brake-slack adjuster, i.e., taking up slack due to shoe wear as well as other lost motion in the brake rigging and trucks. The slack adjuster now becomes a necessary adjunct to the clasp brake and will perform its functions as intended.

Our limited experience with the clasp brake confirms all that the author claims. No new passenger equipment will be constructed without this valuable improvement. Moreover, with its adoption upon important train equipments the way is opened for one of the next desirable improvements in brake mechanisms, i.e., that which will justify producing simultaneous application as well as release of brakes on all cars of the train, which can be done with the electric-control device. The use of the clasp brake on all the cars in an entire train will not completely eliminate possible rough handling because of the time interval between head- and rear-end application.

[1] Boston & Maine R. R., Boston, Mass.

THE TALBOT BOILER, PAUL A. TALBOT

D. K. WARNER[1]. I should like to ask Mr. Talbot if any experiments have been made since those conducted by the U. S. Geological Survey on the temperature of the tube metal in a boiler of natural gravity circulation. Those tests showed that the tube temperature remained practically that of the water in the tubes. As the capacity for receiving heat depends only on the temperature difference between the tube and the gases, and the velocity of the gases, I would take exception to Mr. Talbot's statement that "the high rate of evaporation is obtained because of the high velocity of water in the tubes." Inasmuch as with ordinary circulation the tubes keep as cool as the water, it would seem that the high capacity of this boiler is due more to the high furnace temperature, the absence of baffles and other special features. I would also like to ask if the periodic temperature variations mentioned would be great enough to injure a turbine.

Because of its freedom of expansion this boiler seems admirably suited for very high capacities. May I ask the author then why he limits himself to a draft of two inches of water. Using 20 lb. of air per lb. of oil, a draft of 24 inches of water requires by theory less than 1½ per cent of the power developed in the turbo-generator. Electric fans are built of 50 per cent efficiency, so that it would actually require but 3 per cent of the power. High capacities will be essential on the new ships of such great power and the flue temperatures can be kept down by adding a few layers of tubes.

A Norwegian shipbuilding concern, according to *The Times Engineering Supplement* (Jan. 26, 1917), is about to construct a reinforced-concrete ship of 3000 tons dead-weight capacity which is to be fitted with Diesel engines for propulsive purposes. Hitherto the use of this material has been restricted to small vessels.

The coefficient of friction of bronze on bronze has been the subject of some recent experiments by the U. S. Reclamation Service. The tests were conducted on the slide-gates at the Pathfinder, Arrowrock, and Elephant Butte dams. The head on the center of the gates varied between 50 ft. and 125 ft. The average coefficient of friction of the opening stroke ranged between 0.31 and 0.42 for the different dams. The maximum ranged between 0.383 and 0.44. The average for the closing stroke ranged between 0.254 and 0.29 and the maximum between 0.268 and 0.34. (*Western Engineering*, vol. 8, no. 2, February 1917, p. 51).

[1] Sheffield Scientific School, New Haven, Conn.

LARGE RECLAMATION PUMPING PLANT

Discussion by Louisiana Engineers of the Details of Design of the Largest Drainage Pumping Plant in California

A JOINT meeting of the Louisiana Society of Members of the American Society of Civil Engineers and of the New Orleans Section of The American Society of Mechanical Engineers, held on October 2, 1916, was devoted to the discussion of a paper entitled The Design and Test of a Large Reclamation Pumping Plant,[1] by G. C. Noble, of San Francisco. This discussion is published below, preceded by a brief abstract of the paper, which is given here for the purpose of reference.

The paper by G. C. Noble, purchasing engineer of the Shell Company of California, entitled The Design and Test of a Large Reclamation Pumping Plant, originally presented at a meeting of the San Francisco Section of The American Society of Mechanical Engineers, published in the May 1916 issue of The Journal and later presented at the Thirty-Seventh Annual Meeting of The Society in December 1916, was also discussed at a joint meeting of the New Orleans local association of the American Society of Civil Engineers and the New Orleans Section of The American Society of Mechanical Engineers on October 2, 1916.

Mr. Noble's paper dealt with drainage problems involved in Reclamation District 1500, one of the largest in the state of California, the solution of which problems resulted in the construction of the largest reclamation plant in this country; and what the New Orleans engineers had to say regarding the California project makes interesting reading. Also, the discussion here presented brings out incidentally a number of valuable points in connection with present drainage practice in Louisiana.

ABSTRACT OF PAPER

During the last few years there has been a very rapid development in reclamation work along the rivers of California, with a decided tendency towards the formation of very large districts. To accomplish true reclamation it is necessary not only to exclude the flood or overflow waters, but also to provide a drainage and pumping system which will insure the removal of all surface water, whether from rainfall or seepage, as fast as it accumulates. Failure to do so will result in a very great loss, and it is therefore imperative that the system be designed in accordance with the best engineering practice.

In this paper the author outlines the problems involved in the case of Reclamation District 1500, commonly called Sutter Basin, one of the largest in the state of California, the solution of which has resulted in the construction of the largest reclamation pumping plant in this country, having six 800-hp. units. The District has an area of about 66,000 acres, and to reclaim the tract it was necessary to surround it with some 70 miles of levees.

The author first describes the methods employed in determining the amount of drainage water due to run-off from rainfall and to seepage through levee banks, to be handled by the pumping plant, and after a study of data dealing with the maximum pumping head, concludes that the plant capacity should consist of pumps that can lift 1000 sec-ft. against a 29-ft. head.

As the plant was accessible to three electric-power companies, it was decided to use motor-driven centrifugal pumps; six units, each a 50-in. pump having a normal capacity of 175 sec-ft. against a discharge head of 29 ft. and driven by an 800-hp. motor, being decided on as offering the most satisfactory arrangement and best economical design. Power is delivered at 2200 volts from three 1500-kva. outdoor-type oil-cooled transformers receiving energy at 60,000 volts.

Inasmuch as the district would be flooded the first year after installing the plant on account of non-completion of the levees, and also as a protection against damage to pumps from flooding due to possible breaking of levee at high water, it was necessary to design the walls of the (reinforced-concrete) pumping-plant building to withstand a depth of water on the outside of 18. ft. above floor level, which resulted in the use of walls 4 ft. 6 in. thick at the base of the floor line. The uplift pressure on the bottom of the building amounted to nearly 5000 tons.

Results of preliminary tests on one unit are embodied in the paper in a chart, which shows a combined motor and pump efficiency of very nearly 60 per cent at a discharge of 165 sec-ft. and 29 ft. head.

MR. OKEY DISCUSSES THE DETERMINATION OF THE PROPER CAPACITY OF A PUMPING PLANT

CHARLES W. OKEY.[1] The determination of the proper capacity of a pumping plant to remove the drainage water from a given district is the most important step in its design, for the main purpose of the drainage district is agriculture and not pumping water. A pumping plant might be correctly designed as to economy and reliability of operation, yet might be too small to give the district adequate drainage. The loss of even a portion of one crop on the district might easily exceed the entire cost of a plant of sufficient capacity to insure drainage at all times. This fact has been recognized in a number of places where drainage is secured by pumping, and the present tendency is towards larger relative capacity. This additional money spent in a pumping plant is looked upon by the owners of the land as an insurance policy against loss by floods. In addition, the greater feeling of security given by a pumping plant much larger than those around it has resulted in a rise in land values in districts served by extra-large pumping plants over those not so well protected.

The method Mr. Noble has used in arriving at the proper capacity of pumping plant looks reasonable, except that his assumption of 25 per cent as the proportion of the rainfall that will run off is apparently too small. The heaviest rainfall

[1] The Journal, May 1916, page 371.

[1] Senior Drainage Engineer, U. S. Dept. of Agriculture, Tulane Univ., New Orleans, La.

comes during the winter season when the evaporation is at a minimum. At similar times the percentage of rainfall appearing as run-off has been as high as 75 or 80 per cent on the districts in Louisiana. The plant capacity as he has designed it is about 0.40 in. per 24 hours. The main drainage channel has a storage capacity slightly over 0.20 in. During the storm period of January 12 to 15, 1911, when 5.16 in. of rain fell, the pumping plant and reservoir canals would have been able to take care of a depth of 1.80 in. over the entire watershed, provided the canals were empty when the rain started. This would have been about 35 per cent of the total rainfall. If the land were saturated when this storm started, from comparison with results in Louisiana, this capacity appears to be rather small. However, most of the studies on the districts in Louisiana have been made on much smaller ones than that mentioned by Mr. Noble. As a result, two, or possibly three, days should be added to the period over which pumping occurred. Assuming as he did that the reservoir canal would be empty on January 13, and would be empty again on January 17, the total amount pumped would be about 2.00 in., or nearly 40 per cent of the total.

Even if it were considered that only 60 per cent of the total rainfall had to be handled in five days, starting on January 13, the capacity of the pump would have had to be 0.60 in. per 24 hours. Looking at the question from the side of the investor or actual cultivator of the land, this additional safeguard might be justified.

Present practice in Louisiana is to install a capacity of about 1.50 in. on districts of about 4000 or 5000 acres, where the reservoir capacity is perhaps 0.50 in. Of course the rainfall is much heavier, but this would provide for a much larger percentage of run-off than provided by Mr. Noble. It is to be hoped that records of operation of this plant will be kept, so that future districts will have some actual data on which to base the design of capacity.

MR. HUTSON DISCUSSES THE DISPOSITION OF DISCHARGE PIPES FOR VARIOUS SUBSOIL CONDITIONS

H. L. HUTSON. We should not, in my opinion, compare this plant, with its high lift, with our local drainage projects. Mr. Noble's problem is more nearly comparable with our irrigation plants of Western Louisiana and Texas than with our low-lift drainage plants of the coast country. It is also similar to the drainage projects of Iowa and Illinois, but with somewhat higher lift.

Whether or not it is the best practice to have the discharge pipes pass through or over the levee is, to my mind, a question to be decided with a full knowledge of the strata beneath the plant. If the plant rests on impervious strata, there is no reason why it should not be set in the levee and the pipes pass through the latter, for with a plant of this size acting as a core wall, there would be no danger of leakage along the pipes, endangering the levee. In fact, the plant itself may act as a dam, just as do most of the city drainage plants in New Orleans, and as in the case of some of the irrigation plants in Texas.

If there is only a thin stratum of porous material beneath the plant, this may be cut off by a tight bulkhead of sheet piling and the plant designed as if on an impervious foundation, but care should be taken that the bulkhead is long enough to prevent flow around the ends.

If the plant rests on a porous foundation, we must then so design that the seepage through the porous material will be so retarded as to preclude any movement of the porous material. This may be accomplished by placing the suction and discharge basins a sufficient distance apart for the friction through the porous material at a safe rate of percolation to equal the maximum head. The cheapest way to connect these suction and discharge basins is usually by metal pipes, and there is an added element of safety by having the pipes go over the levee.

As has been pointed out several times in articles on dams, a perfectly safe dam may be built on sand or other porous material, provided proper coefficients are used in figuring the length of travel for the water through the porous material. Mr. W. G. Bligh has given the following:

$$L = CH$$

where H = head of water or difference in level of water above and below dam

L = length of travel for water while percolating through the porous material.

For very fine sand and silt	$C = 18$
For fine sand	$C = 15$
For coarse sand	$C = 12$
For sand and gravel	$C = 9$
For boulders and gravel	$C = 4$ to 6.

If there is a line of sheet piling or a cut-off wall extending into the porous material, L may be measured along the course which the seepage would take, namely, horizontally through the porous strata until it strikes the obstruction, then down one side and up the other, the water following the surfaces of the solid material.

By this use of sheet piling the horizontal distance between suction and discharge basins may be reduced. An apron of impervious material on the discharge side of the plant may also be used to cut down the length of discharge pipe necessary. A row of sheet piling on the outer edge of this apron is also helpful. On the other hand, there is no advantage in having the intake paved with a watertight pavement over using rip-rap merely to prevent scour. If the pavement were watertight, there would probably be uplift enough to crack the pavement.

MR. DUSENBURY COMMENTS ON THE HIGH NOZZLE VELOCITY OF THE PUMPS

ALLEN T. DUSENBURY.[1] Pump manufacturers have urged that nozzle velocities should not exceed 6 or 8 ft. per sec. The nozzle velocity in Mr. Noble's pump, at 175 cu. ft. per sec. discharge, is about 13 ft. per sec. I wondered why this was so, and why they did not enlarge the nozzles on the pumps.

The paper states little or nothing about the type of soil and its reservoir capacity throughout the district, so that the amount of run-off cannot be judged. If the soil is like some of the Sacramento Valley land, where the peat bogs are 50 ft. thick, then the matter of building levees is a continuous one. If that is the character of soil, it does not require much pumping capacity to handle the water, because the soil will take care of so much with the small rainfalls in the district.

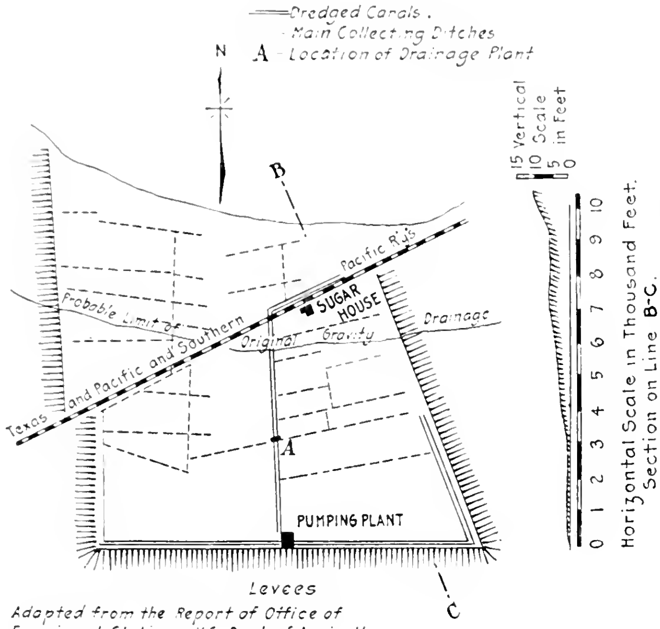
The paper states nothing about the character of the soil under the pumping plant, and does not show how the danger from seepage flow under the plant is overcome. With a difference of head of sometimes 29 ft., there would be a very great tendency for leakage to occur. I presume possibly that, for such high heads, the manufacturers did not advocate the lesser nozzle velocity so much as they do in the low-lift pumps.

[1] Vice-President and Chief Engineer, Louisiana Meadows Co., New Orleans, La.

Mr. Hutson replied to Mr. Dusenbury that the pump manufacturers do change the rating of the pump with the increase of head. He did not know just what was the rule employed, but the higher the head pumped against, the greater capacity would the manufacturers rate their pump at, because a high velocity was necessary in the impeller to pump against that head.

MR. SHAW DESCRIBES DITCHING AND CANAL SYSTEM USED ON A LOUISIANA PLANTATION

A. M. Shaw.[1] In connection with the question raised by Mr. Dusenbury in regard to the soil formation, we know that the Sacramento River is a silt bearing stream. I am not positive with regard to the Feather River, but the contour lines given on the map in the paper would indicate that this river has also built up a set of natural levees along its banks, and for that reason one would feel almost certain that at the confluence of these two rivers, at which point the pumping plant has been constructed, a silt formation rather than a peaty bog would be found, typical of certain other portions of the Sacramento River Valley.



Adapted from the Report of Office of Experiment Stations, U.S. Dept of Agriculture June 30, 1909.

Fig. 1 Willswood Plantation, St. Charles Parish, La., Showing Canals and Main Ditches

A point to be stressed is the division of the tract being reclaimed into zones, with the idea of bringing the water to the pumping plant in such a manner that it can work to best serve the entire area. That is a method of arrangement of ditches which has not been given sufficient attention in this section. It does not enter into the problem, particularly, of the reclamation of the typical flat prairie lands of the Delta country, but does enter very markedly into the reclamation or the drainage of the river-front lands. We have in the vicinity of New Orleans a number of tracts which are drained artificially, which are the result of evolution from the river-front lands. These were drained by gravity, but finding the back lands more fertile, the owners have pushed back their rear levee and gradually taken in additional land. This new land was too low to drain by gravity, so they have put in pumps on the back levee and drained the entire tract artificially, the result being that the original system of ditches is incorporated in the final system; and on account of the original system having been designed with the idea of getting rid of the water as quickly as possible, it usually dumps the water from the front lands (which are more or less impervious and have a considerable slope) back to the pumping plant, a mile or more away, at about the same time that the nearer water reaches the pumps.

The plan of the author was to divide this into zones, so that the supply of water to be pumped out will reach the plant in a manner which will enable it to serve the entire tract as nearly as possible at an equal rate. It is doubtful if any system of ditches could be designed to serve a tract of this nature in an ideal manner under all conditions of rainfall. As the author states, the elevation of the lowest point in the basin is 19 ft. above datum, and the maximum elevation is 30 ft. above datum. Undoubtedly, therefore, a great deal of benefit is derived by designing the ditches as the paper describes.

It occurs to one reading the paper that a tract of the size of the District and a project of such importance would justify at least a consideration of two separate drainage systems. That is something which should be considered in a number of the reclamation projects along the river front in the locality of New Orleans, and which has been worked out already on a very small scale in a few instances. With the data furnished in regard to the project under discussion, it is impossible to judge whether a separate system of drainage would be justified in that particular instance, but it is interesting to note what might be worked out provided things are as we assume.

A gravity drainage system might be installed following approximately the 24-ft. contour (starting a little above that, so as to get fall for the ditch), and diverting all of the water from the area above that contour to some point which would be reasonably near, if not at, a point which would be suitable also for the main pumping plant of the district. If it could be brought to the same point, all the works could be controlled by the same crew of men that would operate the pumping plant. Such a system would not be operative at times of extreme high water in the Sacramento River, but it is reasonable to suppose that a large proportion of the flood water during a considerable portion of the year could be discharged by gravity, or, if not by gravity, by an independent low-lift pump, at a very much lesser cost per acre of drainage than by allowing the entire flood to drop into the sump, making necessary the maximum lift for the entire drainage.

The two points discussed should be given more attention in the Louisiana drainage projects along the Mississippi River, where we have somewhat similar conditions to contend with.

At Willswood we have a situation about as shown in Fig. 1. The entire tract contains about 2500 acres. The original plantation ran a little over one-third of the distance back from the river.

I believe that the original tract was drained entirely by gravity. As the demand for more land was felt, a levee was constructed as shown in the figure, which enclosed a considerably greater area. This new land was too low to drain by gravity and a drainage wheel was constructed. All the drainage from the older as well as from the new lands was brought to this point and pumped out on the prairies to the rear. The

[1] Consulting Engineer, New Orleans, La.

ditching system was on the regular "checkerboard" system common to the front lands, and this system was extended to the entire final project, which was installed fifteen or twenty years ago.

As will be noted, the entire ditching and canal system is of such a design that drainage water will be rushed to the pumps as quickly as practicable from even the most distant points of the plantation. As the land farthest from the pumps is practically impervious and has a slope of from 2 to 4 ft. per 1000 ft., the effect is to flood the lower lands before the water from even ordinarily heavy storms can be removed—this in spite of the fact that the Willswood plantation has an exceptionally large pumping capacity per acre of area served. The damage from such flooding in the past has not been serious, as the rear lands have usually been planted in cane, and cane will stand flooding for several hours, but the arrangement is not ideal.

An element which we find common in the multiple-unit plants in Louisiana, which does not seem to have been taken advantage of in the plant under discussion, is the variation in the type of pumps and power units. These, apparently, are exact duplicates throughout the entire plant. It is probable that in the case at hand, as well as in those that we have in this section, a very large proportion of the pumping could be done by one or two units, and in a project of that size it would seem reasonable to suppose that those one or two units might be designed for a maximum efficiency. The sacrifice of efficiency for financial reasons is considered, and probably wisely so, but in the multiple-unit plants in this section we find that we can put in one pump of a sort of constant-duty type which will handle a great deal of water over a long period of time with greater economy than the pumps which are put in as purely flood-protection equipment.

MR. NELSON DESCRIBES AN ARRANGEMENT OF PUMP AND DISCHARGE PIPE HAVING SEVERAL ADVANTAGES

B. S. NELSON.[1] With reference to the question of bringing the discharge pipes over the levee, Mr. Noble said that there would be considerable trouble in priming the pumps without the gate valves, due to the long line of discharge pipe.

[1] Engineer for A. M. Lockett & Co., Ltd., New Orleans, La.

It might be of interest to show, Fig. 2, a somewhat similar installation near Pharr, Texas, where we had very nearly the same conditions, although the plant in question is an irrigation plant. The pump in this installation is located about 400 ft. away from the concrete bulkhead of the canal. The discharge pipe is a wooden-stave pipe about 7 ft. in diameter. One end of this pipe connects to this concrete bulkhead, the other end runs back to within a short distance of the pump. On the discharge of the pump we used an ordinary sheet iron increaser, with an inexpensive flap valve on the end, to recover the velocity head. This valve was about 5 ft. in diameter

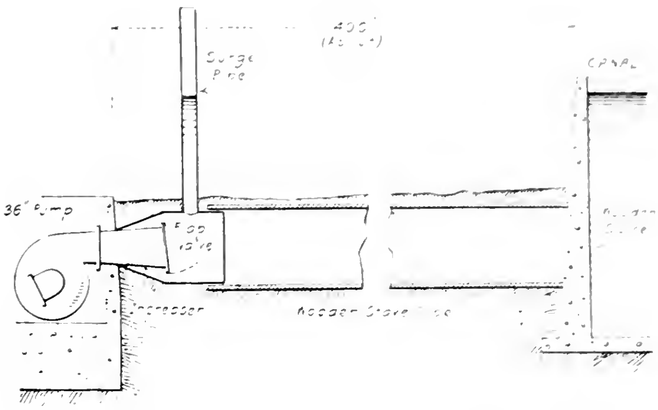


FIG. 2 ARRANGEMENT OF PUMP AND DISCHARGE PIPE USED IN INSTALLATION AT PHARR, TEX.

On the outside of the increaser was riveted a larger cone, one end fastened to the increaser and the other to the wooden pipe.

The advantages of this arrangement were that we recovered the velocity head by using an increaser; we substituted an inexpensive flap valve for an expensive gate valve, and we could prime the pump without priming the long discharge pipe.

There is no trouble about getting at the flap valve, because a sort of wooden sluice gate was arranged which could be let down over the bulkhead end of the wooden pipe and this pipe then drained back through the pump so that workmen could get into it.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

Underfeed-Stoker Furnace Action

TO THE EDITOR:

In the course of the discussion of Mr. Victor J. Azbe's paper on Power-Plant Efficiency, presented at the recent Annual Meeting of the Society, the statement was made that the process of combustion in an underfeed-stoker furnace is identical with the surface-combustion process. It was claimed that the short flame resulting from this process of firing was due to an accelerated chemical reaction brought about by the combined presence of the combustible gases with air and the solid fuel bed, interacting with surface-combustion effect.

The real reason for the comparatively short flame (especially with our Eastern bituminous coals) from the bed of fuel operated by the underfeed principle is that the combustible gases liberated from the coal are subjected to a blowpipe action during their travel through the upper part of the fuel bed.

Owing to the separated positions of the retorts in the underfeed stoker, the greater part of the distilling-off of the volatile gases occurs only in isolated strips running from front to rear of the furnace and not evenly over the entire area of the fire bed.

Air is required to consume this gas rapidly, and in order to penetrate the part of the fuel bed found above the grate sur-

face and lying above the retorts, where the rapid gas distillation is taking place, the air is blasted into the fire bed through restricted openings or tuyères under more or less pressure; and it will be noted that these air openings, instead of being evenly distributed under the entire bed of fuel, are located in separated longitudinal lines, from front to back of the furnace, underlying only a small percentage of the grate area.

The quantity of air thus delivered is therefore very many times the volume needed to complete the combustion of the fuel located *directly* above the air openings (as the fuel lying over other portions of the grate area must also receive its needed air supply).

This projected air traveling at a considerable velocity is forced through the various cracks and interstices found in the compact fuel bed, which coal has been delivered into the furnace by the ramming action of the feeding plungers (or screws).

We next find this air mixing with the rising and very recently liberated gases, and both air and gases are hurled together against the heated masses of fuel (or coke) which intercept their paths of escape to the combustion chamber above.

Thus we have the blast of cool air meeting the combustible gases (heated in this case to a degree approximately their ignition temperature) and being projected with them against the highly heated baffle (or block) which acts with regenerative effect with just the same conditions and effect that we find in blowpipe practice in our shops or laboratories.

Such handling of the air and gas within the fuel bed tends to support a temperature within the burning mass which raises their mixture above the temperature of ignition of the gas, and this temperature is further maintained by the burning of the coke resulting from the coal after its gas has been distilled off.

The coke, which is, practically speaking, carbon, when raised to temperatures of from 1500 deg. to 1850 deg. fahr. would normally, under a quiescent state, burn to carbon monoxide, but with a large excess of air present which is made to sweep over its surface at high velocity, experiment has shown that carbon dioxide is produced.

These two actions of the gas and air within the fire bed have a tendency to complete the combustion of the combustible matter within the fuel mass, but only at such positions as the air and gas can find sufficiently free paths of passage to travel with sufficient velocity.

Owing to the compressed condition of the fuel bed, due to the ramming action of the feeding devices, the fire bed of the underfeed-stoker furnace is never open and spongy and of equal density over its entire surface, but it loosens up over the grate surface in lumps (especially with the caking coals) and opens in cracks and fissures, through which separated openings the air and newly generated gas are hurried at too high a velocity to produce a thoroughly even burning effect throughout any cross-section of the fuel bed.

It is due to the compactness of the fire bed and the small area of air-admission openings of the underfeed stoker that the (comparatively speaking) high air-blast pressures are required to force sufficient air into the furnace to complete the combustion of the entire fuel.

The underfeed method of stoking unquestionably produces a certain amount of gas combustion within its more or less deep fuel beds and this results in the production of a shorter flame above the fire surface, but does it always go far enough in this direction to eliminate all smoke?

At one time I was called upon to investigate a form of down-draft furnace which the inventor claimed embodied the principle of surface combustion, and I believe that he had a much better right to make such a claim than those trying to apply this theory to the action taking place in the fire beds of underfeed stokers, notwithstanding the fact that I could not wholly support the claim of the down-draft-furnace inventor.

The so-called *surface combustion* is produced by bringing a mixture of combustible gas with but slight excess of its required amount of air into intimate or penetrative contact with some solid body of a more or less porous, open, or granular structure heated to a high temperature, which form of solid body is known as a *catalyzer*. The tendency of the resulting chemical action (or catalytic action) taking place at the surface of these catalytic agents is to increase the velocity of the chemical combination, while the agents, in themselves, are left unchanged at the end of the reaction.

Every heated solid substance exerts some accelerating action on gaseous reactions, notably the metals of the platinum group in some of their subdivided forms, nickel, iron oxide, firebrick or other refractories, but it does not stand to reason that all other solids beside those named are equally effective catalyzers.

Reactions always occur most slowly in free-gas space, but there is the greatest difference in the catalytic activity of the various solids.

Catalytic action may take place on the surface of a lump of glowing coal during the time its occluded or liberated gases are given off by the action of the heat, but it does not follow that lumps of coal brought in contact with other surrounding gas act to very materially accelerate, in a similar manner, their reaction (necessary to effect the final product of combustion).

There are two ways in which the complete combustion of gases takes place. The first is a homogeneous combustion in which the velocity of the chemical change is dependent upon the order of the reaction, and combustion or reactions occur equally throughout the entire mass; in the second a heterogeneous combustion occurs in layers immediately in contact with a hot surface, and for this reason the term *surface combustion* has been given to this form of combustion.

But it must be noted that in order to obtain an effective surface combustion a refractory material is best adapted, and the activity of the surface presented is governed by the texture of the surface, the condition of the surface as related to the kind of gas consumed, and its retarding effect upon the films of gas formed.

Surface combustion is effected by forcing an explosive mixture of air and gas through refractory porous diaphragms, and in such cases the combustion seems to be concentrated within the interstices of the fireclay body, being always the most intense on the outer surface, where no flame is visible.

Surface combustion is also obtained by a somewhat less effective means by which the air and gas are forced through a porous bed of incandescent granular refractory material under pressure, and under favorable conditions the flame disappears and a high temperature results at the surface of the catalyzer.

With a proper understanding of what the term *surface combustion* is intended to convey, there can be but little reason for making a claim that the action in the fuel bed of an underfeed furnace is one of surface combustion.

In the underfeed furnace we find a great number of reverberatory actions taking place throughout the fuel bed, which rapidly raise the temperature of the air and gases; and by thus increasing their temperature we hasten the rate of combustion and this tends to produce a higher temperature, the same as is produced in ordinary blowpipe practice, where the flame is projected against a block having the ability to maintain a

high temperature; but it is not reasonable to call such an action one of surface combustion.

Albert A. Cary.

New York, N. Y.

Systematic Committee Work in Technical Societies

To the Editor:

Referring to the letter on systematic committee work in technical societies, submitted by Mr. Hess, I must take exception to Mr. Hess's strictures on the Research Committee. It is evident that he is imperfectly informed about the Committee's activity and methods, in undertaking a somewhat sweeping criticism. It is true that so far as actual research is concerned the Committee has, until last year, never been able to produce final results. No research can be handled without money. The Committee has been the means of getting some research work done, the results being published in papers. It is certainly very far from true that the Committee is not active. It is also not true that they have not asked for funds. I have upon several occasions applied to the Secretary for funds for the research work, but up to the present none have been allotted. The $300 mentioned by Mr. Hess is intended only for clerical work, and is entirely used up for that purpose.

The report of the Finance Committee to which Mr. Hess refers certainly shows some signs of life on the part of the Committee, so that at least it may be attested as something not quite ornamental. However, as regards the coordination of effort, I am in agreement with Mr. Hess, and the efforts of the Research Committee have been intended to aid in securing it. The writer has several times pointed out the need for eliminating duplicate committees in the various societies with a view to avoiding duplicate work; there should be some general plan adopted for correlating the work of all societies. The latest movement for the accomplishment of this end has been by way of the National Academy of Sciences, but there appears to be no more difficult task than trying to get people together on the subject of research. We have many different research bodies in this country, all more or less endowed, employed upon scattering research. These would produce their results much more efficiently if they were correlated so that no overlapping work was undertaken. It would appear to be the duty of the new secretary of the National Research Council to be the center through whom all of these various research activities would be cleared. I agree with Mr. Hess that the absence of funds is a handicap in getting results, but it is not at all impossible to obtain funds.

With regard to the suggested plan of Mr. Hess, perhaps he is not aware that the Research Committee is already working along these lines, except that the sub-committees have as yet never had any funds allotted to them, but have procured what funds they could from outside sources. There is all the more credit due, I think, in this case to those sub-committees that have accomplished definite results.

R. J. S. Pigott.

Bridgeport, Conn. *Chairman Research Committee.*

WORK OF THE BOILER CODE COMMITTEE

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in The Journal, in order that anyone interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee as approved by the Council on February 16, 1917, in Cases Nos. 76, 116, and 124 to 135 inclusive. In this report, as previously, the names of inquirers have been omitted.

Case No. 76 (Reopened)

Inquiry: What net area should be considered in calculating staybolts with tell-tale holes drilled in their ends? Also an opinion is requested whether in determining the load on a bolt, the full pitch dimensions of the area stayed should be used, or whether the area occupied by the bolt itself should be deducted.

Reply: The question as to the area of a drilled staybolt is answered by Par. 220, which specifies clearly the net cross sectional area of the stay. The full pitch dimensions of the stays should be employed in determining the total area and the area occupied by the bolt itself may be deducted to determine the net area to be supported by the stays and the load carried by the stays.

Case No. 116

Inquiry: In the case of safety valves does the second sentence of Par. 286 require the raised face specified as a detail in Tables 15 and 16 of the Appendix? Would it not be better practice to make the boiler flanges of all safety valves flat-faced?

Reply: It is the opinion of the Committee that flanged cast iron pipe fittings used for boiler parts, for pressures up to and including 160 lb. per sq. in. shall conform to the American Standards given in Tables 15 and 16 of the Appendix, except that the face of the flange of a safety valve as well as that of a safety valve nozzle, shall be flat and without the raised face. The face of the flange of a safety valve, as well as that of a safety valve nozzle, shall have a flat face for pressures up to and including 250 lb. per sq. in. and shall have a raised face at higher pressures.

Case No. 124

Inquiry: *a* Where reinforcing of heads is provided for as in locomotive type boilers, the heads being braced by separate plates, what material may be used for this reinforcing plate, as well as also for the gusset plates?

b Does Par. 269 allow the use of two safety valves whose combined area is equal to the 3 in. valve?

c Is it allowable under Pars. 182 and 183 to insert a row of staybolts through the center of a joint, the spacing to be the same as the outer row of rivets in the joint?

Reply: a It is the opinion of the Committee that this question is answered by Pars. 2 and 5 of the Boiler Code, flange steel being acceptable where not exposed to the fire or products of combustion.

b The intent of Par. 269 will be expressed by adding the following words to the paragraph: "In which case one or more safety valves may be used."

c A row of staybolts is allowable through the center of a joint provided the requirements in the Code as to back pitch of rivets and dimensions of ligaments are met, by considering a staybolt or other hole in the same way as a rivet hole. Where the plates at the two ends of a stay are of different thicknesses, the pitch must be that corresponding to the thinnest plate.

Case No. 125

Inquiry: Is the method of fastening the crown sheet of the boiler shown in Fig. 6 by using staybolts that pass through

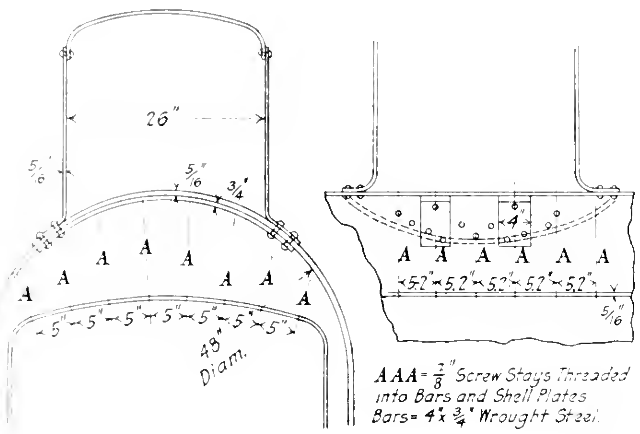


Fig. 6 Proposed Method of Reinforcing Neutral Sheet under Dome for Support of Crown Sheet

the reinforced neutral sheet underneath the dome strong enough to withstand 100 lb. working pressure?

Reply: The construction illustrated is unusual and is not directly covered in the Boiler Code. The stresses in the reinforcing bars which come beneath the dome are similar to those which exist in crown bars and the required section of the bars may be computed by the rules given in Par. 230 of the Code.

Case No. 126 (Annulled)

Case No. 127

Inquiry: An interpretation is requested of Pars. 323, 324, and 325 in their application to different types of boilers. If Par. 325 is to be used in conjunction with Pars. 323 and 324 and refers to return tubular boilers only, should this not be so stated?

Reply: It is the opinion of the Committee that Par. 325 refers to any type of boiler.

Case No. 128

Inquiry: An explanation is desired of the conflict that appears to exist between Pars. 12 and 268 of the Boiler Code in their application to the use of cast iron nozzles for boilers.

Reply: It is the intent of the rules in the Boiler Code not to allow the use of cast iron nozzles riveted to the shell of a steam boiler for any temperature or pressure.

Case No. 129

Inquiry: In view of the difficulty at the present time of securing iron boiler tubes to meet the Code specifications, permission is requested to use wrought iron tubes which on account of their small diameter, cannot meet the flanging test.

Reply: The requirements of the flanging test for wrought iron tubes will be changed in the forthcoming revision of the Code. They will be so modified as to make it possible for acceptable wrought iron tubes of small diameter to meet them.

Case No. 130

Inquiry: A ruling is requested covering the staying of crown sheets of furnaces of locomotive type boilers by means of a special form of arch bars which are attached to the crown sheet by stays spaced at regular intervals.

Reply: There are no rules in the Boiler Code for arch bars of the special type referred to. There are rules given in Par. 230 for straight crown bars and girder stays which would have to be modified in order to apply them to these special arch bars.

Where furnaces require staying Par. 212 of the Code specifies that they shall be stayed as flat surfaces. The rule for staying as flat surfaces is given in Par. 199 and the maximum pitch of staybolts at different working pressures and for different thicknesses of plate is given in Table 3. These rules and the values in the table would apply in the case of the stays used between the top of the furnace and the arch bars, the pitch to be used being the maximum, measured either between the rows of stays in the arch bars or between the stays in a given arch bar. By applying the rules for stays the allowable working pressure can be determined if the crown bars are made strong enough and are properly supported at their ends.

Case No. 131

Inquiry: Will a $1\frac{1}{2}$-in. brass body safety valve be acceptable on the outlet from a superheater provided it conforms to all other requirements of the Boiler Code?

Reply: It is the opinion of the Committee that under Par. 289 the use of brass body safety valves is not permissible with superheated steam.

Case No. 132

Inquiry: Is Par. 321 intended to apply to the fittings on water columns as well as to the pipe connections? In other words can extra heavy cast iron crosses be used for the fittings instead of brass crosses?

Reply: It is the opinion of the Committee that Par. 321 applies to the fittings as well as the pipe connections. Therefore cast iron crosses or other fittings will not be permissible.

Case No. 133 (Annulled)

Case No. 134 (Annulled)

Case No. 135

Inquiry: Is it permissible to make use of patch bolts instead of rivets in fastening the flanged edges of the sheets in a door hole of a locomotive type boiler, where accessibility to the work for riveting is impossible?

Reply: Where there is insufficient room to use rivets such as in the specific case mentioned the Boiler Code does not prohibit the use of patch bolts.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

THE most far-reaching step, not only recently but in the progress of the engineering profession, has been taken during the past month. Upon a foundation laid by others, President Hollis, with characteristic energy, has actually accomplished the preliminary work toward the organization of a clearing house for the engineering profession, whereby questions of general interest may be properly considered and a means provided for united action upon matters of concern common to engineers and the public. All societies, participating by representatives, like the states in our Union, preserve in all respects their prerogatives, entities and freedom for individual action. This organization is to be known as the Engineering Council. It will be a department of the United Engineering Society and participated in by not only the Founder Societies of the United Engineering Society but all the other leading societies.

Each of the societies will be represented by one or more delegates according to its size and, unless objection is made by some of the member societies, the Council shall speak for the societies collectively on public questions. When there is objection the matter shall be referred to the governing bodies of the societies whose representatives protested.

The Council will meet in various places and in this way establish a national atmosphere, and in every way develop a representative but nevertheless democratic organization.

In the past month Dr. Hollis has also secured the coöperation of the other societies in a joint telegram to the President of the United States, as follows:

To the President,

Executive Mansion, Washington, D. C.

We, the presidents of the National Societies of Civil, Mining, Mechanical, and Electrical Engineers, and of United Engineering Society, with a membership of thirty thousand, cordially unite in supporting Congress and the Administration in the stand for freedom and safety on the seas, and we are confident that we represent the membership of the four societies in offering to assist toward the organization of engineers for service to our country in case of war.

(Signed) GEORGE H. PEGRAM, President,
American Society of Civil Engineers.
L. D. RICKETTS, President,
American Institute of Mining Engineers.
IRA N. HOLLIS, President,
American Society of Mechanical Engineers.
H. W. BUCK, President,
American Institute of Electrical Engineers.
CHARLES F. RAND, President,
United Engineering Society.

The President of our Society and myself have received a number of communications and oral inquiries in regard to enrollment in an officers' reserve corps, and it is the expectation within the near future to take up comprehensively the whole subject and to prepare a digest of all the acts of Congress and authorizations pertaining to this matter both for the Army and for the Navy, and to instruct the membership in general terms as to how engineers may secure assignment to positions for which they are especially fitted.

CALVIN W. RICE, *Secretary.*

THE SPRING MEETING AT CINCINNATI

PLANS for the Spring Meeting of The American Society of Mechanical Engineers, the semi-annual general meeting of the Society, to be held in Cincinnati, Ohio, May 21 to 24, are sufficiently under way to enable the following announcements regarding the professional and social events of the meeting to be made.

There will be a Joint Session with the Machine Tool Builders' Association, as previously announced in The Journal. A session has been planned by the Sub-Committee on Gas Power on the subject of High-Speed Gasoline Engines. Recent developments in connection with high-speed engines for automobile and aviation service, based on a clearer understanding of the processes of combustion and the mechanical problems involved, have led to increase of mean effective pressure and improvement in combustion-chamber design, valve arrangements, balancing, and the use of aluminum alloys, etc.

There will be a Machine-Shop Session in charge of the Sub-Committee on Machine Shop Practice, at which will be discussed questions relating to the design and construction of machine tools, and other problems of interest, particularly to those engineers connected with the machine-tool industry.

A session on some of the economic principles involved in the manufacture of munitions, such as questions relating to financing, specifications, inspection, design of parts for quantity manufacture, principles of organization which have been found successful, etc., will also be held.

The proposed entertainment features include an informal gathering on the first evening, with addresses of welcome, followed by dancing.

On Tuesday morning there will be a trolley ride to Fort Thomas, a beautiful site overlooking the Ohio River, and of particular interest at this time. During the afternoon the ladies will be invited to visit Rookwood Pottery and the Art Museum. For the evening there is planned a symphony concert or a dinner followed by dancing at the Zoo.

On Wednesday morning a trip will be arranged for the ladies through the leading stores of Cincinnati, some of which are very handsome, and a trip through one of the city's skyscrapers in order to get a view of the city and the Ohio Valley. On Wednesday afternoon a trip will be ar-

ranged to the Zoo in special cars; this is a very beautiful place in May and one of great interest.

On Thursday morning a special ladies' program, the details of which have not yet been arranged, will be given. In the afternoon a motor-car ride is planned to prominent places in Cincinnati, including Mt. Storm Park, University of Cincinnati, Observatory, and Ault Park.

On Friday morning trips will be arranged at additional expense to members to such places as Fort Ancient, Mammoth Cave, in Kentucky, and Lexington, Kentucky. It is believed that cards can be provided for all guests to one of the golf clubs here.

The Society has already held two general meetings at Cincinnati, one in May 1890 and the other in May 1900.

Nothing can furnish a more potent testimony of the growth of the Society than a reperusal of the minutes of the 1890 Cincinnati Meeting. In it we find that "the Council has made arrangements by which the Society will enter upon the occupancy of part of the house No. 12 West Thirty-first Street, New York City." The seating capacity of the auditorium is given as "over two hundred," the top floor and basement were leased to other parties to meet the financial burden imposed during the first year of occupancy of the House. The American Institute of Electrical Engineers were also tenants, etc. Comparison with present facilities of the Society in the Engineering Societies' Building—and the present accommodation is becoming increasingly inadequate—affords sufficient evidence that each of the twenty-six years passed has contributed its share to the general and unmistakable progress of the Society and ipso facto of the Engineer.

The 1890 Cincinnati Meeting is memorable for the report of a "Special Committee appointed by the Council to memorialize the Congress of the United States in the matter of a suitable recognition by the Nation of the work of Capt. John Ericsson, late member of this Society." It will perhaps be recalled that in The Journal for May 1916 are reported the speeches of members representing the Society at the Hearing of the Bill before Congress for the erection of a monument to the memory of Ericsson, which, it is to be hoped, will lead to the speedy consummation of the projected memorial.

The 1900 Cincinnati Meeting was also a memorable one, for on that occasion was read the first paper on motor vehicles, "The Automobile Wagon for Heavy Duty," by Arthur Herschmann. "I believe," said the author in his conclusion, "that if the motor wagon is given an unobstructed field and fair play, it will hold its own and oust the horse-drawn truck in short order. The change must come, and with perhaps the exception of the harness maker, everybody will benefit by it." The investigations described in that paper were made in the interest of the Adams Express Co., and, judging by their ubiquitous delivery wagons alone, have borne ample fruit.

We have every reason therefore to look forward to the third Cincinnati Meeting, and do not doubt that it will be instrumental in furthering the general interests of the Society and the profession.

Cincinnati is a convenient city for conventions, being within a night's ride of the principal cities of the central states and many southern and eastern cities; also within twenty hours of the Atlantic seaboard and the western prairies. It is the terminal for 200,000 miles of first-class railways; to the east there are six trunk lines, the Big Four Division of the New York Central, connecting New York and Boston, the Erie and Pennsylvania from New York, Baltimore and Ohio from New York and Baltimore, Chesapeake and Ohio from New York and Newport News, and the Norfolk and Western from Norfolk, Va. From the west come the trunk lines of the Big Four, and Baltimore and Ohio.

The city has a great many points of interest. There is the Rookwood Pottery, located on the brow of Mt. Adams, overlooking the downtown section of the city. Here the beautiful Rookwood ware is produced; every piece is a separate and distinct creation of the artist and is given a finish by a secret process which has never been successfully imitated. Nothing is more interesting than to watch the potter take a piece of wet clay and before the eyes of the visitor make it into a vase which, after it has been burned in the great furnaces for many days, receives a finishing touch causing it to become a thing of great beauty and high value.

Then there is the Fernbank Dam in the Ohio River at the western city limits, said to be the largest movable dam in the world. It is one of the series of fifty-four locks and dams being built by the United States Government in the Ohio River, at a cost of about sixty million dollars, to make it navigable, with a depth of not less than nine feet, all the way from Pittsburgh to the river's mouth at Cairo.

The Cincinnati University in Burnet Woods comprises McMicken, Cunningham, and Hanna Halls, the Van Wormer Library, Engineering Hall, Chemistry Building, Gymnasium, Power Plant and Observatory, which latter is on Mount Lookout, six miles from the center of the city. It is the only municipal university in the United States. The entire group of buildings cost nearly $2,000,000. The Ohio Mechanics' Institute is another great educational institution. It is now housed in a magnificent new structure at Walnut, Canal and Clay Streets, which accommodates 4000 students, and is a big factor among scientific and industrial training schools. Cincinnati has a city hall which cost $2,000,000, and three new high schools which in architecture and appointments are not excelled in any city in the United States. The government building and custom house on Fifth Avenue cost over $6,000,000. A new municipal hospital cost $4,000,000.

Other points meriting the attention of the visitor are: the water-tower, a stone structure 120 ft. high, surrounded by a beautiful residence district; from the Fort may be had what is said to be the finest river view in the United States. The Tyler Davidson Fountain, given to the city by Henry Probasco as a memorial to Tyler Davidson, a public-spirited citizen of the old days in Cincinnati (this was cast at the Royal Bronze Foundry in Bavaria and is made of old cannon from numerous battlefields of Europe); the Old St. Peter's Cathedral; the hall where Robert G. Ingersoll made his famous "plumed knight" speech in nominating James G. Blaine for President; the inclined planes which lift cars from the downtown levels to the top of the surrounding hills; and the Music Hall on Elm Street, opposite Washington Park.

Cincinnati has a system of public parks and boulevards which covers about 2500 acres, and is now undergoing extensions and improvements. The oldest is Eden Park, located on the crest of Mt. Adams. It was once the vineyard of Nicholas Longworth, great-grandfather of Congressman Longworth. When the late King Edward VII of England visited Cincinnati, while Prince of Wales, he pronounced Eden Park the most beautiful natural park of any he had seen in his travels. Others have testified to the beauty of this park and especially to the splendor of the river scenery. Other beautiful parks in Cincinnati are Burnet Woods, in which is located the University of Cincinnati; Lincoln Park and Washington Park, the latter being located in the downtown district, where thousands tarry for a few minutes each bright day.

Members attending this meeting will have an opportunity of making tours in various directions, besides the parties already arranged, as stated at the beginning. Among the points most easily reached from Cincinnati may be mentioned: Chattanooga, Tenn., where the battlefields of Lookout Mountain, Signal Mountain and Missionary Ridge offer sentiment, history and beauty; Boonesborough, Ky., which is the oldest settlement established by English-speaking people in the Mississippi Valley, and which lies on the west bank of Kentucky River, about 150 miles from Cincinnati. Lincoln's birthplace, near Hodgenville, Ky., is another place of historical interest in Kentucky, easily reached from Cincinnati; Mammoth Cave and Colossal Cavern are 200 miles distant from Cincinnati, being about eight miles from Glasgow Junction, Ky.; the tomb of President Harrison is situated at North Bend, fifteen miles from Cincinnati; Point Pleasant, Ohio, the home and birthplace of Ulysses S. Grant, is only about twenty miles from Cincinnati, while Georgetown, where the great General spent his boyhood, is but forty miles distant.

Cincinnati has quite a German element in its population and its view of life has been much influenced by the German idea of hard work when work is on the program and wholesome recreation when there is time to play. Back of it all there is a people whose hospitality has always been of the most open-hearted kind, a people ready to give the Society a hearty welcome at its forthcoming meeting there.

Nominations for Officers of the Am. Soc. M. E.

For Election in December 1917

The Constitution of the Society in C 47 provides among the Annual Committees:

"A Nominating Committee appointed by the President."

It further provides in C 48

A "Special Nominating Committee: Twenty or more persons entitled to vote may constitute themselves a Special Nominating Committee, with the same powers as the Annual Nominating Committee."

The procedure in the nominations for office is provided in the following By-Laws:

B-27 A Nominating Committee of five members, not members of the Council, shall be appointed before February first of each year by the President. The Secretary shall publish the names of this Committee in the March issue of The Journal together with a request to the voting membership of the Society that they recommend to the Committee the names of eligible persons for the elective offices to be filled at the next election. This Committee shall deliver to the Secretary in writing between the first and the fifteenth of June the names of its nominees for the various effective offices next falling vacant under the Constitution, together with the written consent of each nominee. The names of the nominees for the various offices proposed by this Committee shall be published by the Secretary under the names of the Committee in the July issue of The Journal.

B-28 A special Nominating Committee, if organized, shall on or before October fifteenth, present to the Secretary the names of its nominees for the elective offices next falling vacant under the Constitution, together with the written consent of each nominee. The names of the nominees for the various offices proposed by this Committee shall be published by the Secretary under the names of this Committee in the November issue of The Journal.

There are to be elected in December next:

A President to hold office for one year

Three Vice-Presidents to hold office for two years

Three Managers to hold office for three years

A Treasurer to hold office for one year

The President, Ira N. Hollis, has appointed the following Nominating Committee for these officers:

Willis H. Carrier, of Buffalo

Fredk. W. Gay, of San Francisco

A. M. Lockett, of New Orleans

Paul B. Morgan, of Worcester

Louis E. Strothman, of Milwaukee

These names were selected by the following Sections, grouped geographically, and accepted by the President:

Group 1 San Francisco and Los Angeles

Group 2 Atlanta, Birmingham, Cincinnati, New Orleans and St. Louis

Group 3 Chicago, Detroit, Indianapolis, Milwaukee and Minnesota

Group 4 Boston, New Haven and Worcester

Group 5 Baltimore, Buffalo, Erie, New York and Philadelphia

This Nominating Committee is to meet at the Spring Meeting of the Society in Cincinnati, Ohio, May 21-24, and would be pleased to receive suggestions from the membership.

Under the terms of By-Laws B-27 and B-28 the voting membership are requested to send the Nominating Committee or Committees, in care of the Secretary, 29 West 39th Street, New York, N. Y., their recommendations of names for any or all of the elective offices to be filled at the next election.

These recommendations should be sent in early and not later than June 1st.

Sir William H. White Memorial

It will be remembered that shortly after the death of Sir William White, on Feb. 27, 1913, a movement was initiated to establish a suitable memorial in his honor.

The members of many engineering and scientific societies of several nations were given an opportunity to subscribe and a committee of notable engineers was formed in England to take charge of the movement.

A considerable number of the members of The American Society of Mechanical Engineers responded to the invitation and a goodly sum was sent to the committee in the name of our Society, of which Sir William was an Honorary Member.

The work has been consummated and the Committee has made its final report.

The memorial funds, resulting from private subscription, amounted to over \$16,000.

The memorial has taken three forms:

1 The "Sir William White Research Scholarship in Naval Architecture," which is to be administered by the Council of the Institution of Naval Architects with a fund of nearly \$14,000.

2 A donation to Westminster Hospital of \$500.

3 A portrait panel in marble of Sir William erected in the Entrance Hall of the Institution of Civil Engineers in London, in which about \$1500 is invested.

A reproduction of this latter memorial is shown in this number of The Journal.

A larger reproduction will be suitably inscribed and framed and placed on the wall of the Society's home.

Thus has been accomplished the desire of many engineers of many nations to do honor to an engineer of great distinction and a man of most lovely character.

The Committee of the Am.Soc.M.E. was Jesse M. Smith, *chairman;* Alexander C. Humphreys, Frederick R. Hutton.

The Americanization Movement

The Chamber of Commerce of the United States, whose Immigration Committee is displaying special activities in the direction of absorbing foreign elements into our national stock, is to be congratulated on its recent efforts to enlist the coöperation of the engineering profession in the furtherance of Americanization. A dinner was given on January 19, followed by a discussion on The Engineer in Americanization, in which quite a number of speakers took part.

Portrait Panel of Sir William Henry White

Dr. Hollis, President Am.Soc.M.E., touching on the question under discussion, said that the underlying aspect of the European War related to the attitude of the individual toward government: whether he believed in the government and heart and soul obeyed the orders of a government, or whether the government was a mere machine through which the individual was permitted to develop as high as possible in the service of mankind. He could not help feel that this was the most important side of preparedness in this country, and that too much emphasis had been put on *military* at the expense of *service* to our nation. He had never believed that the foreigners in this country, Russian, German, English, French or any other, were against America, nor that we have any German population opposed to American institutions.

He favored some definite constructive suggestion rather than discussion, and thought the best thing to do with regard to foreigners coming to America was to organize for after-work education and scholarships, and a general education, especially in American institutions. In conclusion he said he felt very strongly that the Engineer would back up anything the Chamber of Commerce might propose towards the betterment of citizenship in America and of Americanization.

Mr. Howard E. Coffin spoke on the constitution of the Committee on Industrial Preparedness, and the work it had already accomplished in connection with the industrial inventory of the country, the data of which will form the basis of the whole structure toward our national military and naval defence.

With regard to Americanization, he favored employment cards in every employment agency, which would give particulars as to naturalization, when first papers were taken out, etc., followed in due course by a definite declaration that no employee will be raised to a position of responsibility or trust unless he is an American citizen.

Transactions Errata

From time to time the attention of the Society has been called to slight errata in the volumes of Transactions, and these errata have been kept on file and will be compiled and published at an early date.

Mr. F. W. Dean furnishes the following corrected Table 1 of his paper on Damages for Loss of Water Power, which was presented at the December, 1915, meeting of the Society and published in Volume 36 of the Transactions:

TABLE 1 GENERAL COSTS OF POWER BY STEAM AND WATER

Annual Costs of Power by a Steam Plant.	Annual Costs of Power by Water Combined with Steam Sufficient for a Uniform Power	
	Water Power Plant	Auxiliary Steam Plant
Interest	Interest	Interest
Depreciation	Depreciation	Depreciation
Repairs	Repairs	Repairs
Insurance	Insurance	Insurance
Taxes	Taxes	Taxes
Attendance	Attendance	Attendance
Fuel	....	Fuel
Supplies	Supplies	Supplies

Naval Consulting Board

A special meeting of the Naval Consulting Board of the United States, called at the request of Secretary of the Navy Daniels, was recently held in the Engineering Societies Building for the purpose of considering certain matters which are vital to the proper defense of the United States in the event of war.

William L. Saunders, vice-chairman of the board, presided, and some of the matters discussed were the production and organization of the industries whose outputs would be national necessities in the event of war, aeronautics, transportation,

submarines, mines and torpedoes, and ordnance and explosives.

Among those at the meeting were Bion J. Arnold, Frank J. Sprague, Peter Cooper Hewitt, Howard E. Coffin, Hudson Maxim, Elmer A. Sperry, and Lawrence Addicks, who are members of the board, and Rear Admiral G. E. Burd, Industrial Manager of the New York Navy Yard; Captain W. S. Smith, U. S. N., representing the Navy Department in Washington, and Lieutenant Commander Charles S. McWhorter, one of the submarine experts of the service.

It was voted to notify the Secretary of the Navy that the "board holds itself at the service of the Department of War or of the National Council of Defense, to act as a board of inventions, or in any other capacity which may be of use to the Government in the present emergency."

The board adjourned to meet at the call of the President, who is Thomas A. Edison, who was reelected. William L. Saunders, Peter Cooper Hewitt, and Thomas Robins [illegible] other executive officers elected.

Ericsson Monument

The advisory committee, to be known as the John Ericsson Monument Commission, appointed by the United States Government to handle certain details with regard to the erection and unveiling of the monument to Captain John Ericsson at Washington, includes the following members of The American Society of Mechanical Engineers: John E. Ericsson, Chicago, Ill.; John G. Bergquist, Glenhead, L. I.; F. O. Hoagland, Hartford, Conn.; C. von Philp, Bethlehem, Pa.; Erik Oberg, New York City.

The commission will meet in the spring in Chicago.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER APRIL 10, 1917

The American Society of Mechanical Engineers is an organization for mutual service of over 7700 engineers and associates coöperating with engineers. The membership of the Society comprises Honorary Members, Members, Associates, Associate-Members and Juniors, all elected by ballot of the Council. Application for membership is made on a regular form furnished by the Secretary which provides for a statement of the standing and professional experience of the applicant and requires references from voting members personally acquainted with the applicant. The requirements for admission to the various grades will be furnished upon request.

Below is the list of candidates who have filed applications for membership since the date of the last issue of The Journal. These are classified according to the grades for which their ages quality, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate-Member or Junior, and those in the third class under Junior grade only. Applications for change of grading are also posted.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by April 10, 1917, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about May 20.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

Alabama

GABOURY, John D., Superintendent of Power, Woodward Iron Co., Woodward
LANDGREBE, Karl L., Assistant General Superintendent, Tenn. Coal, Iron & R. R. Co., Ensley
LIND, Edward W., Draftsman, Tenn. Coal, Iron & R. R. Co., Fairfield
LOWE, James R., Vice-Pres., McCleary Jemison Mchy. Co., Ensley
MAHONEY, John C., Turbine Engineer, Atlanta Dist., General Electric Co., Atlanta
MOFFETT, Charles A., Vice-President, Gulf States Steel Co., Birmingham
TAYLOR, Flemen C., General Gas Foreman, Tenn. Coal, Iron & R. R. Co., Ensley
WILCOX, William F., Superintendent Water Supply, Tenn. Coal, Iron & R. R. Co., Ensley

California

ALLEN, Arthur P., Chief Draftsman, Engineering Department, Union Iron Works Co., San Francisco
BENNETT, Frederick, formerly manager of Mchy. Dept., Parrott & Co., San Francisco
DEMAREST, D. C., Manager, Angels Iron Works, Angels Camp
FIELD, Robert N., Mechanical Engineer, Mammoth Copper Mining Co., Kennett
KIBELE, O. B., General Superintendent Transportation, Union Co., Los Angeles
SCHARPENBERG, Charles C., Efficiency Engineer, Standard Oil Co., Bakersfield
STODDARD, Charles H., Engineer, Moore & Scott Iron Works, San Francisco

Colorado

CARSON, Louis T., Assistant Chief Engineer, Great Western Sugar Co., Denver
DEWEY, Louis C., Mechanical Engineer, Jackson Compressor Co., Denver
JONES, Arthur L., District Engineer, General Electric Co., Denver

Connecticut

ABBOTT, Roy J., Section Leader, Pratt & Whitney Co., [illegible]
ALLGRUNN, Frederick S., Mechanical [illegible], Remington Arms & Ammunition Co., [illegible]
FRAY, George H., Assistant to Me[illegible], Bridgeport Brass Co., [illegible]
GORDON, William A., General [illegible], Birmingham Iron Fdy., [illegible]
HULME, Percy A., Assistant [illegible], New Britain Mch. Co., [illegible]
JOHNSON, Eugene A., Eq[illegible], Remington Arms U[illegible] M[illegible], [illegible]
LATTIN, Albert N., Me[illegible], New Departure Mfg. Co., [illegible]
LOOMER, Lewis L., Testing [illegible], American Brass Co., [illegible]
McGRATH, William C., Sup[illegible], Stamford Rolling Mills Co., [illegible]
MUNSON, John G., Construction [illegible], J. G. White Engineering Corp., New Haven
OTTERSON, John E., Vice-President, Winchester Repeating Arms Co., New Haven
PICKLES, John F., With W. F. Pickles, Manufacturing Automatic Drying Regulator for Paper Making Machines, Buckland
RODNEY, Keith R., Engineering, Bullard Machine Tool Co., Bridgeport

ROMER, ALBERT J., Sales Engineer,
The New Departure Mfg. Co., Bristol

SIMPSON, GEORGE P., Superintendent,
Oven Equipment & Mfg. Co., New Haven

UNGER, G. A., Technical Manager and Chief Engineer,
S K F Ball Bearing Co., Hartford

WILLIAMS, CHARLES E., General Manager,
William L. Gilbert Clock Co., Winsted

Delaware

BRENTLINGER, JOHN M., Operative Engineering Div., Engineering Department,
E. I. du Pont de Nemours & Co., Wilmington

DERR, RALPH, Engineer, Mech. Experimental Div.,
E. I. du Pont de Nemours & Co., Wilmington

FOSTER, WILLIAM B., Assistant Chief Engineer,
E. I. duPont de Nemours & Co., Wilmington

MEREDITH, HARRY P., Master Mech., Maryland & Delaware Div.,
Baltimore & Washington R. R., Wilmington

SCHULZ, LOU E., Construction Engineer,
E. I. du Pont de Nemours & Co., Wilmington

SELLERS, WILLIAM F., President,
Edge Moor Iron Co., Edge Moor

STONE, ROY L., Operative Engineer,
E. I. du Pont de Nemours & Co., Wilmington

WARNER, JACOB L., Assistant Engineer,
E. I. du Pont de Nemours & Co., Wilmington

District of Columbia

JOHNSON, ELMER, Assistant Mechanical Engineer,
U. S. Office of Public Roads & Rural Engrg., Washington

SMITH, THOMAS W., Mechanical Engineer, Transportation Div.,
Quartermaster Corps, U. S. Army, Washington

Georgia

GREAGAN, JOHN J., Sales Engineer,
Allis Chalmers Mfg. Co., of Wis., Atlanta

Illinois

AKERS, AXEL, Engineer in Charge Mech. Section,
Department of Public Works, Bureau of Engineering, Chicago

ALLAN, CHARLES D., Consulting Engineer, Chicago

BABCOCK, FRED R., Proprietor,
Electrical & Power Equipment Co., Chicago

CROSBY, WILLIAM F., Service Manager,
International Motor Co., Chicago

HANNIFIN, A. V., Treasurer and Works Engineer,
Hannifin Mfg. Co., Chicago

HENLEY, ROY A., General Superintendent,
The American Cement Plaster Co., Chicago

HENNING, CHARLES F., Manager,
Gypsum Fireproofing Co., Chicago

KYLE, SAMUEL C., Consulting Engineer,
Engineering & Sales Corp., Chicago

MONTAGUE, EDWARD, Superintendent,
Amalgamated Mchy. Corp., Chicago

SEIDLE, NORMAN R., Manager Plate Construction Dept.,
Joseph T. Ryerson & Son, Chicago

WILDER, THOMAS E., President,
Wilder & Co., Chicago

WILSON, GEORGE L., Counsel Service,
Efficiency Engineering Lines, Chicago

Indiana

EVANS, BERNARD C., Die Designing,
General Electric Co., Fort Wayne

HAYDON, GEORGE F., Chief Engineer,
Prudential Casualty Co., Indianapolis

WILLIAMS, LEWIS M., Sales Engineer,
Fort Wayne Oil & Supply Co., Fort Wayne

Kentucky

TREFZ, JULIUS J., General Superintendent,
The Anglo-American Mill Co., Owensboro

Louisiana

ANDERSON, JAMES, JR., Superintendent, Pipe Line Dept.,
Standard Oil Co. of La., Shreveport

SPENCER, ORRIE G., Chief and Consulting Engineer,
Lyon Lumber Co., Garyville

Maine

GOLDSMITH, WILLIAM H., JR., Chief Draftsman,
Biddeford Plant, Saco-Lowell Shops, Biddeford

SAWYER, HARRY B., Treasurer,
The Kelley Spear Co., Bath

Maryland

BRIDGES, JOHN S., President and General Manager,
Coale Muffler & Safety Valve Co., Baltimore

SCHMEISSER, ERNEST G., Secretary and Treasurer,
Baltimore Oil Engine Co., Baltimore

WYGODSKY, LEON, Vice-President and General Manager,
Baltimore Oil Engine Co., Baltimore

Massachusetts

CURRY, MALCOLM, General Engineer,
American Thread Co., Holyoke

LOFTUS, JAMES J., Sales Engineer,
Reed Prentice Co., Worcester

MACKAY, SIMON, Works Manager,
The L. S. Starrett Co., Athol

NEWTON, ALBERT E.,
With Reed Prentice Co., Worcester

NORTH, FRED K., Superintendent,
American Steam Gauge & Valve Mfg. Co., Boston

ROBINSON, CHARLES A., Mechanical Superintendent,
Merrimack Mfg. Co., Lowell

SOPER, CLEVELAND C., Instructor Machine Drawing and Design,
Wentworth Institute, Boston

TENNEY, Arthur A., Purchasing Agent,
Fitchburg Steam Engine Co., Fitchburg

WARREN, RALPH L., General Manager,
Warren Brothers Co., Boston

WIDDERBERG, OSCAR A., Machine and Mill Designer,
American Steel & Wire Co., Worcester

Michigan

DE VISSER, JOHN H., Treasurer,
The Coon-De Visser Co., Detroit

HEAVENRICH, OSMOND D., Chief Engineer,
Detroit Pressed Steel Co., Detroit

KNUDSON, WILLIAM S., Mechanical Engineer,
Ford Motor Co., Detroit

PARKS, BURRITT A., Consulting Engineer,
Byron E. Parks & Son, Grand Rapids

RIX, MILTON H., General Superintendent,
Sheffield Car Co., Three Rivers

TOWER, GLENN L., Mechanical Engineering,
With The Detroit Edison Co., Detroit

Minnesota

LILYGREEN, FRANK G., General Shop Superintendent,
American Hoist & Derrick Co., St. Paul

MOYER, MALCOLM B., President,
Moyer Manufacturing Co., Montevideo

Missouri

ROSENOW, HENRY F., Chief Engineer Power Plants,
Brown Shoe Co., St. Louis

STOLBERG, EMIL C., Assistant Engineer, Improvement Dept.,
American Car & Foundry Co., St. Louis

Nebraska

SOUTH, JOHN H., Superintendent,
Nebraska Culvert & Mfg. Co., Wahoo

New Jersey

CARNEY, EDWARD B., Mechanical Engineer,
Safety Insulated Wire & Cable Co., Bayonne

CAVE, HENRY, Director Technical Research,
Davis-Bournonville Co., Jersey City

HANNUM, JOHN P., Mechanical Assistant Superintendent,
E. I. du Pont de Nemours & Co., Carney's Point

LOVEKIN, LUTHER D., Engineer,
New York Shipbuilding Co., Camden

ROUSE, RICHARD, JR., Manager Manufacturing Dept.,
Boynton Furnace Co., Jersey City

VAIL, THOMAS C., Superintendent,
Spicer Mfg. Co., South Plainfield

WELDON, JOHN M., Power Engineer,
E. I. du Pont de Nemours Co., Carney Point

New York

ALLEN, OLIVER F., Power and Mining Department,
General Electric Co., New York

AYR, SAMUEL, Factory Manager,
Automatic Transportation Co., Buffalo

BENSEL, JOHN A., Consulting Engineer, New York

BUSSEY, CHARLES C., President,
Coal Products Corporation of America, New York

COLDWELL, ARTHUR J., Superintendent,
Coldwell Lawn Mower Co., Newburgh

COLE, FORREST W., Mechanical Engineer,
The Solvay Process Co., Syracuse

COLEMAN, CHARLES P., Vice-President,
Worthington Pump & Mchy. Corp., New York

DECKER, RUDOLPH J., M. E.,
Kaolin Prod. Corp., New York

DEVINE, JOSEPH P., President,
J. P. Devine Co., Buffalo

DRAKE, WARREN C., Mechanical Engineer,
Westinghouse Elec. & Mfg. Co., New York

DYGERT, CHARLES B., Equipment Engineer,
Remington Arms U. M. C. Co., Ilion

EVERETT, CHESTER M., Member of Firm,
Hazen, Whipple & Fuller, Cons. Civil Engrs., New York

GOODSPEED, CHARLES A., Machine Tool Salesman, Henry Prentiss Co., New York
GREIST, ALVA O., Consulting Engineer, New York
HAYDEN, THOMAS J., Instructor, Practical and Applied Electricity, Department of Education, New York
HEQUEMBOURG, WALTER J., Assistant General Manager, New York Dock Co., Brooklyn
HIRSCHBERG, CHARLES A., Advertising Manager, Ingersoll-Rand Co., New York
HUDSON, ALBERT H., General Purchasing Agent, Wright-Martin Aircraft Corp., New York
INGLES, ROBERT N., Chief Engineer, M. W. Kellogg Co., New York
ISKOLS, ANATOL D., Mechanical Designer, Switchboard Dept., General Electric Co., Schenectady
JOHNSTON, ROBERT B., Supervisor of General Machining, Remington Arms & Ammunition Co., Ilion
KING, NORMAN M., Engineer in charge, The Singer Building Power Plant, New York
LINDENKOHL, HENRY, Engineer of Construction, American Locomotive Co., Schenectady
McCLEARY, WILLIAM, Superintendent, New York & Richmond Gas Co., New York
MYERS, CHARLES T., Production Engineer, Savage Arms Co., Utica
PECK, ROSS S., Engineer, Westinghouse, Church, Kerr & Co., New York
PEEBLES, ERFORD J., Factory Engineer, Divine Brothers Co., Utica
SACCHI, GUSTAVO A., Engineer, Power Div., Westinghouse Elec. & Mfg. Co., New York
SHAW, HUBERT A., Metallurgist, American Can Co., Geneva
SITNEY, MASSEY, Mechanical Engineer, New York Navy Yard, New York
STALEY, FREDERICK W., Fuel Engineer, The Texas Co., New York
STEWART, JAMES T., Resident Inspector, The Hartford Steam Boiler Inspection & Insurance Co., Utica
TAYLOR, JAMES D., Advisory and Operating Engineer, New York
TUCKER, JOSEPH H., Construction Superintendent, Grant Contracting Co., New York
WILFERT, GEORGE, Assistant Chief Inspector, Remington Arms Union Metallic Cartridge Co., Ilion
WORTH, B. G., Vice-President, Walter Kidde & Co., Inc., New York
WRIGHT, DONALD C., Production Supervisor, Remington U. M. C. Co., Ilion

Ohio

AICHBERGER, CARL, Mechanical Engineer, The Sandusky Foundry & Machine Co., Sandusky
BICKFORD, FRANK, Engineer, The Recording & Computing Mchs. Co., Dayton
BLANCHARD, CHARLES M., Chief Engineer, The Standard Fuel Oil Engine Co., Willoughby
BURGER, FREDERICK W., Superintendent, Delphos Mfg. Co., Delphos
CARMAN, EDWIN S., Secretary and Chief Engineer, The Osborn Mfg. Co., Cleveland
CASE, GEORGE S., Factory Manager, The Lamson & Sessions Co., Cleveland
FULTON, WILLIAM B., Supervising Engineer, The Colin Gardner Paper Co., Middletown
FRYER, WILLIAM H., Chief Engineer, The National Cash Register Co., Dayton
GEOGHEGAN, JOHN T., Mechanical Engineer, C. N. O. & T. P. Rwy., Cincinnati
GIBBONS, MICHAEL J., JR., Secretary, M. J. Gibbons Supply Co., Dayton
LOHMANN, ALFRED P., Engineer in Charge, Engineering Dept., The B. F. Goodrich Co., Akron
MOORE, CHARLES C., Chief Engineer Power Sta., The National Cash Register Co., Dayton
MUELLER, OSCAR W., President, The Mueller Machine Tool Co., Cincinnati
PERKINS, J. B., President, The Hill Clutch Co., Cleveland
PATTERSON, A. HUGO, Contracting Engineer, The Mt. Vernon Bridge Co., Mt. Vernon
PELTZ, ARTHUR C., General Manager, The Morris Machine Tool Co., Cincinnati
RASTALL, WALTER H., Engineer, Worthington Pump & Machinery Corp., Cincinnati
RICHARDS, ARTHUR, Consulting Engineer, Richards Engineering Co., Columbus
ROLLMAN, BRUCE B., Experimental Engineer, New Idea Spreader Co., Coldwater
SAFBERG, B. F., Superintendent, Barberton Works, The Babcock & Wilcox Co., Barberton
SHUTT, MILO, With Alliance Machine Co., Alliance
TREADWAY, LYMAN H., President, The Peck, Stow & Wilcox Co., Cleveland

Oregon

MEANY, JAMES M., Western Representative, Clyde Iron Works of Duluth, Minn., Portland

Pennsylvania

ADAMS, LOUIS W., Superintendent of Plant, Bethlehem Steel Co., South Bethlehem
BELL, CLINTON W., 1st Assistant Chief Engineer, Hauto Power Sta., Lehigh Navigation Electric Co., Hauto
CARTER, J. WALLACE, Superintendent, Penn. Barrel Co., Philadelphia
CARTER, OSCAR S., Assistant to Combustion Engr., United Gas Improvement Co., Philadelphia
CRISFIELD, JAMES A. P., Engineer, The United Gas Improvement Co., Philadelphia
DALE, R. BURDETTE, Chief Engineer, Erie City Iron Works, Erie
EATON, GEORGE M., Division Engineer, Rwy. Div. Eng. Dept., Westinghouse Elec. & Mfg. Co., E. Pittsburgh
FISCHER, VALDEMAR B., Toolroom Foreman, Midvale Steel Co., Philadelphia
HAYES, LAWRENCE W., Salesman, Worthington Pump & Machinery Corp., Pittsburgh
HINKENS, EDWARD H., Shop Engineer, Westinghouse Elec. & Mfg. Co., Pittsburgh
HOUGH, ROBERT H., Consulting and Developing Engineer, Clarke Thomson Research, Philadelphia
JOHNSON, LEON H., Works Engineer, Struthers Wells Co., Warren
MARVIN, HOWARD, General Manager, Boyts-Porter & Co., Connellsville
ROGERS, FRANK H., Assistant Hydraulic Engineer, I. P. Morris Co., Philadelphia
SCHREIBER, HERMANN V., Research Engineer, E. W. Clark & Co., Philadelphia
SHIMER, ABRAHAM, Assistant Chief Engineer, The New Jersey Zinc Co., Palmerton
SODERSTROM, KARL A., Designing Engineer, The Midvale Steel Co., Philadelphia
SPEER, J. RAMSEY, President, Pittsburgh Iron & Steel Foundries Co., Pittsburgh
SPRINGER, LESLIE W., Civilian Superintendent, Hull Div., Philadelphia Navy Yard, Philadelphia

Rhode Island

HATCH, WILLARD T., Engineer Power and Construction, Brown & Sharpe Mfg. Co., Providence

West Virginia

FAIRCHILD, ALBERT R., Assistant Superintendent, Appalachian Power Co., Bluefield

Wisconsin

BOYER, GEORGE H., Assistant Engineer Power Plant, Milwaukee Electric Rwy. & Lt. Co., Milwaukee
BULLARD, EARL J., Manager, Field Production Service, Gisholt Mch. Co., Madison
MACKLEM, GEORGE A., Engineer, Beloit Iron Works, Beloit
MESSENGER, C. R., Vice-President, Chain Belt Co., Milwaukee
WILSON, JOHN C., Manager, Thomas Met r Dept., The Cutler-Hammer Mfg. Co., Milwaukee

South America

OLDITCH, FREDERICK W., Construction and Designing Engineer, and Partner, Buxton, Olditch & Cia., Buenos Aires, Argentine

Canada

CAMERON, N. C., Chief Engineer, Imperial Tobacco Co. of Canada, Ltd., Montreal
DRYER, REGINALD P., Assistant General Sales Manager, Canadian Allis-Chalmers, Ltd., Toronto
LEE, GEORGE E., Asst. to Vice-President, and General Manager, Canadian Locomotive Co., Kingston
LINCOLN, ELLIS S., Assistant Superintendent, Nova Scotia Steel & Coal Co., Ltd., New Glasgow
WARD, FRED B., Chief Engineer and Asst. to General Manager, John Inglis Co., Toronto

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

California

HALLORAN, LEWIS F., Partner, Halloran & Golcher, San Francisco
SLAUGHTER, WILLIAM B., Mechanical Engr. and Superintendent, Marine Mechanical Works, San Pedro

Connecticut

BALL, Charles P., Jr., Demonstrator,
Bullard Machine Tool Co., Bridgeport

BASMAJIAN, Serope P.,
with Winchester Repeating Arms Co., New Haven

BURRILL, Albert S., Assistant Chief Draftsman,
Pratt & Whitney Co., Hartford

MALONE, George B., Assistant Equipment Engineer, Gun Dept.,
Winchester Repeating Arms Co., New Haven

Delaware

MINER, Harold L., Fire Protection Engineer,
E. I. du Pont de Nemours & Co., Wilmington

District of Columbia

DAVIDS, Robert L., Mechanical Draftsman,
Office of the Chief of Ordnance, Washington

Illinois

BEITMAN, Arthur H., Engineer and Manager, Quincy Branch,
Edmund E. Perkins Engineering Co., Chicago

BENNETT, Arthur R., Furnace Man,
American Steel Foundries, E. St. Louis

SCOTT, Edwin M., Meter Engineer, Testing Department,
Commonwealth Edison Co., Chicago

WILSON, Leroy A., Assistant, Engineering Experiment Sta.,
University of Illinois, Urbana

Indiana

MARTIN, D. Stanley, Assistant Superintendent of Services,
Citizens Gas Co., Indianapolis

SAUERS, John A., Instructor Mechanical Engineering,
Purdue University, W. Lafayette

Maine

NEWCOMBE, Garfield M., Mechanical Designer,
Eastern Mfg. Co., Bangor

Maryland

STUMP, John, Jr., Construction Department,
General Electric Co., Philadelphia

Massachusetts

ANDREWS, Bernard R., New England Manager,
Buffalo Forge Co., Buffalo Steam Pump Co., Boston

HORTON, Lucien B., Superintendent Loading Plant,
United States Cartridge Co., Lowell

PHILLIPS, Edmund M., Draftsman,
General Electric Co., Lynn

Michigan

BROCKBANK, Victor, Chief Draftsman,
Superior Machine & Engineering Co., Detroit

FIELD, Lawrence N., Assistant Professor Mechanical Engineering,
Michigan Agricultural College, E. Lansing

GANDHI, Jaswant Rai, Mechanical Draftsman, Power Dept.,
Ford Motor Co., Detroit

Minnesota

KOBEL, W. C., Assistant Superintendent, Gas Power Sta.,
Minn. Steel Co., Duluth

Missouri

CARNEGIE, James, Assistant Engineer to Chief Engineer,
Union Electric Light & Power Co., St. Louis

HUFF, Lyman C., Chief Draftsman,
Union Electric Light & Power Co., St. Louis

New Jersey

JACKSON, Robert E., Assistant Superintendent,
Edison Laboratory, West Orange

LACEY, Lester K., Cost Accountant,
American Smelting & Refining Co., Maurer

TOMPKINS, Harold D., Engineer,
Smooth-On Mfg. Co., Jersey City

WHITE, J. W. Huyler, First Assistant Chief Engineer,
The American Sugar Refining Co., Jersey City

New York

EVANS, Herbert W., District Manager,
Reeves Pulley Co., of Columbus, Ind., New York

FINKEL, J. J., Inspection Engineer,
New England Westinghouse Co., New York

FRAYNE, William D., Sales Engineer,
Ridgway Dynamo & Engine Co., New York

GEARY, Robert J., Engineering Department,
Semet-Solvay Co., Syracuse

GOALWIN, Harry A., Student at Columbia University and occasional work for Moses, Pope & Messer, Cons. Engrs., New York

GOLDRICH, Phillip, Draftsman,
Guarantee Construction Co., New York

GOODSELL, Charles D., Master Mechanic,
Columbian Rope Co., Auburn

HATCH, Frederick N., Engineer,
Westinghouse, Church, Kerr & Co., New York

MORSE, Albert W., Vice-President,
The Anthony Co., Long Island City

NELSON, Charles R., Assistant to Supt. of Manufacture,
Ice Manufacturing Co., New York

POTTER, Ebford M., Supervising Engineer,
Douglas Robinson, Charles S. Brown Co., New York

RYAN, William F., Construction Superintendent,
Interborough Rapid Transit Co., New York

SKINNER, Howard A., Cadet,
Westchester Lighting Co., Gas Department, Mount Vernon

SONDERMAN, Herman C.,
With Brooklyn Rapid Transit System, Brooklyn

STUBER, Adolph, Efficiency Engineer, Camera Works,
Eastman Kodak Co., Rochester

THOMPSON, Dwinel B., Mechanical Inspector,
New York Central R.R., New York

TORNBERG, Isidor, Designer,
R. Hoe & Co., New York

VANDE MARK, Eugene S., Manager Technical Department,
National Employment Exchange, New York

WAHL, James H., Machinery Inspector,
Transit Development Co., Brooklyn

WORTHEN, Charles B., Chief Inspector, Aeroplanes and Aeromotors, Signal Corps., United States Army, College Point

Ohio

BRODERICK, George H., Factory Manager,
Corrugated Container Corp., Columbus

McLAUGHLIN, Glenn D., Maintenance Engineer,
Recording & Computing Machines Co., Dayton

MORNINGSTAR, B. Franklin, Engineer Main Power Station,
The River Furnace Co., Cleveland

SCHIRMER, Carl E., Chief Draftsman,
Schaffer Engineering & Equipment Co., Tiffin

TAGGART, Arthur B., Secretary,
Advance Machinery Co., Toledo

WIGHT, Harry C., Superintendent Div. of Water,
Dayton Water Works, Dayton

Pennsylvania

BENNY, Irwin H., Superintendent Mfg.,
Penn Barrel Co., Philadelphia

BRYANS, Henry B., Engineer Schuylkill District,
Counties Gas & Elec. Co., Norristown

CHURCHILL, Harold W., Executive Engineer, Motor Drill Dept.,
Burke Electric Co., Erie

DOWELL, Henry L., Instructor in Mech. Engrg.,
University of Penn., Philadelphia

HORTON, Ernest J., Mechanical Engineer,
Ruud Manufacturing Co., Pittsburgh

MacLEAN, Archibald, Jr., Marine Engineering Dept.,
Westinghouse Machine Co., East Pittsburgh

ORR, Harold S., Assistant to Superintendent of Inspection,
Remington Arms Co., Eddystone

SCHULZ, Gustav E., Factory Organizer, Instructor of Scientific Management,
Tabor Mfg. Co., Philadelphia

SLAYMAKER, William W., Assistant Mechanical Engineer,
Bureau of Surveys, Philadelphia

South Carolina

LE TELLIER, Louis S., Professor,
The Citadel, The Military College of South Carolina, Charleston

Texas

GUNTHER, Ernest, Sheet Metal Mfg.,
H. Welsh Co., El Paso

Virginia

WILLIAMS, Samuel S., Chief Engineer of Power Stations,
Roanoke Rwy. & Elec. Co., Roanoke

West Virginia

BALLARD, A. M., Chief Engineer,
Wayland Oil & Gas Co., Charleston

Wisconsin

WEGNER, Arnold A., Engineer, Elevating & Conveying Dept.,
Chain Belt Co., Milwaukee

Canada

SMOCK, Harold E., Chief Draftsman,
Page-Hersey Iron Tube & Lead Co., Welland

FOR CONSIDERATION AS JUNIOR

Alabama

GLIMM, William F, Jr., Engineer,
Barrett Co., Fairfield

SPEARMAN, Guy M., Draftsman,
American Cast Iron Pipe Co., Birmingham

Colorado

ROUSE, John E.,
With The United Oil Co., Florence

Connecticut

CLARK, Russell G., Draftsman,
The American Thread Co., Willimantic

HILL, CLARK B.,
with Terry Steam Turbine Co., Hartford

HIRSCH, ROBERT R., Technical Writer, Advertising Dept.,
S. K. F. Ball Bearing Co., Hartford

HOLMS, TURY B., Designing Draftsman,
Terry Steam Turbine Co., Hartford

JOY, JOSEPH, Mechanical Engineer,
Peter A. Frasse & Co., Hartford

LEES, KENNETH F., Chief Engineer,
Greist Mfg. Co., New Haven

MAGZOCCO, DANTE V., Assistant Floor Foreman,
Ashcroft Mfg. Co., Bridgeport

Delaware

TAYLOR, HENRY M., JR.,
with Harlan & Hollingsworth Corp., Wilmington

WISE, ALLEN S., Drafting,
Remington Arms Co., Wilmington

Illinois

EDE, ALBERT B., Engineer,
Cobden Machine Works, Cobden

FLIEGNER, CARL G., Section Chief, Manufacturing Layouts Dept.,
Western Elec. Co., Inc., Cicero

KNIESE, HAROLD G., Engineer,
Central Illinois Light Co., Peoria

Louisiana

HATFIELD, EDWARD R., Draftsman,
Slidell Shipbuilding Co., Slidell

Maryland

WEST, G. ALVIN, Draftsman-Designer,
P. B. & W. R. R. Co., Wilmington

Massachusetts

EDWARDS, HAROLD H., Engineer,
Swift & Co., Boston

GFROERER, HERBERT G., Mechanical Engineer,
Carver Cotton Gin Co., E. Bridgewater

IRWIN, KILSHAW M., Engineer, Station Betterment Dept.,
Stone & Webster Engrg. Corp., Boston

WESTERVELT, NELSON H.,
with Norton Co., Worcester

New Jersey

CLARKSON, ROBERT C., JR., Construction Engineer,
J. E. Campbell Co., Camden

EVANS, JAMES M., Efficiency Engineer,
Hyatt Roller Bearing Co., Harrison

HALAMA, FREDERICK D. H., Draftsman,
Babcock & Wilcox Co., Bayonne

MANDEL, ARTHUR C.,
with Simplex Automobile Co., New Brunswick

SCHLITZ, BERNARD P., Chief Tool Designer,
Simplex Automobile Co., New Brunswick

TALBOT, JOHN A., Superintendent Butler Factory,
Bloomingdale Rubber Co., Bloomingdale

New York

CASABLANCA, FRANK J., Chief Draftsman, Marine Dept.,
Kerr Turbine Co., Wellsville

GAISER, J. H., Secretary,
Booth Felt Co., Inc., Brooklyn

GODSON, JOHN A., Draftsman, Williamsburg Power Station,
Brooklyn Rapid Transit Co., Brooklyn

GREENE, GEORGE F., Draftsman,
M. H. Treadwell Co., New York

HASELTON, PHILIP H., Assistant Manager,
Newman Clock Co., New York

KELLY, WILLIAM, Assistant in M. E. Dept.
Rensselaer Polytechnic Institute, Troy

MAGILL, FRANKLIN R., Engineer, Charge Reduction Gears Design,
Kerr Turbine Co., Wellsville

MARTIN, EDWARD, Efficiency Engineering,
American La France Engine Co., Elmira

MOZEEN, HERBERT D.,
with Mulliner-Enlund Tool Co., Syracuse

QUACKENBUSH, EUGENE S., Engineer,
Friedmann, Robertson & Keeler, New York

SIPE, CHARLES A., Time Study Work,
Remington Typewriter Co., Syracuse

TREWIN, FRANK H., Lubricating Engineer,
Vacuum Oil Co., New York

WALKER, GEORGE G.,
with Vacuum Oil Co., New York

WEBER, HUGH H., Sales Engineer,
The Texas Co., New York

North Carolina

SANDERS, WALTER C., Mechanical Draftsman,
Atlantic Coast Line R. R. Co., Wilmington

Ohio

BRETT, ROY C., Instructor in Mechanical Engineering,
Case School of Applied Science, Cleveland

GALLUP, ALDEN W., Mechanical Engineer,
The Hinde & Dauch Paper Co., Sandusky

MITCHELL, MIRON A.,
with The National Vacuum Machinery Co., Dayton

TERRIBERRY, G. GILSON, Production Engineer,
Niles-Bement Pond Co., Hamilton

WARD, J. CARLTON, JR., Mechanical Engineer,
Niles-Bement Pond Co., Hamilton

Oklahoma

LICHTY, LESTER C., Assistant Professor Mechanical Engrg.,
University of Oklahoma, Norman

Pennsylvania

AICHER, ALFRED L., Chief Draftsman,
F. J. Stokes Machine Co., Philadelphia

DISMUKES, ALBERT R., Efficiency Engineer,
The Emerson Co., Pittsburgh

GANTS, ELWYN T., Assistant Test Engineer,
Pittsburgh Crucible Steel Co., Midland

GIBSON, JULIAN B., Special Apprentice,
Niles-Bement Pond Co., Philadelphia

GRING, WILBUR D., Superintendent Motive Power,
Newport & Shermans Valley R. R. Co., Newport

HENDERSON, DOUGLAS, Instructor, Mechanical Engineering,
The Drexel Institute, Philadelphia

MABREY, NELSON L., Assistant Engineer,
Standard Car Construction Co., Sharon

POWELL, WILLIAM W., Assistant Sales Manager,
Mesta Machine Co., Pittsburgh

SANDER, MALVIN G. F.,
With National Tube Co., Pittsburgh

STROUD, WILLIAM T., Mechanical Engineer,
The Atlantic Refining Co., Philadelphia

Rhode Island

McDEVITT, JOHN N., Vice-President and Assistant Treasurer,
Dover-McDevitt Co., Providence

MANDEVILLE, THEODORE C., Mechanical and Construction, Engrg.,
Sayles Finishing Plants, Saylesville

Texas

CAPEN, FREDERICK B., Mechanical Engineer,
The Texas Co., Port Arthur

EDGAR, OSMER N., Engineer-in-Charge Industrial Dept.,
Houston Chamber of Commerce, Houston

Wisconsin

COVELL, CLIFFORD C., Assistant Draftsman, Car Dept.,
Chicago, St. Paul, Minneapolis & Omaha Ry., Hudson

LAABS, ERIC H., Mechanical Engineer,
Cutler-Hammer Mfg. Co., Milwaukee

LEWIS, DEMPSTER C., Student Apprentice,
Allis-Chalmers Mfg. Co., Milwaukee

WHYTE, TESSEL S., Secretary,
Macomber & Whyte Rope Co., Kenosha

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

Ohio

GRIESS, JUSTIN, Second Vice-President,
The McMyler Interstate Co., Bedford

PROMOTION FROM ASSOCIATE-MEMBER

Georgia

EAGER, WILLIAM G., Second Vice-President,
Valdosta Lighting Co., Valdosta

Massachusetts

GRUNWELL, PAUL C., Mechanical Engineer,
New Bedford Westinghouse Co., Springfield

New York

KETCHUM, SAMUEL, Mechanical Engineer,
M. H. Treadwell Co., New York

PAUSIN, HUGO R., Superintendent Torpedo Dept.,
E. W. Bliss Co., Brooklyn

PROMOTION FROM JUNIOR

Connecticut

TREDWELL, KENNETH L., Production Engineer's Staff,
Winchester Repeating Arms Co., New Haven

Illinois

DOWSON, HARRY R., Experimental Engineer,
F. W. Matthiessen, La Salle

Michigan

IDDLES, ALFRED, Instructor Eng. Division, Michigan Agricultural College, East Lansing

Minnesota

FULLER, FLOYD M., Consulting Mechanical and Electrical Engr., Duluth

STAUDE, EDWIN G., Pres., E. G. Staude Mfg. Co., St. Paul

New York

FARRELL, MORGAN G., Vice President, Willard Case & Co., New York

LIBBEY, RICHARD H., Engineer, Otis Elevator Co., New York

SHOUDY, WILLIAM A., Assistant Mechanical Engineer, J. G. White Engineering Corp., New York

Pennsylvania

MEHARG, LAURENCE, Assistant to Superintendent of Power, Hazel Atlas Glass Co., Washington

West Virginia

MORGAN, JOHN T., District Sales Agent, The Ohio Brass Co., Charlestown

SUMMARY

New applications	324
Applications for change of grading:	
Promotion from Associate	1
Promotion from Associate-Member	4
Promotion from Junior	10
Total	339

NECROLOGY

J. LINWOOD BROWN

J. Linwood Brown was born in England in 1846. His experience as an engineer began in railway service, in which he progressed to responsible work in mechanical and construction engineering. He built and operated the Southern and West Wisconsin Railroad; held the position of Engineer of Construction with the Mexican Central, the Veronej and Rosstoff Railroad and the Panama Railroad, and was subsequently Superintendent of Motive Power and Maintenance of the Ohio Southern and Pittsburg & Western Railroads. His later work was as Superintendent of the Bureau of Water Supply and Distribution of the city of Allegheny, Pa. He died September 11, 1916. His membership in the Society dates from 1902.

EDWARD THOMAS HENDEE

Edward Thomas Hendee, who was born at Claremont, N. H., February 22, 1880, died at Minneapolis, Minn., November 12, 1916. Upon graduation from New York University in 1900, he received the degree of B.S., and immediately assumed the duties of instructor and assistant professor of chemical and mechanical engineering at New York University, receiving the degrees of M.E. and M.S. during that time. In 1901 he also received the degree of Sc.D. at Columbia University.

In 1902 he associated himself with the firm of Joseph T. Ryerson & Son, Chicago, Ill., as mechanical engineer, and in 1906 became manager of the machinery department. Between the years 1909 and 1913 he acted in the capacity of assistant to the president of the company and in 1913 became secretary, continuing so until his death. Under Mr. Hendee's management both the domestic and foreign machine business and the railway-supply business of the company were very widely extended.

Besides his affiliation with Joseph T. Ryerson & Son, Mr. Hendee was vice-president and director of the Lennox Machine Co. and director of the American Glyco Metal Co. He was a member of the University Club, of the Alumni Board of Trustees of New York University, and of a number of athletic clubs in Chicago. In 1908 he was elected an Associate of this Society and in 1915 became a Member.

WILLIAM KNOX MILLHOLLAND

William Knox Millholland, president of the W. K. Millholland Co., Indianapolis, Ind., and for many years distinguished as a machine-tool designer, died October 9, 1916. He was born in Baltimore, Md., in 1856 and educated in the public schools. In 1874 he started his mechanical training as apprentice with Flynn & Emerick, of Baltimore, Md., in their drafting room and machine department. He remained in their employ five years, during which time he completed an evening course in the Maryland School of Arts and Design. In 1881 he became superintendent of the Falls Rivet and Machine Co., Cuyahoga Falls, O., where he designed and built special machine tools and brought out several inventions. In 1887 he moved to Chicago, Ill., and entered the employ of the M. C. Bullock Mfg. Co., as tool maker and designer. He continued with this company until 1893, when he became superintendent for the Geo. D. Whitcomb Co., designing and building coal-cutting machinery, knitting machinery, etc. In 1898 he became sales manager for the Gisholt Machine Co., Madison, Wis., in which work he continued until 1906, when he organized the International Machine Tool Co., Indianapolis, Ind., and became its secretary. In 1909 he established and became president of the W. K. Millholland Machine Co., in which he was actively interested until the time of his death. Four of his seven sons are continuing the business.

Mr. Millholland was among the first members of the Society, being elected in 1883.

FRANK L. STRONG

Frank L. Strong, who was born in Amherst, Mass., in 1845, was educated in the public schools of Andover, Mass., and later in Phillips Academy. After leaving school, he decided to become a machinist and accordingly apprenticed himself to the Davis & Furber Machine Shop, at North Andover Depot, where he remained two years. During the Civil War he resigned to enlist, and worked his way to third assistant engineer in the Navy, receiving his honorable discharge at its close. He returned to Chicago in 1867 and finally settled there, having been in charge of various large manufacturing plants before he became superintendent and part owner of the Hercules Refrigerating and Ice Machinery Co.

In June, 1898, at the outbreak of the Spanish-American War, he again enlisted as engineer, this time becoming chief engineer of the Illinois Naval Reserves. He returned to Chicago in 1899, entering the field of consulting mechanical engineering, and in 1900 was retained by the Quartermaster-General of the Army as consulting engineer and superintendent of erection of the refrigerating and ice-making plant at Manila. When this work was completed, he opened an office for himself under the name of the Frank L. Strong Machinery Co. (1902) and engaged in private practice, also representing a number of home manufacturers.

Besides being a Member of the Society, to which he was elected in 1912, he was a member of the Business Men's Association in Manila, a member of the Loyal Legion, the Sons of the American Revolution and a number of local clubs in Manila. He was a prominent worker in the Masonic Order, and was Master of the first lodge in Manila.

AMONG THE SECTIONS

AT the recent conference of Sections' delegates a committee was appointed to draft a report embodying suggestions as to activities which may be properly undertaken by the Sections of the Society. Messrs. Hans R. Setz, Chairman of the St. Louis Section, and William G. Starkweather, Secretary of the Boston Section, prepared the report which was adopted by the conference. It contains so many suggestions of value that the Committee on Sections have recommended its reproduction in full. The report follows:

SUGGESTIONS REGARDING LOCAL SECTION ACTIVITIES

Irrespective of local conditions there are certain points which may well be generalized as applying to all the Section meetings. The two principal ones are that the meeting shall attract as large an attendance as possible, and that each member shall leave each meeting with the feeling that the hours devoted to it were well spent.

In these days of engineering and trade journals and excellent technical books, it hardly seems possible to attain the above ends by the presentation of lectures or discussions on highly technical subjects. Exceptions, of course, occur where for instance some new or very important development in connection with local industries is taking place. Generally speaking, however, such papers seldom interest more than just those who are closely connected with the particular subject, which could hardly be otherwise since we have to accept the condition which calls for specialization in our professional work.

The important thing then is to find the subject for our meetings on other fields than the strictly technical, and of such there is indeed a great number. We are all aware of the fact that individually, and especially as a professional unit, engineers are finding practically no recognition in the community, and it is quite certain that this condition will continue to exist as long as we are satisfied to let all our interest be centered on the study and pursuance of our professional work. It is here we see the principal mission of our Sections at the present time and for some time to come.

This brings us at once face to face with the question of speakers, and we believe there is no better way of manifesting and cultivating the spirit of interest and coöperation in the happenings of the community than by securing local speakers. In every town where the existence of a local section of mechanical engineers is warranted, there is enough industrial activity to bring forth problems in which the human side is of predominating importance. Such problems are the question of unemployment, insurance against accidents and disability from old age, education and recreation of workmen and their children, supply of food and commodities, hygienic problems, etc., which are all brought about by the concentration of comparatively great masses of people on small areas, in other words, by the industries for which we engineers are responsible. Much work along such lines has already been done by liberal church societies and philanthropic organizations, although very much lacking in concerted and harmonious effort to bring about a maximum of good. There should be no difficulty to procure speakers on the above subjects who are familiar with the particular local conditions. Securing local speakers on such problems will probably at first not look very attractive, but as such a plan is carried on, the increasing knowledge of the human side of our work is bound to awaken an interest and produce results which cannot fail to be ultimately of the utmost importance to our profession.

Another series of meetings may be arranged to cover questions that will eventually lead to standardization in the determination of cost of manufactured articles. This will become of utmost importance in trying to clearly understand and arrive at a fair method of establishing tariff rates, in which it is to be hoped engineers may have a word to say.

Many other similar questions of local as well as national importance could be cited here which will all help to broaden the interest of engineers and put them on an equal footing with doctors and lawyers who, on account of the strong human element in their professional work, are today exerting such a strong influence in the activities of the community.

The routine of meetings must be adjusted to local requirements, for which no general rules can be laid down.

In the general plan of the meetings there are many who believe a luncheon very desirable either before or after the meeting; this promotes acquaintance, assists in securing pleasant remembrances, helps membership and provides diversion. A supper preceding the meeting seems preferable, since this helps to bring the members together promptly and permits an early closing. This supper need only be of the simplest kind, and in the arrangements it would seem desirable to provide individual tables seating not more than from four to six people.

In deciding on the number of meetings per year, it seems preferable to have a few well-attended interesting affairs rather than frequent forced evenings. Invitations to these meetings are preferably sent out by return postal cards which should reach the members not less than three days, and preferably about seven days, ahead of the meeting.

Where there are no other engineering societies in the community, the mailing list for invitations to the meetings of the local section should include every man in any way actively interested in manufacturing, consulting or directing of industries. Where other engineering societies exist, these mailing lists must, of course, be arranged so as not to interfere with the activities of these sister societies. Frequent revisions of these mailing lists should be made so as to keep them up to date; the names of visitors who are too persistent in availing themselves of our hospitality without response to occasional gentle hints to join the Society should be removed from the list after one year.

In conducting the meetings, papers should start early, say 7:30 or 7:45 p. m.; the time allotted for the presentation of a paper should not exceed three-quarters of an hour. It is advisable to notify those most interested in the subject of the evening that they may be called upon to participate in the discussion; this should be done sufficiently in advance to enable them to prepare themselves. This will lead to a short, snappy session which can be closed early and will leave a good impression.

Particular attention should be paid to the publicity of local Sections' activities. Advance notice should be sent the newspapers, reporters invited, and abstracts furnished, if desired, by the secretary. Publicity for the engineer has long been neglected and is partly to blame for the lack of coöperation in, and disorganized condition of the profession.

Respectfully submitted,

WM. J. STARKWEATHER,
HANS R. SETZ.

BIRMINGHAM, JANUARY 24

The Birmingham Section met on the evening of January 24 when J. T. Anthony, a combustion expert of New York, gave an illustrated lecture on The Locomotive Firebox and Combustion Chamber.

The author considered that future operating conditions of railroads are problematical but the indications are that in addition to present demands for high-hauling capacity there will be a demand for higher speeds. The controlling factor will then be the firebox and its ability to burn the coal properly and liberate the heat required over long periods of time. He presented arguments regarding the effect of heat radiation from the fuel bed, flameways and brick work and the necessity of large firebox volume and long flameway. He showed a number of illustrations of furnace layouts of locomotives in actual operation and the results obtained in fuel economy, boiler capacity and cost of maintenance.

PAUL WRIGHT,
Section Secretary.

BALTIMORE, FEBRUARY 9

Harrington Emerson, Mem.Am.Soc.M.E., of New York, addressed the Baltimore Section at their meeting on February 9, on The Flow of Values Through an Industrial Plant. He

emphasized the fact that the important factors in an organization are the men connected with it. This consideration led Mr. Emerson to study the means of analyzing men before taking them into his organization and he developed a system of character analysis. A series of examples of the application of this method was shown by means of lantern slides.

Turning next to the organization itself, Mr. Emerson threw a diagram on the screen which illustrated in an exceptionally clear manner how values entered the business in the form of cash, from the sale of its securities and finished products, and how this money appeared as values throughout the process until the goods finally reached the customers. The diagram also illustrated the relative potential values of each step in the process, and the functions of the organization and the accounting department were very forcibly brought out by the stop-cocks and returns on the diagram. Mr. Emerson further compared the former view of accounting that simply insisted on authority, allotment and accuracy, and the modern view that demanded real facts regarding production. An interesting discussion followed.

A. G. Christie,
Section Secretary.

BUFFALO, JANUARY 31

Non-Ferrous Metallurgy was the subject of W. M. Corse's paper read before The Engineering Society of Buffalo at their meeting on January 31. Mr. Corse dwelt particularly upon the separate types of brass and bronze when alloyed with phosphorus, manganese, aluminum and silicon. Slides illustrated many of the findings presented in his paper and proved the rapid advances made in non-ferrous metallurgy.

There was a general discussion of Mr. Corse's paper, following which A. L. Johnson briefly explained the activities of the American Society for Testing Materials.

The Engineering Society of Buffalo, which is an outgrowth of the Buffalo Section of the Am.Soc.M.E., held a meeting on February 15, at which the formation of a General Technical Society was discussed. The project includes provision for all branches of the engineering profession, chemists, electro-chemists, etc. Preceding this discussion, Henry A. Brown gave a brief description of The Design of the Latest Development of Milling Cutter, illustrated by slides, showing the attainments of the tool in actual operation.

Louis J. Foley,
Assistant to Secretary.

BOSTON, FEBRUARY 7

More than 500 engineers attended the annual banquet at the Boston City Club on the evening of February 7, representing The American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the Boston Society of Civil Engineers. They unanimously pledged their support to President Wilson in the present crisis and formally voted to send a copy of the following resolution, presented by Dr. Ira N. Hollis, Pres., Am. Soc.M.E., to President Wilson:

> "In view of the grave crisis which our country is facing, and in recognition of the stand recently taken by the President of the United States for the protection of American rights and American lives on the sea.
>
> "BE IT RESOLVED that we, the members of the Convention of the Societies of Electrical, Civil and Mechanical Engineers, held jointly in Boston, Wednesday, February 7, 1917, *first* do pledge ourselves to the support of the President and Congress in their hope that our rights may be maintained by peaceful means, and, *second*, we pledge ourselves likewise to the utmost of our powers and our service, in case our country is forced into war as the only means of maintaining all our rights, freedom and safety the world over.
>
> "BE IT FURTHER RESOLVED that a copy of this resolution be sent to the President at the White House at Washington and to every Senator and Representative from New England."

Dr. Hollis in his subsequent speech declared: "We engineers can take only one attitude, it is that every citizen is permitted, even expected, to develop himself to the highest degree of service for his nation and mankind. There is only one way to do this, and it is for us to unite in the kind of goodwill and good-fellowship that will enable us to work together towards the glory of our country in peace, we hope, but in war if it is absolutely necessary."

Other speakers of the evening were Prof. Elihu Thomson, who stated in part: "We want a definite program laid out by intelligent men, by engineers, and followed without delay. What we need in this country is recognition of the fact that we are in an engineering age, that encouragement of research in scientific matters cannot be carried to excess. Our Government should be willing to spend large sums in putting forward the sciences and their applications." Dr. Hugh Cabot, chief of the Harvard Surgical Unit, who related some of his experiences at the front; Mr. Richard A. Hale, President of the Boston Society of Civil Engineers, who laid stress upon the importance of the engineers' work in case the country should be brought into the war and strongly advocated a central conference of all engineers to fix and distribute their services; and E. W. Ewartz, who spoke on Submarines and illustrated his subject throughout with many interesting slides.

W. G. Starkweather,
Section Secretary.

CHICAGO, JANUARY 19

Col. Henry A. Allen, Consulting Engineer, Garbage Disposal Plant, City of Chicago, gave an illustrated lecture on Problems in Waste Disposal before the Chicago Section at their meeting on January 19. He based his remarks on the information obtained in his study of Chicago's $7,000,000 project. He gave a description of the important disposal systems and told of the new plant being constructed for the city, together with what by-products may be obtained from the plant. By means of stereopticon views he showed the methods of construction and interesting details in apparatus and equipment used in the plant.

Robert E. Thayer,
Section Secretary.

CINCINNATI, JANUARY 18

At a joint meeting of the Cincinnati Section and the Engineers' Club of Cincinnati on January 18, J. H. Hunt, Research Engineer for the Dayton Engineering Laboratories Co., gave an interesting paper on Modern Internal-Combustion-Engine Ignition. The paper considered the requirements of the two general types of electrical ignition: the so-called wipe-spark and the jump-spark ignition. The point was emphasized that the condenser is merely a part of the breaker mechanism and has no useful purpose other than that of enabling the latter to act properly.

Oscillograph records were shown of the oscillation occurring in the primary circuit at the break when the secondary is disconnected, of the primary current and the voltage of the primary coil during normal operation together with the secondary current, and of the reduction in the final value of the current caused by chatter. Records were also shown of apparatus operated at speeds equivalent to 4000 r.p.m. of the engine, the spark obtained with the magneto at low speed, and the prolonged flame or arc persisting after the first spark in the magneto runs at very high speed.

The oscillograms illustrated some of the interesting relations in magneto design which are not generally known.

The paper concluded with a discussion of the effect of ignition upon power, and in this connection it was shown that the only thing ignition can do is to ignite, and that when properly timed any absolutely certain ignition will give all the power the motor is capable of developing at a given speed and carburetor adjustment.

John T. Faig,
Section Secretary.

CINCINNATI, FEBRUARY 15

The February meeting of the Cincinnati Section was held jointly with the Engineers' Club on February 15. A. Lewis Jenkins, Mem.Am.Soc.M.E., Associate Professor of Mechanical Engineering at the University of Cincinnati, read an interesting paper on Combined Stresses. Abner Doble, of the General Electric Co., Detroit, Mich., followed Professor Jenkins with a paper on the Doble Steam Car, of which he is the inventor and which is a new development. This car uses kerosene as fuel, has a water-

tube boiler and uniflow engine. Stereopticon slides illustrated its many novel and interesting features.

John T. Faig,
Section Secretary.

ERIE, FEBRUARY 13

At the meeting of the Engineers Society of Northwestern Pennsylvania, held February 13, to which the members of the Erie Section of the Am.Soc.M.E. were invited, a resolution was passed to affiliate with the Erie Section, to work for the better interests of both societies and of the engineering profession.

The Erie Section will hold a big meeting before the summer recess.

J. P. Wadsworth,
Section Secretary.

LOS ANGELES, JANUARY 24

The Los Angeles Section met on January 24 to discuss How Cities in the United States Are Disposing of Their Sewage. The speakers of the evening were T. D. Allin, Commissioner for the city of Pasadena, and R. V. Orbison, City Engineer of Pasadena. Both Mr. Allin and Mr. Orbison took an extended trip through the United States for the purpose of investigating this subject and their remarks were founded on personal observations.

Ford W. Harris,
Section Secretary.

MINNESOTA, JANUARY 25

On January 25, the Minnesota Section and the American Institute of Electrical Engineers held a joint meeting at the University of Minnesota. The early part of the evening was devoted to a discussion by Charles L. Pillsbury, Mem.Am.Soc.M.E., on What is Valuation. Mr. Pillbsury has just recently perfected for the United States Government a complete physical valuation of all the public utilities within the jurisdiction of the district of Columbia. E. H. Smith followed Mr. Pillsbury with a talk on Oxy-Acetylene Welding and Cutting, illustrating it throughout with practical demonstrations. General discussion followed each of these subjects.

D. M. Forfar,
Section Secretary.

NEW ORLEANS, JANUARY 22

Oil Fuel was the subject of the main paper, presented at the January 22 meeting of the New Orleans Section by B. S. Nelson, Mem.Am.Soc.M.E. Written and verbal discussions by a number of engineers followed.

H. L. Hutson,
Section Secretary.

PHILADELPHIA, FEBRUARY 1

The Philadelphia Section and The Franklin Institute held a joint meeting February 1, when the By-Product Coking Industry was discussed by C. J. Ramsberg, vice-president of the H. Koppers Co., Pittsburgh, Pa. He treated of the design, construction and operation of the modern by-product plant, coal used in by-product coking, coke structures as affected by coal, conditions affecting the efficiency of operation and recovery, and the future of the industry, illustrating his lecture throughout by means of slides and moving pictures. Special attention was devoted to benzol and benzol recovery.

John P. Mudd,
Section Correspondent.

NEW YORK, FEBRUARY 13

The New York Section was well represented at the February 13 meeting when Dr. Ira N. Hollis, Pres.Am.Soc.M.E., discussed The Engineer and Organization, and C. W. Hunt, Mem.Am.Soc.M.E., read a paper on Narrow Gauge Motor Cars.

Following the lines of his well-received addresses before some of the other Sections, Dr. Hollis drew a picture of the progress of mankind as dependent in a very large degree upon engineering. "Engineering," he said, "by eliminating drudgery, has done much for the betterment of humanity." He concluded his remarks with a plea that engineers through their organization, take a more active part in public affairs and announced a plan for closer coöperation between the national engineering societies in matters of common interest.

Mr. Hunt's paper reviewed the growing field for narrow gage motor cars, the several designs intended to meet certain conditions of service, trucks, transmission and loading, and the most economical sizes of car to employ. He also touched upon cable railways and gave data for the solution of problems connected therewith.

A. D. Blake,
Section Secretary.

PROVIDENCE, JANUARY 24

Some Mechanical Analogies in Electricity was the subject of Prof. William S. Franklin's talk before the Providence Engineering Society at their meeting on January 24. By means of some very ingenious mechanical pieces, he illustrated the analogies between mass and inductance, elasticity and capacity, and the effects of these characteristics on both mechanical and electrical systems. He pointed out that there were between twenty and thirty mathematical equations applying to mechanics which take exactly the same form when applied to electricity. President Faunce of Brown University followed Professor Franklin with an expression of gratification at the coöperation of the members of the engineering profession of Rhode Island and Brown University.

Albert E. Thornley,
Corresponding Secretary.

ST. LOUIS, JANUARY 31

On January 31, the St. Louis Section and the Associated Engineering Societies of St. Louis held a joint meeting, when George R. Wadleigh, Mem.Am.Soc.M.E., read a paper on Cotton-Mill Design. He described the processes involved in the manufacture of plain unbleached cotton goods and the major features of cotton-mill design. At the conclusion of the paper there was general discussion by the members of the Section.

Good-will and jollity reigned at the Annual Dinner of the Engineering Club of St. Louis and the Associated Engineering Societies, held at the City Club on January 24.

L. A. Day,
Section Secretary.

ST. LOUIS, FEBRUARY 10

Louis C. Nordmeyer, Mem.Am.Soc.M.E., of the firm of Tait & Nordmeyer Engineering Co., gave a lecture with illustrations on China at the meeting of the St. Louis Section on February 10. Mr. Nordmeyer related some of his interesting experiences while engaged in important engineering work in Shanghai.

On February 14 the Associated Engineering Societies of St. Louis held a joint meeting with the American Society of Engineering Contractors, when Mr. Alroy S. Phillips, Attorney, spoke on The Workmen's Compensation Law. Mr. Phillips was chairman of the legislative committee appointed under former Governor Hadley of St. Louis to investigate workmen's compensation laws throughout the country.

L. A. Day,
Section Secretary.

STUDENT BRANCHES

The large group of Student Branches was augmented by the Council at its meeting on February 16 by the approval of petitions received from the engineering students at Johns Hopkins University, the University of Pittsburgh, and Washington University. This brings the total number of Student Branches up to forty-three.

Plans for a Joint Meeting of Student-Branch members are being perfected. This meeting will occur on Friday afternoon and evening, March 30, at the Engineering Societies

Building, 29 West 39th Street, New York. In addition to the four Metropolitan Student Branches (Columbia University, New York University, Polytechnic Institute of Brooklyn and Stevens Institute of Technology) who have charge of the arrangements, it is expected that the Student Members at Pennsylvania State College and Yale University will also participate. Other Student Branches are urged to arrange to participate and individual student members and graduate student members will also be welcome.

BUCKNELL UNIVERSITY

At the meeting of the Bucknell University Student Branch on February 5, H. C. Liebensberger gave a very comprehensive talk on The Manufacture of Coke in Southern Virginia. He described the methods employed in taking coal from the mine, giving his hearers an insight into the various operations in coal handling before it is finally taken from the beehive ovens and loaded on cars. Professors Kepple and Burpee, Mem.Am.Soc.M.E., took part in the discussion which followed.

On February 7, Professor Burpee gave an instructive illustrated lecture before the students on The Combustion of Fuel, and Heat Transmission with Special Reference to Steam Boilers.

C. M. KRINER,
Branch Secretary.

COLORADO STATE AGRICULTURAL COLLEGE

The meeting of the Student Branch of the State Agricultural College on January 15 was devoted to an inspection of the new heating plant of the college. Prof. L. D. Crain, Mem.Am.Soc.M.E., discussed in detail the workings of the plant. He called attention to the two Stirling boilers, each of 234 hp. and equipped with automatic stokers, the steel bunkers with capacity of 250 tons, the pumps and receivers, which are to take the return water from the steam-heating system and pump it back to the boilers, the two tunnels leading off to all the buildings on the campus, and the hopper under the railroad track, where coal will be received and conveyed by machinery to the bunkers in the boiler room. He further explained that the boilers, coal-handling machinery, pumps and other equipment were designed so that tests of each part of the plant or the plant as a whole may easily be made by the students of mechanical and electrical engineering.

E. C. JOHNSON,
Branch Chairman.

COLUMBIA UNIVERSITY

The United Engineering Society held a joint meeting with the Mining Society on January 17, when the speakers of the evening were Charles Piez, Mem.Am.Soc.M.E., on The Art of Conveying Materials, J. P. Channing on Human Engineering, and Fred H. Rindge on The Industrial Service Movement of the Y. M. C. A.

J. L. KRETZMER,
Branch Chairman.

JOHNS HOPKINS UNIVERSITY

The first meeting of the Johns Hopkins University Student Branch was held December 15, 1916, and the following officers elected: President, Edward Stewart; vice-president, A. McWolfe; treasurer, N. Owings; and secretary, B. A. Sullivan.

On January 17 the Branch was addressed by J. O. Martin, of the Chesapeake & Potomac Telephone Co., of Baltimore, Md. His subject, The Romance of the Telephone, was exhaustively treated, and the many interesting slides shown gave the students a good insight into past and present telephone work.

B. A. SULLIVAN,
Branch Secretary.

KANSAS STATE AGRICULTURAL COLLEGE

Walter W. Carlson, Mem.Am.Soc.M.E., professor of mechanical engineering and shop practice at the Kansas State Agricultural College, gave an illustrated lecture on The Future Incomes of College Engineers, before the Student Branch of that college on January 18. The curves on the charts displayed, were drawn from data taken from several of the most representative colleges in America, and formulæ were derived whereby a student may roughly foretell his income at any year after graduation. The following table shows the formulæ for the average student: (X equals number of years after graduation).

All Colleges	750 + 170X	Salary	(year)	Max.	in	20	years
K. S. A. C.......	600 + 200X	"	"	"	"	20	"
Trade School...	150 + 125X	"	"	"	"	10	"
Shop Training...	150 + 90X	"	"	"	"	8	"
Laborer	200 + 100X	"	"	"	"	5	"

W. N. CATON,
Branch Secretary.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

The Massachusetts Institute of Technology held their first smoker of the new term on the evening of February 9. The first speaker was R. H. Sawyer, '17. He briefly outlined the process of paper manufacture and described some of the important machinery used in the work. The second speaker was T. K. Corey, of the Wm. Filene Sons Co., Boston, who is in charge of the 2500 employees of the company and was therefore in position to ably handle the subject of Human Engineering. He particularly emphasized the necessity of coöperation between the employer and employee in order to assure satisfaction and contentment on both sides. Mr. Corey kindly extended to the students an invitation to visit the plant to view a few of its mechanical features, which include a complete power station and boiler house, located six floors below the street, a refrigerating plant and a large wireless station.

EDW. W. ROUNDS,
Branch Secretary.

NEW YORK UNIVERSITY

An interesting talk on Water Power Plant Design was given at the February 9 meeting of the Student Branch of New York University by H. M. Garson. An hour of lively discussion followed.

JOSEPH GILMAN,
Branch Secretary.

POLYTECHNIC INSTITUTE OF BROOKLYN

At the February 13 meeting of the Student Branch of the Brooklyn Polytechnic Institute the two speakers were Bronson L. Huestis, Mem.Am.Soc.M.E., and Samuel Stern of the class of '17.

Mr. Huestis' subject was Materials and Manufacture of Mixed Paints. He described in detail the various kinds of pigments and solvents, enumerating their advantages and disadvantages. He said paints containing adulterants, such as clay, whiting, barium sulphate, etc., in their proper proportions, make better paints than the pure substances alone.

A discussion on The Development of the Phonograph was given next by Mr. Stern. He explained the operation of the diaphragm, the construction of the sound-box, the speed regulation of the motor and the different types of motor used.

President Hollis delivered an interesting lecture before 300 students of the Institute on February 14, on the subject of Service to Our Country. He stated that we all ought to be ready to give our service to our country whenever needed. Although there had been no definite call for service, he sincerely believed that if the test should come no man in the United States would be found wanting. Dr. Hollis emphasized the word Service, bringing out the fact that Congress, in discussing compulsory military service laws, laid too much stress on the word *military*, rather than *service*. If our country should be involved in war, fully one-third of the men would do more useful service in the factories than in the Army or Navy.

He stated that in his opinion war would never cease, unless some substitute were found where men could sacrifice themselves for their country, with the same spirit that they do on the battlefield. He really believed that that incentive existed, if we would only look for it. He pointed out the difference between democracy, autocracy and nationalism, defining a democracy as a place where man has permission to develop himself to a maximum efficiency. Democracy was bound to fail unless men could develop them-

selves to that efficiency to which they are forced under nationalism. There is much room for better efficiency in this country, since in no country in the world is there as much waste as in the United States.

In reporting the January 6 meeting it was neglected to state that Mr. Rosenzweig's talk was accompanied by a number of slides showing the poppet-valve engine of his own design. He also gave a description of his return flow and uniflow types as built by the York Mfg. Co., York, Pa.

George Cherr,
Branch Secretary.

PURDUE UNIVERSITY

The Reasons Why Chinese Industries Have Not Progressed, was the subject of the talk T. S. Yue, a senior mechanical student, gave before the Student Branch of Purdue University at their meeting on January 22. The reasons he gave were the retardation of ethical teachings, political oppression, and the social and home bondage. As a remedy for the first two he suggested the republican form of government now existing, and as an aid to the latter the completion of the railroads now contemplated.

The meeting held by the Purdue Branch on February 7 was of an informal nature. Professor Aitkenhead, of the Farm Mechanics' department of the School of Agriculture, initiated those present into the mysteries of the square, the single and double bowline, the catspaw and other useful knots, as well as several types of rope splicing.

W. G. Schutt,
Branch Secretary.

STATE UNIVERSITY OF KENTUCKY

The Student Branch at the State University of Kentucky has held three business meetings during the college year. Several other meetings have been held which have been devoted entirely to the study of technical magazines, each member reporting on the contents of the particular journal assigned to him. In this way a large number of the engineering problems confronting the technical graduate are brought into discussion.

At the meeting on February 8 an interesting discussion of the development of the steel industry was given by Governor A. O. Stanley.

D. S. Springer,
Branch Secretary.

STEVENS INSTITUTE OF TECHNOLOGY

The Stevens Engineering Society, which includes the Student Branch of the Am.Soc.M.E., announces that it will resume its schedule of inspection trips on February 21. Among the trips planned are those to the Shadyside Plant of the Barrett Mfg. Co., Loose Wiles Biscuit Co., Hoboken Factory Terminal and the Nagel Packing House.

Alvin G. Searles,
Branch Secretary.

UNIVERSITY OF CALIFORNIA

The first regular semi-monthly meeting of the Student Branch of the University of California for the second semester was held on January 31. Herman Greenwood tendered his resignation as chairman and W. Kenneth Potts was elected to take his place. At its close, Leroy Hill read a paper discussing at length the theory, practice and use of the various types of aeroplane-motor radiators, describing and illustrating the models and showing by comparison the various proportions and sizes used by different manufacturers.

John H. Fenton,
Branch Secretary.

UNIVERSITY OF COLORADO

Mr. Welch of the Strait Scale Co., Boulder, Colo., gave an interesting illustrated talk on The Construction and Operation of Scales at the January 11 meeting of the Student Branch of the University of Colorado. A large aluminum model, which Mr. Welch brought with him, served to show in detail the fine points of construction and the method of operation of the scale. He claimed that the fundaments of scale operation are the power of ratio, and the perfection of the alignment of the knife edges, and that scale errors depend solely upon the distance between pivots and not on scale ratio.

Wayne S. Beattie,
Branch Secretary.

UNIVERSITY OF ILLINOIS

On the evening of February 8 the Student Branch of the University of Illinois met for the election of officers for the coming semester. The new officers are: President, Ralph M. Overton; vice-president, F. E. Evans; secretary, H. C. Dieserud, and treasurer, W. Minkema. The work of the semester is quite promising, several lectures being already scheduled.

H. C. Dieserud,
Branch Secretary.

UNIVERSITY OF MAINE

The University of Maine Branch held their regular monthly meeting January 17, the subject for discussion being The Farm Tractor. Numerous pictures of the tractor in action were shown by means of a reflectoscope, which testified to its adaptability and usefulness to farmers all over the country. Several interesting designs of the machine were shown, their history given, and salient points discussed.

R. E. Fraser,
Branch Secretary.

UNIVERSITY OF MICHIGAN

Ball Bearings was the subject of the first lecture of the year, given January 16, before the University of Michigan Student Branch by F. M. Sawin. Stereopticon slides illustrated the modern improvements on ball bearings and the process of manufacture from the raw material to the finished product.

The January 18 meeting was devoted to the election of the following officers: chairman, W. A. McKinley; vice-chairman, W. C. Good; secretary, Karl Bintz; treasurer, E. F. Jagodzinski.

Karl Bintz,
Branch Secretary.

UNIVERSITY OF MINNESOTA

The Student Branch of the University of Minnesota held a meeting on January 20 when the following officers were elected: president, Edwin F. Jones, vice-president, L. N. Eustis; corresponding secretary, H. G. Fortune; recording secretary, J. Walfred; treasurer, G. N. Moffet. Following the election, Prof. J. J. Flather, Mem.Am.Soc.M.E., head of the mechanical engineering department of the University, read and discussed the Report of the Boiler Code Committee.

C. Q. Swenson,
Corresponding Secretary.

WORCESTER POLYTECHNIC INSTITUTE

On Friday evening, February 2, the Worcester Polytechnic Student Branch held their regular monthly meeting, Charles M. Allen, Mem.Am.Soc.M.E., and Professor of Hydraulic Engineering at the Institute, giving an interesting illustrated talk on The Testing of Water Wheels After Installation.

As a consulting engineer, Professor Allen had occasion to test many installations of water wheels in hydroelectric plants, and the lantern slides evidenced the work done under the most varying conditions, from that in which the building had been built around the machinery in some backwoods ravine to an installation of the most up-to-date sort, in which the building was provided with spur tracks, traveling cranes and other appliances, making the installation of the dynamometers a comparatively easy matter. He emphasized the facts that water wheels should be tested after installation to show whether or not they were so set as to give their full power and efficiency rating; that all power stations should be provided with the proper cranes and appliances for installing heavy machinery and for future repair purposes.

H. P. Fairfield,
Branch Secretary.

EMPLOYMENT BULLETIN

***THE SECRETARY** considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping any-one desiring engineering services. The Society acts only as a clearing house in these matters.*

POSITIONS AVAILABLE

In forwarding applications, stamps should be enclosed for transmittal to advertisers; applications from non-members should be accompanied by a letter of reference or introduction from a member, such reference letter to be filed with the Society. Copy for notices must be in hand by the 15th of the month.

PARTNERSHIP. Present owner desires capable assistant in running a business which is well established. Investment of $20,000 to $25,000 required, as well as practical working interest in business near Philadelphia engaged in operation on a limited scale for making silica brick. 522

DRAFTSMAN, capable of designing machines of comparatively large size for boring and milling purposes, and fixtures and tools for use on such machines. Location Providence. 525

CHEMICAL ENGINEER who is experienced in aniline-dye manufacturing to become department engineer. Position pays $40-$75 per week, depending upon the man's ability. Name confidential. Location New York State. 530

DRAFTSMAN experienced in factory design and installation of elevator and conveying machinery in general cement-plant work. Location Pennsylvania. 710.

DRAFTSMAN. Prefer man with one or two years' experience out of college. Location Virginia. 747

DESIGNER. Expert mechanical engineer qualified to design machinery for the manufacture of shaving brushes. Location New York. Name confidential. 757

FOREIGN REPRESENTATIVE. New York firm desires a competent man with knowledge of machinery to take charge of machinery business in France; must speak the French language fluently. 758

ENGINEERS wanted to train and develop in the fundamentals of a firm primarily engaged in the distillation of coal tar with the resultant principal production of bituminous road and roofing materials, with the ultimate object of filling operating positions in various plants as foremen, head chemist, assistant superintendents, or superintendents. Chemical engineering training desirable but not essential. As contemplated work will eventually be of an executive nature, ability to handle men is a desirable asset. 796.

DRAFTSMEN, with special experience in the design of chemical plant equipment; familiar with power-plant design, piping layouts, foundation work, light structural-steel work and timber-platform construction. Location Brooklyn. 803.

FOUNDRY MANAGER with capital to invest in gray-iron foundry. Location Northern Ohio. 808.

DRAFTSMAN on elevating and conveying machinery and light structural and plate work. Permanent employment to desirable man, with opportunities for advancement. Salary $125 per month to an experienced man. Location Hudson, N. Y. 809.

ELECTRICAL ENGINEER possessing extensive experience with electrolytic plants for producing oxygen and hydrogen, wanted by New York concern. 811.

CHIEF ENGINEER for large central-station power house in an Atlantic seaboard city. Must be qualified to take charge of an 80,000-kw. plant and experienced in handling Curtiss turbines, jet and surface condensers, Taylor stokers, and other apparatus found in large central-station plants. State age, experience and salary expected. If employed, give name of company and reason for changing. All replies strictly confidential. 813.

ASSISTANT to the head of engineering department of Boston concern. Young technical graduate, mechanical or engineering course. Salary $100 a month; good chance for advancement. 817.

SALES CORRESPONDENT and TRAVELING SALESMAN, two men who know machinery, preferably equipment used either in paper mills or factories working on paper as a raw material such as printers, box makers, bag, envelope or paper-specialty manufacturers. Engineering degree not necessary, but character, ability, energy and clean record are. Salary $1,500 per year after instruction period, increasing with ability. Prefer letter outlining record before interview. Location Brooklyn, New York. 820-821.

OFFICE INSPECTOR to show how to improve work. Experienced in foundry work and machine-shop tool work. Salary according to man, say $2,000 to start. New York location. 822.

CHIEF DRAFTSMAN for large malleable-iron foundry, with pattern, machine, and smith shops and finishing department. Output consists principally of railway specialties. Experience required in charge of drafting-room work, steel freight car construction, both body and trucks, design of special shop equipment such as molding machines, tools, jigs and fixtures, the installation of power-transmission machinery. Prefer a young man who has had experience either with a railroad or a car builder, who is personally quick, accurate and of pleasing address, able to secure results from the men under him. Salary, $150 to $175 per month; prospect good for promotion to the right man. Location New York State. 823.

ENGINEER OF TESTS. Young man of more or less technical training in mechanical engineering, to be of assistance to the engineer in general testing work on boilers, engines and turbines. Salary to start, about $15 per week. Location New York. 824.

DESIGNER and ASSISTANT ENGINEER on power-plant work, both mechanical and electrical side; must have had experience in this line of work. Location New York. 825.

EXECUTIVE to take charge of grab-bucket department of structural-steel plant. 845

TWO SALESMEN or SALES REPRESENTATIVES, 25 to 30 years of age, unmarried, energetic and intelligent. Technical and selling experience, with knowledge of accessory business required, although would consider competent and experienced salesmen without technical training. Position requires ability to sell to jobbers and develop large territory. Salary $45 to $50 per week with traveling expenses. Territory: Middle West and South, and West, respectively. 863

SALES ENGINEERS, technical training, two or more years' practical experience in selling, to coöperate with salesmen in various districts in the U. S. to further the sale of lineshaft roller bearings. Salary $1,200 to $1,800. 864

DRAFTSMAN, technical graduate, mechanical engineer, one or two years' experience in designing power-house installations; water-, steam- and air-piping systems, for large manufacturing concern near Philadelphia. State age, experience to date, references, salary desired, and how soon available. 865

DRAFTSMAN, familiar with marine-engine and boiler work, preferably man with some experience in hull work. State age, salary, experience and references. 869

EXPERIENCED TIME-STUDY MAN, familiar with the production of small interchangeable parts, wanted for manufacturing plant in Philadelphia. Position will lead to one of responsibility. 826.

CHIEF DRAFTSMAN or ASSISTANT ENGINEER to handle primarily steam piping. Salary $175. Location New York. 827.

ASSISTANT ENGINEER, with technical training and a successful record in the operation and maintenance of power plants and factories—also handling of men. Hours at present 7 a.m. to 5:30 p.m. Salary to start, $200 per month. Excellent opportunity for advancement for a man of initiative and energy. Location Brooklyn. 830.

DRAFTSMAN on machine-shop equipment—jigs, tools, etc. State experience and salary expected. Location Canada. 838.

SUPERINTENDENT and **MECHANICAL ENGINEER**. Good opportunity for young man to start with a new, growing concern; one who has experience on conveyors and sawmill and pulp mill machinery. State fully experience and give references. Location Michigan. S42.

SALES ENGINEER for established Detroit concern, manufacturers of boiler accessories. Salary commensurate with experience and ability. Must be thoroughly acquainted with boilers and be able to successfully meet and impress technically trained executives, and capable of closing contracts ranging from $300 to $10,000. Write explicitly, giving experience, minimum salary to start and references. Correspondence confidential. Address E. C. W. 80 First Street, Detroit, Mich. S53.

MECHANICAL DRAFTSMEN for small [illegible] works. Salary $18-$20 and $20-$25. Men that have [illegible] "know how and why." Location Newark, N. J. S55-S56.

DRAFTSMAN to design transmission machinery. Salary $30 per week. Location New York. S57.

ENGINEERING APPRENTICES. Openings for two recent technical graduates, with opportunity for experience in steam turbine manufacture, testing and designing. Salary $15 per week for first nine months. Will also consider 1917 graduates, to begin work in June or July. Location Connecticut. S59.

CHEMICAL ENGINEER for a permanent position in the Philippines. One who has had considerable experience in extracting plants and understands the extraction of oils from cake with trichlorethylene, carbon tetrachloride, naphtha, etc. Must be more or less familiar with the refining of vegetable oils and soap manufacturing. Correspondence will be carried on through New York office. S60.

DRAFTSMAN for machine design and small tool work. Young man with some experience. "Live wire." Salary depends on man. Location New York. S61.

ENGINEER experienced in milling graphite by wet process, to take up construction of new plant. Salary depends on man. Location Alabama. S12.

EFFICIENCY ENGINEER for general efficiency work in car manufacturing plants. In replying state age, experience and salary expected. Probable location, Canada. S70

MECHANICAL ENGINEERS of highest type—especially experienced in steel machinery, designing and building, wanted for newly organized plant; must be able to handle men. Give age, previous experience. Probable location Middle West. S71

MASSACHUSETTS concern wants technically trained man, about 30 years of age, married, who has brains, personality and tact. Write stating full particulars. S72

WORKS ENGINEER. Highly experienced [illegible] power and construction matters in rapidly [illegible] employing 3000. Must be active and tactful and of demonstrated [illegible]. Preference to man with technical training. In first [illegible] salary and complete statement of experience. Location [illegible] West. S77.

CAPABLE MAN, with experience in [illegible] and repair, for position as traveling service inspector [illegible] Wisconsin. S78

MEN AVAILABLE

Only members of the Society are listed in the published notices in this section. Copy for notices should be in hand by the 15th of the month, and the form of the notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

MECHANICAL ENGINEER or **ASSISTANT SUPERINTENDENT**, technical graduate, age 30, married. Seven years' experience in manufacturing plants as draftsman, mechanical engineer and division superintendent and in planning production and time-study work. Ambitious and desirous of locating with Eastern concern offering good opportunity. C-104

PURCHASING AGENT, with several years' experience with large manufacturing concern, where practical mechanical knowledge was applicable. Familiar with stock-room systems, a close buyer and resourceful. Available on reasonable notice; location immaterial. C-105

INDUSTRIAL PLANT ENGINEER, graduate M. E., aged 30, desires position with growing concern as engineer or assistant engineer, depending upon size of plant. Nine years' [illegible] power plant, construction and maintenance [illegible] in purchasing. Successful in handling men and [illegible] correspondent. Location East or South preferred. C-106.

ENGINEER, with twenty-five years' experience in organizing, manufacturing and operating steam, gas and electrical machinery with some of the largest builders. Competent to take charge of entire manufacturing plant. Desires position where new ideas and personal services may lead to an interest in firm. Ohio, Indiana or Western Pennsylvania preferred. C-107

MECHANICAL ENGINEER or **ASSISTANT SUPERINTENDENT**. M. E. graduate, age 31, married. Seven years' experience on automobiles, motor trucks, accessories, production tools, small punch and die work, inspection gages and a large variety of small and medium special and semi-automatic machinery. Capable of directing as well as executing work. Would like to join small or medium-sized growing organization. At present employed as assistant chief engineer. Present salary $2100. C-108

EXECUTIVE or **MECHANICAL ENGINEER** experienced in factory organization and design of special elevating and conveying machinery, tools and jigs. Technical graduate; desires opportunity with reliable firm. Location New York or vicinity. C-109

MECHANICAL ENGINEER desires position in connection with maintenance or production of railway rolling stock and equipment or production of mechanical equipment incident to preparedness for national defense. At present employed. Twenty years' experience in design and construction of industrial and railway mechanical equipment; highly specialized in practical application of applied science, locomotives, cars, trucks, boilers, engines, turbines, tanks and special machinery, shop layouts and power plants, towers and structural work. C-110

MECHANICAL ENGINEER, technically educated, desires to make change. Fifteen years' experience in the designing, estimating and development of steam shovels, dredges, hoisting engines, derricks and miscellaneous machinery, with some steel-foundry and machine-shop practice. Location in Middle West preferred. At present employed. C-111

ASSISTANT SUPERINTENDENT, M. E. graduate, with eight years' shop experience. Familiar with modern methods in quantity production and capable of producing results and handling men. C-112

EMPLOYMENT MANAGER. Technical graduate, with the proper training and experience, age 31, married. Available after May 1. C-113

MECHANICAL ENGINEER, age 37, would consider partnership or interest in engineering business or position on salary or salary and commission basis. Technical graduate, fourteen years' foreign and domestic experience in designing, selling and erecting water turbines, governors, penstocks and accessories and in making preliminary investigations and reports on water-power projects and efficiency tests on existing plants with a view to making improvements. Well grounded in steam and electrical engineering; several months in charge of gasoline-tractor design. Thoroughly practical, with executive ability, and not afraid of work or responsibility. At present employed but desires change. Location preferably East or South. Best references. C-114

MECHANICAL ENGINEER. Technical graduate in mechanical engineering. Desires position with industrial plant as plant or maintenance engineer. At present employed. Several years' experience in drafting, structural work, and as engineer for large explosives company. Preferable location, Middle West. C-115

RESEARCH ENGINEER, PROFESSOR OF MECHANICAL ENGINEERING, EXPERIMENTAL or **WORKS ENGINEER.** An experienced mechanical and civil engineer, now engaged in munition manufacture, is open for engagement. Graduate of leading university, member S. A. E., experienced in teaching and in engineering work of all kinds. Would consider locating in England or France. C-116

CHIEF ENGINEER, who has held the positions of chief engineer, master mechanic and chief draftsman in large industrial plants. Thorough technical and practical experience, covering construction and operation and upkeep of steam and hydraulic power plants. Specialty, steam and fuel economy. Would consider a change from present position. Salary $2400 per year. C-117

ASSISTANT WORKS ENGINEER, college graduate, 6 years' experience; 3 years of arrangement and installation of turbines, boilers

coal-handling equipment, gas producers, heating and lighting systems, 1 year of machine design, and 1 year of building construction. At present employed. Desires permanent location in Philadelphia or vicinity. C-75

POSITION IN PUBLICITY DEPARTMENT of large mechanical or electrical concern or with a publicity engineer wanted by M. I. T. graduate with broad newspaper experience, future the primary consideration. At present employed in an engineering position. Best of references. C-76

MAINTENANCE ENGINEER or MECHANICAL ENGINEER, Junior Member, Columbia M.E., age 25. Thorough shop, power plant and construction experience, design of special machinery, supervising construction and installation. At present employed. Salary $1500. C-77

POWER PLANT ENGINEER, practical in the designing, building and maintenance of power plants in detail. Now employed. Available at short notice. C-78

PARTNER. Graduate mechanical engineer, age 35, having several years' broad and successful experience as factory manager, wishes to correspond with view to handling the factory end for persons intending to organize a manufacturing business. C-79

MECHANICAL ENGINEER, age 22, technical graduate, member A. S. T. M., with drafting-room and some factory experience and knowledge of accounting, desires situation with manufacturing or engineering firm in or near Boston, if possible. At present employed; good reasons for desiring to make change. C-80

WORKS MANAGER, CHIEF ENGINEER OR GENERAL SUPERINTENDENT, desires to locate within a radius of 100 miles from New York City. A 1 systematizer, organizer and production man with excellent executive ability and able to produce results. American, 44 years of age, with 18 years' practical executive experience in the positions of chief draftsman, general superintendent and works manager on light and medium-heavy interchangeable parts as used on typewriters, moving-picture machines, gasoline and electric autotrucks, water meters, linotype machines, automatic machinery and machine tools, etc. C-81

MASTER MECHANIC or CHIEF DRAFTSMAN, with 15 years' experience on automatic machinery. Salary $2600. C-82.

ENGINEERING EXECUTIVE and SALES ENGINEER, aged 31, married. Have organized and managed both machinery and retail sales forces. Shop experience in machine-tool works. Started and developed a successful retail business which has been recently bought. Location preferred New York City or New Jersey. C-83

STOREKEEPER and PLANNING DEPARTMENT MAN, married, ten years' experience. Salary $35 per week. C-84

DESIGNING ENGINEER, age 30, married. Ten years' experience, English and American, in commercial trucks, tractors and motor fire apparatus; exceptional experience on front-wheel-drive trucks. Fully conversant with interchangeable manufacture. Assoc. Mem. A.S.M.E., Inst. Mech. Engineers (London). Minimum salary $2400. C-85.

ASSISTANT to EXECUTIVE or WORKS MANAGER, age 29, married. Technical graduate, six years' experience in industrial engineering design and construction of buildings, installation of machinery, purchase of equipment and handling of men. At present employed, but wishes position in operating work. Best references. Immediate salary subordinate to future prospects. C-86

MECHANICAL ENGINEER, age 32, now mechanical superintendent of one of the largest cotton mills, would like opportunity to prove that he is capable of handling higher position in mill or high class consulting engineer's office. Considers hard work a pleasure. C-87.

STUDENT MEMBER. Will graduate in June in mechanical engineering course of Bucknell University. One year of practical drafting and two years' practical experience in general repair shop. Free to go wherever there is a chance for advancement. References upon application. C-88

MECHANICAL SUPERINTENDENT or CHIEF ENGINEER, graduate in mechanical engineering, age 38. Fifteen years' experience, ten of which were in charge of power generation, construction and maintenance in large industrial plant. Good references from present employer. C-89

SALES ENGINEER, practical machinist, age 31, married. Technical graduate, with experience in drafting room, plant operation and selling. Now holding position where not only first-class salesmanship but also good engineering ability is very essential. Desires change and would be available in 30 days to one who is looking for an aggressive, capable man of integrity who will push a line with merit, preferably on salary and commission, or on straight salary or straight commission basis. C-90

SUPERVISING ENGINEER, age 28. Technical man, hustler, at present with manufacturing drug concern in charge of construction, light, heat, power, sprinklers and plumbing. Desires change for bigger opportunity. Good, varied experience in labor-saving methods, planning factory layouts, buying and maintenance of equipment and power plants. C-91

PRODUCTION or WORKS MANAGER, age 40. Twenty-one years' experience in time keeping, costs, buying, selling, piece work, planning and production. Thoroughly capable in both office and factory organization; competent to assume responsibility and produce results. Minimum salary $2800. C-92

TECHNICAL GRADUATE, age 23, desires position in manufacturing line. Twenty months' practical experience. Good knowledge in design of small electrical machines. Study of power-plant operation and design. Thorough knowledge of internal-combustion motors and automobiles. Salary $100 per month to start. Location preferred New York. C-93

COMPETENT ASSISTANT to EXECUTIVE. Graduate of Mass. Institute of Technology (1910), has made good in a large munition plant. Now employed but wants a change. Can give references. Salary $2500. C-94

WORKS MANAGER, with successful experience in manufacture of interchangeable parts and shrapnel shells. Chicago vicinity preferred though not essential. C-95

SALES ENGINEER. Mechanical engineer, opening sales office in Chicago in near future, wishes to handle power-plant machinery and specialties on salary or commission basis. Familiar through experience in plant engineering and management with conditions to be met in manufacturing and power plants. C-96

PLANT ENGINEER. Competent to lay out electrical and mechanical transmission and power-plant work in general, and to maintain and improve structures and grounds. At present employed directing work. Prefers large industrial concern. C-97

WORKS MANAGER OR GENERAL SUPERINTENDENT. Production engineer, successful executive; experienced in revising plant management and in the introduction of modern systems. Technical graduate, 20 years' experience in positions from foreman to manager of works employing several hundred men, covering manufacture of machine tools, internal-combustion and steam engines, electrical machinery and construction of works. Available in about 60 days. C-98

EXECUTIVE ENGINEER. Graduate in mechanical engineering, 1907, with exceptional training in mechanical and electrical fields as executive and engineer in construction, sales and accounting work. A consequential thinker, with energy, initiative and aggressiveness. Can consider a proposition where intelligence and ability to "cash in" ten years of hard-earned and valuable experience will bring results. C-99

PARTNERSHIP. Mechanical engineer desires partnership in consulting engineering or contracting firm doing business with industrial concerns. Will make investment. Specialties: power-plant design, construction and operation; industrial plant layout; design of special machinery. Familiar with brass and copper mill practice. C-100

MECHANICAL ENGINEER. Technical graduate, with six years' experience in the design and manufacture of and experimental work on valves, lubricators and general brass goods. At present head draftsman. Systematic and reliable, possessing originality and initiative. Desires position with a responsible future. C-101

ASSISTANT SUPERINTENDENT or EXECUTIVE. American, age 36. Technical education, twelve years in drafting room, including position as chief draftsman; six years' shop experience, one as foreman of shop. Practical mechanic, familiar with the design of special machinery, tools, jigs, fixtures, etc., for manufacturing duplicate parts on the interchangeable system. Salary $2000 per annum. Location preferred New York or vicinity. C-102

ASSISTANT to MANUFACTURING EXECUTIVE, technical graduate, age 31. Familiar with manufacturing practice, production, construction and handling men. Good knowledge of purchasing. Desires position with future. C-103

ENGINEERING SURVEY

A Review of Engineering Publications in All Languages. All the leading periodicals of the engineering world, embracing over 1000 different publications, are received at the Library. These are systematically examined for review each month in the Survey.

SUBJECTS OF ABSTRACTS

ARRANGED IN THE ORDER OF THEIR APPEARANCE IN THE SURVEY

In the past month in the Grand Central Palace, New York City, two expositions were held which were closely related in many respects. The first was the Motor Boat Show and the second, the first Pan-American Aeronautic Exposition. Both bore in the first place testimony to the triumph of internal-combustion engineering and in particular to the development of the explosion engine. Both showed that some of the problems of this comparatively new branch of engineering may be considered as having been solved satisfactorily. Such are the problems of ignition, lubrication and water cooling. The question of air-cooling design appears to be still under a cloud of doubt. The problem of fuel is fully solved in so far as gasolines are concerned, but when we come to kerosenes there is still a wide field open for further research and invention. It appears, however, from a paper read at the last annual meeting of the S.A.E., that even here a large amount of success has been achieved; there are several designs of kerosene carburetors practically available which can efficiently handle the heavier fuels (as compared with the gasolines), and the most important problem now before the designer of a kerosene-burning engine is not the carburetor but the combustion chamber.

As regards the Aeronautic Show, the most striking feature of it to those who have closely followed the vicissitudes of the early days of heavier-than-air-machine building are the truly tremendous strides made in the last two years. To the aeronautical industry the war has certainly been a big opportunity. No precise data are of course available as to the number of machines used by the belligerent countries, but Captain Clarke, U.S.A., at a recent meeting of the S.A.E., gave those present to understand that the French alone have not less than 20,000 planes. From various sources one can glean that the number of British machines is at least as large, which would mean that the two great allied nations alone have something like 40,000 machines, representing an establishment worth, with its shops and auxiliaries, not less than the stupendous sum of $500,000,000; all of this spent in something like twenty-four months. There certainly never has been an instance where a new industry, less than ten years old, has been given such an opportunity. How fully it has made use of it can be determined only after an investigation of what has been done in Europe, which is unfortunately impossible at the present time.

THIS MONTH'S ARTICLES

In the section Air Engineering is described a fan capable of separating water and dust from the air by a process similar to that of centrifugation.

In the same section is abstracted a university thesis on the flow of air through nozzles and orifices. Particular attention is called to this work, as it contains English translations of the most important investigations on this subject for the last century. Unfortunately, some of the formulæ are printed in such a manner as to make their meaning doubtful.

Under Automobiles is described a British farm tractor employing broad-treaded rollers instead of the usual driving wheels. In the same section is described a unique system of spring lubrication.

From a British publication is abstracted the description of a belt-conveyor coal-loading plant having several unusual features of design.

F. N. Speller, in a paper before The American Society of Heating and Ventilating Engineers, describes an experimental plant installed for testing a method of elimination of corrosion in hot-water-supply pipe by fixation of oxygen in water before the water is admitted to the pipes.

J. O. Ross, in a paper before the same society, discusses the fundamental principles underlying the design of driers and the fields of service of various types of this class of machinery.

Results of an experimental investigation of the brittleness produced in steel springs by electroplating are presented in the section Engineering Materials. While no explanation of this brittleness has been found, the results are of a certain practical interest.

Cast iron for engine cylinders is the subject of a paper by J. Edgar Hurst before the Manchester Association of Engineers. The paper presents interesting material on the subject of the growth of alloys.

Formulæ on measuring gases by a standard orifice are reported in a composite abstract of papers by Prof. Thomas G. Estep and H. G. Geissinger.

The somewhat unexpected fact that gas-heated rivets remained hot longer than those oil-heated is brought forward in the *Bulletin of the Southern Gas Association.*

From *The Engineer* (London) is taken a description of a high-lift centrifugal pump, of interest particularly because of the automatic hydraulic balancing arrangement used.

Data on comparative costs of steam and electric operation of hydraulic-elevator pumps are abstracted from an article in the *Electrical Review and Western Electrician.*

A description of an experimental refrigerator car of the Pennsylvania Railroad, combining features of passenger- and freight-car construction, will be found in the section Railroad Engineering.

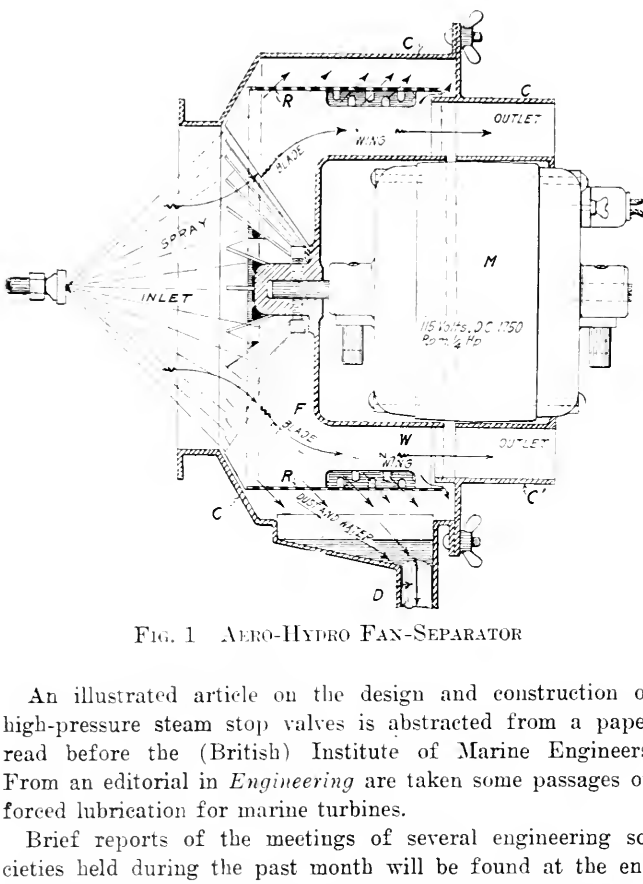


FIG. 1 AERO-HYDRO FAN-SEPARATOR

An illustrated article on the design and construction of high-pressure steam stop valves is abstracted from a paper read before the (British) Institute of Marine Engineers. From an editorial in *Engineering* are taken some passages on forced lubrication for marine turbines.

Brief reports of the meetings of several engineering societies held during the past month will be found at the end of the Survey, as well as more complete accounts of the Motor Boat Show and Pan-American Aeronautic Exposition.

Air Machinery

AERO-HYDRO FAN-SEPARATOR, Wm. J. Baldwin

Description of an improved fan capable of separating water or watery matter or dust from the air. The apparatus dealt with in the article is designed for a hospital ship and is located in a deadlight. The diameter of the hole in the ship's side, which is the inlet, is 8½ in., and the greatest diameter of the apparatus over its flanges is 14 in. Its capacity is 35,000 cu. ft. of air per hour and it permits of keeping the portholes open even in rainy or bad weather.

In Fig. 1, which is a longitudinal section through the apparatus, C and C' represent the stationary case and F the fan revolving within the case. The motor M is fastened to the outlet port of the case C, and the shaft carries the fan F and the rotor R with the wings W. The revolving part is made of aluminum and weighs 7 lb. The plates of the fan are radial and straight so that the apparatus can be run in either direction, any way the current happens to be applied.

When water or spray enters the inlet it strikes the blades of the fan, and, being heavier than the air, goes off almost perpendicularly to the axis of rotation, striking the rotor and being thrown through it about as indicated by the straight arrows. In this way the water escapes at the pipe D and runs outward through a small piece of flexible hose to the deck of the ship or overboard. The air follows the direction of the feathered arrows. It has been found that with the finest spray nozzles that can be obtained the hygrometric condition at the outlet of the cabin end of the apparatus is from 45 to 50 per cent of saturation, and the peculiarity of the apparatus is that even in fog the water will seize on the fog and carry it with it through the rotor, the air escaping into the cabin still showing about 50 per cent of saturation.

The author enumerates many uses for the apparatus described, especially in the field of dust separation. Among these he describes experiments with high-temperature-furnace fumes in a plant where, after the detinning process is completed, the old cans are made into sash weights. By means of the separator they have succeeded in recovering the dust and gases from the top of the cupola, with temperatures probably above 1200 deg., and have taken the tin, lead, zinc, etc., from the gases by the use of the wet process, throwing them into a tank as a mud. This example is cited to show that fumes from gases and metals can be treated at very high temperatures. (*Journal of the American Society of Heating and Ventilating Engineers,* vol. 23, no. 2, January 1917, pp. 209-215, 6 figs, *de*)

THE FLOW OF AIR THROUGH NOZZLES AND ORIFICES, J. Lynn Reynolds and Homer J. Ling

Historical review of the development of the theory of flow of air through orifices, comprising a number of translations and abstractions of various writers of the nineteenth and present centuries, beginning with Koch, Buff, and Saint Venant and ending with Captain Morley, thus bringing the review down to within a year of the present day.

The second part of the work is devoted to a discussion of the design of needle nozzles. .

As regards the general theory of flow of air through orifices and nozzles with special regard to problems of measurement, the writers believe that the main reason why the nozzle-and-orifice method for measuring the discharge of air has been discredited is due to the ambiguous presentation of data by different experimenters, which led to the use of improper coefficients with the given orifices or nozzles in cases where, if proper coefficients were used, the results would have been satisfactory. Further, the actual discharge of air through a given nozzle or orifice is less than the theoretical discharge under identical conditions of pressure and temperature. This is due to the fact that as a general rule the stream of air has a smaller cross-section than that of the orifice itself. Also, because of internal and external frictions, the effective velocity of flow is less than the theoretical value. With the thin-edge orifices the coefficient of velocity is practically unity, that is,

the orifice is considered to be frictionless; in which case the coefficient of discharge may be considered equal to the coefficient of contraction.

When these two factors, *vena contracta* and diminished velocity, are taken into account, it necessarily follows that the measured discharge is a smaller quantity than the value given by the theoretical formula. The writers note that if a = coefficient of contraction, and b = coefficient of velocity, then ab = coefficient of discharge.

As to the factors that influence the quantity of flow through an orifice, the following are listed as the most important:

1 Initial pressure of air supply, and in some cases the ratio of the back to the initial pressure.

2 The shape of the orifice, whether it is cylindrical, conical, of convergent or divergent type, or a combination of the two. The length, or rather the ratio of diameter to length, or if an orifice in a thin plate, whether it is bevel- or straight-edged.

3 The condition of the interior surface—smoothness. And also whether the entrance is well rounded and free from sharp breaks in outline of the nozzle curve.

It appears that the coefficient increases with the initial pressure and also with the ratio of back to initial pressure, and that a short orifice with well-rounded approaches will give a coefficient of discharge of approximately 0.98.

Another important factor brought out is that since the time of Zeuner and Fliegner's experiments it has been well established that when the ratio of the final pressure P_2 to the initial pressure P_1 has a value of 0.527, the discharge is a maximum: and for all values $P_2 < 0.527\ P_1$ the discharge remains a constant maximum value. It is well to note, though, that in the case of orifices in thin plates, W (see notation below) appears to keep on increasing after the pressure becomes lower than 0.527 P_1, although the increment of increase has a decreasing value as zero is approached and is very much less than the increment from P_1 to the critical pressure.

Now if

W=weight of air discharged per sec.

A=throat area of orifice in sq. ft.

P_1, P = pressures inside and outside orifice in lb. per sq. ft.

n = ratio of specific heats = 1.404

T = absolute temperature at P

V = volume in cu. ft. at P

the weight of gas discharged in unit time for frictionless adiabatic flow is

When $T = 460 \quad 60$

$n = 1.404$

$$r = \frac{P_2}{P_1}$$

P = pounds per square inch.

$$W = 0.07058\ d^2\ P_1\ n \sqrt{r^{1.425} - r^{1.712}}$$

and the best values of the discharge coefficients as shown by this review are as follows:

For Orifices in Thin Plates (Straight-Edged):

Low pressures (1-12 in. water) . . . . $\mu = 0.60$

Medium pressures (15-50 lb.) . . . . $\mu = 0.63$

High pressures (50-150 lb.) . . . . $\mu = 0.65$

For Nozzles:

Short cylindrical . . . . $\mu = 0.75$

Short, well rounded, convergent . . . . $\mu = 0.98$

Convergent 6°-10° . . . . $\mu = 0.90$

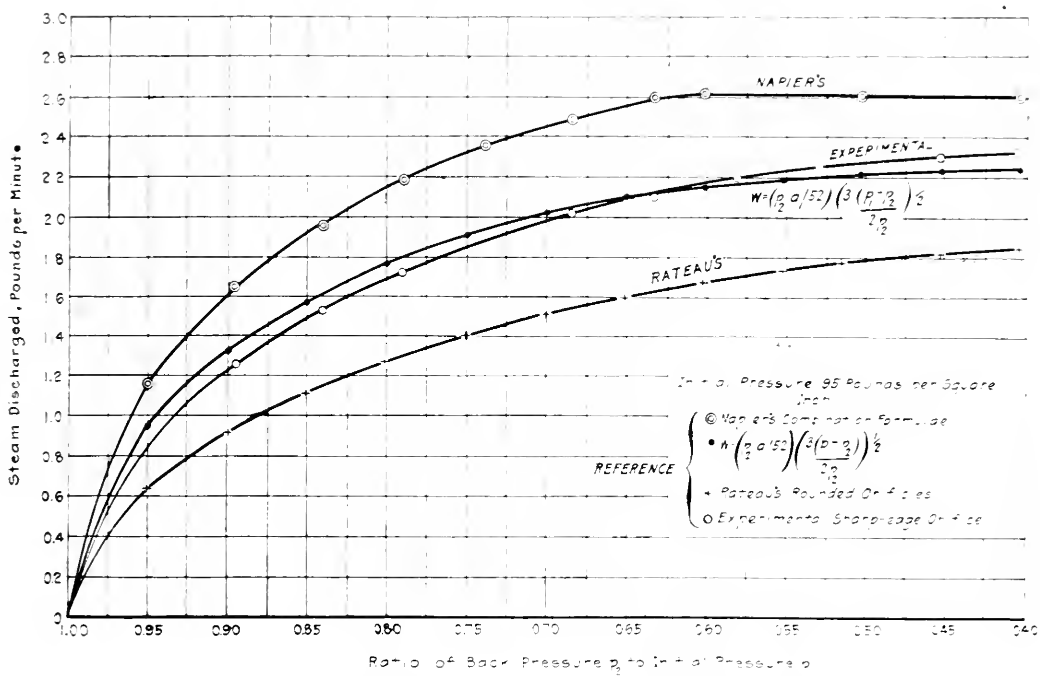


Fig. 2 Comparison of Formulae for Flow of Steam through Orifices

As regards the investigation on needle nozzles, the writers had before them the problem of designing a needle-nozzle control of air discharge from a turbo-compressor set that would meet the following requirements:

1 To deliver 30 hp. at 3400 r.p.m., that is, 2500 cu. ft. of air at 60 deg. fahr. and 14.7 lb. barometric pressure, having a delivery pressure of 2 lb.

2 Of such shape of needle that the issuing core stream from the nozzle could in any position of the former be explored as to cross-section, velocity, and pressure conditions existing in it.

Thus the problem resolved itself into two divisions, the design of the nozzle proper and the design of the needle. An

adiabatic formula for frictionless flow was adopted as the basis of design.

The needle was designed by using a combination of curves that would give in outline one similar to the present water nozzle needles and of such shape as to offer small resistance to flow. It soon appeared, however, that while this would satisfy conditions for full load, in going from this output to no output the needle would be so located that the velocity from initial to final point would have a decreasing increment at most positions. This was due to the fact that the area between the nozzle and the needle at the inlet was less than the net area of the outlet. Thus it became necessary to adopt a design which in any position of the needle would give such a succession of areas between the nozzle and the needle from the entrance to the outlet, that the velocity would have an increasing increment in traveling this distance and that as nearly as possible the flow would approach the frictionless adiabatic as an ideal.

The following plan was followed: The nozzle was designed for full load, and then a series of areas determined that would give $^3/_4$, $^1/_2$, and $^1/_4$ loads, respectively. The next step was to so lay out the needle that at these different positions the effective area—the difference between the nozzle's and the needle's areas—would be a series that would fulfill the flow and load requirements for that position. This was done by shifting

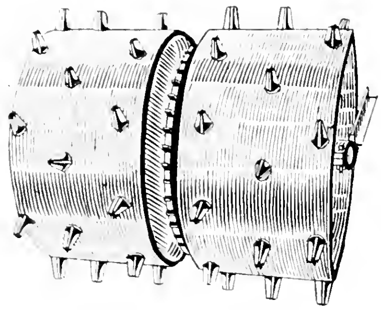


Fig. 3 The Rear Wheels of the Whiting-Standard Tractor

along a vertical axis the superimposed curves (different curves) and then drawing an averaging curve through them.

The area to be obstructed by the needle at different loads is the annular area between the full-load adiabatic and the adiabatic for the given load. The needle difference curves are plotted by radii, which radii are the radii of circles whose areas are those of the annular rings.

From the first part of this report one of the main conclusions of the investigation in regard to the flow of air through orifices was to the effect that a well-rounded short nozzle had as the highest coefficient of discharge the value of 0.98. Therefore a short nozzle designed by the adiabatic formula, following this type and using a needle whose shape was determined as previously stated, may be expected to have a high degree of flow efficiency. This remains for experimental determination.

In connection with the above investigation, a series of tests was run to determine by actual measurement the rate of discharge of steam through a sharp-edged orifice 0.203 in. in diameter and in a 0.125-in.-thick brass plate.

In the computation of the rate of discharge, the authors used Grashof's formula. The results of the tests are shown in Fig. 2, where the curve obtained in the present experiments is compared with those of Napier and Rateau. (*Thesis presented to the Department of Mechanical Engineering, Leland Stanford Jr. University*, 1916, *et*)

Automobiles

Whiting-Standard Farm Tractor

The essential feature of this tractor is the employment, instead of the usual driving wheels, of two broad-treaded rollers (3 ft. 9 in. diameter) which together make up considerably more than 4 ft. There is no differential on the shaft to which both rollers are keyed (Fig. 3) and by which both are driven. The drive is effected through a single strong chain from a simple form of gearing, with one speed forward and one backward.

With such an arrangement it would be very undesirable to have one roller on the land and the other in the furrow, and therefore when plowing the plow is hitched on so as to come well to the side.

The two front wheels are quite close together. In the steering gear a small bevel pinion on the end of the steering column turns the bevel pinion mounted on a vertical shaft. In addition to this another small bevel pinion mounted on the same vertical shaft as the bevel wheel is in mesh with a large-radius tooth quadrant keyed to the central column which forms the pivot upon which the short front axle turns. This multiplies the mechanical advantage of the bevel several times. With this gear the machine can be turned in a circle of 30 ft. diameter; in other words, on a 15 ft. headland. (*Motor Traction*, vol. 24, no. 620, January 17, 1917, pp. 41-42, 4 figs., *d*)

Truck-Spring Lubrication

The Fageol truck, made by the Fageol Motor Company of Oakland, Cal., has a unique system of spring lubrication, shown in Fig. 4. The upper view shows the support for the rear end of the front spring. The frame bracket is hollow and can be filled with oil. A wick leads from the reservoir to the center of the upper shackle bolt. This is drilled out and bored with a cross-hole, allowing the oil to pass to the left-hand end, whence it goes down through a hole in the side of the shackle to the lower bolt, which is also drilled to carry the lubrication to the middle of the bushings.

The lower view shows the suspension for the front end of the rear springs, the section being a projection on the center line of the filler cap. At the bottom is the rear-end hanger for the rear spring, in which the wick lifts the oil from the reservoir to the upper bolt.

It is not stated how often the oil is to be replenished in the reservoirs, but this operation would not have to be performed except at fairly long intervals. (*The Automobile*, vol. 36, no 3, January 18, 1917, p. 185 illustr. *d*)

Conveying Machinery

Belt-Conveyor Coal-Loading Plant in New South Wales.

Description of a large belt-conveyor coal-loading plant recently erected at Port Kembla, N. S. W., under the direction of the Department of Public Works of New South Wales.

The port of Kembla was designed to accommodate ocean-going ships. On the completion of the port the breakwaters will include an area of 335 acres, with an entrance 1000 ft. wide. The depth of water at the entrance will be 49 ft. and on the coaling jetty 25 to 34 ft. at low water. The distance

from the railway along which the coal arrives to the 25-ft. low-water-depth line is 355 ft., and it was decided to build a jetty at right angles to the shore and equip it with a belt-conveying plant.

Siding accommodation is provided at the shore end of the jetty for 500 trucks. The full cars approach the shore end of the jetty on an incline of 1 in 120, and when empty proceed via the remainder of the loop to the empty sidings. Although the feeding loop as it approaches the jetty is on an incline, it is found advisable to have the trucks coupled and controlled by a shunting engine when unloading, as by this method the trucks are more readily handled than if gravitated, owing to the time lost in stopping and starting. At the point of intersection of the feeder lines and jetty, and under the former, is

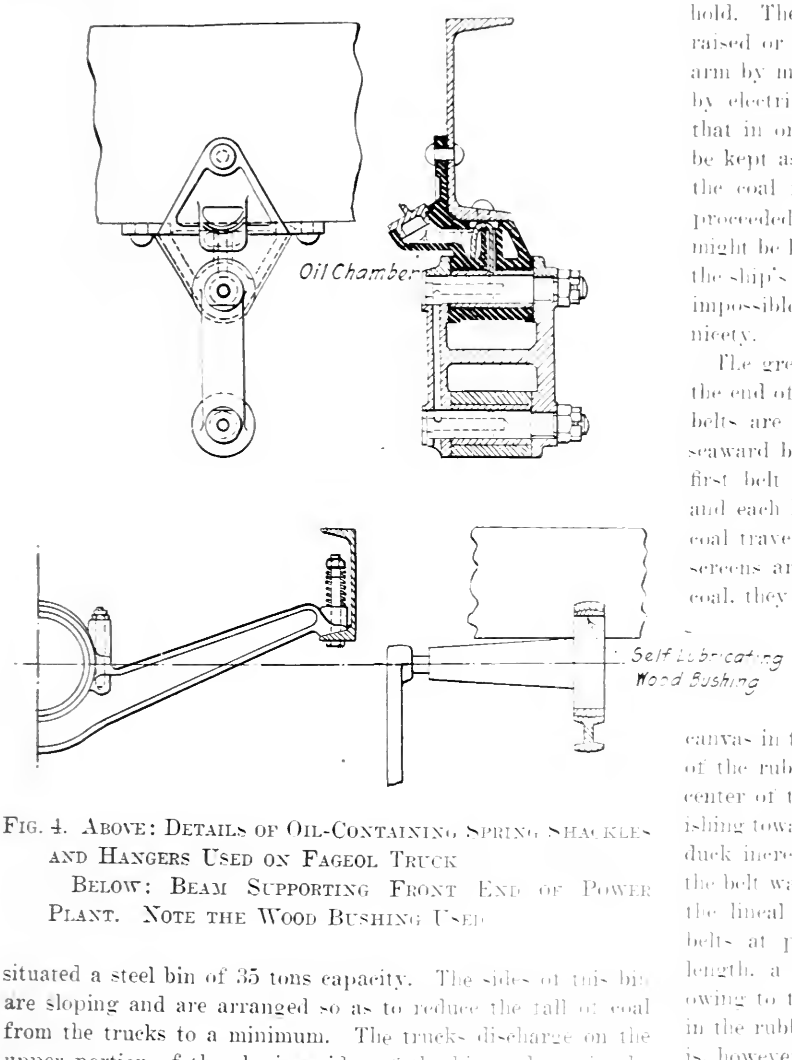


Fig. 4. Above: Details of Oil-Containing Spring Shackles and Hangers Used on Fageol Truck
Below: Beam Supporting Front End of Power Plant. Note the Wood Bushing Used

situated a steel bin of 35 tons capacity. The sides of this bin are sloping and are arranged so as to reduce the fall of coal from the trucks to a minimum. The trucks discharge on the upper portion of the sloping sides of the bin and not in the center, which minimizes the free drop of the coal and consequent breakage.

Because of lack of space, only the more unusual features of the design will be here reported.

The deck of the jetty is 8 ft. above high water of spring tides. The main conveyor belt is carried 3 ft. above the deck level of the jetty for 480 ft. from the shore, and at 580 ft. a driving station is constructed and the first section of belting ends. From this point the belt rises on a gradient of 1 in 5.5 on a light structure for a distance of 105 ft., and is continued on that level 22 ft. above the deck to the end of the jetty. While the jetty itself is of substantial construction, the framework carrying the main belts is of far lighter construction than would be necessary if trucks and locomotives were to be carried, and the gradients are much steeper than would have been practicable for loaded trucks. The fact that the coal can be lifted to the necessary elevation on this comparatively light structure is an important point in favor of economy in first cost of the plant as compared with an ordinary high level jetty designed to carry trucks and locomotives. The further fact that the shore end of the jetty for a length of 531 ft. is only 18 ft. in width is also an economical feature in its construction, as, were it necessary to handle trucks on the jetty, a wider construction would have been necessary throughout. Each of the traveling arms is equipped with a conveyor belt which discharges the coal into a rectangular chute 3 ft. x 3 ft. x 34 ft. long, hung vertically between jaw ends at the end of the arm. Through this chute or loader the coal descends into the ship's hold. The loader has lateral play, and in addition can also be raised or lowered independently of the position of the loader arm by means of side pulleys moving in guides and operated by electric motor. The original intention in the design was that in order to minimize breakage of coal the loader should be kept as low as possible, indeed, practically in contact with the coal in the vessel, and be slowly raised as the loading proceeded. It was thought that in this manner the chute might be kept practically full of coal and actual dropping into the ship's hold be obviated. In practice, however, it was found impossible to regulate the operation of the chute with such nicety.

The great length (1400 ft.) from the flight-conveyor pit to the end of the jetty precluded the use of a single belt, and two belts are used. The short belt is 698 ft. in length, and the seaward belt 722 ft. between centers of tension pulleys. The first belt discharges onto the second over a gridiron chute, and each belt is operated at the forward or seaward end, the coal traveling toward the operating pulley. Although timber screens are provided on each side of the belt to protect the coal, they are not close enough to the belt to act as guides to keep the coal in place, nor are any such guides necessary, the troughing of the belt sufficing for that purpose.

The belts are 36 in. in width, with four-ply duck canvas in the center and seven-ply at the edges. The thickness of the rubber coating is $\frac{1}{16}$ in. on the back and $\frac{3}{16}$ in. in the center of the working face, the thickness of the rubber diminishing toward the edges of the belt as the number of the plies of duck increases. The canvas duck used in the manufacture of the belt was specified to withstand a tensile stress of 400 lb. on the lineal inch after vulcanizing. Each of the four rubber belts at present in use was manufactured in a continuous length, a course which was thought advisable at the time owing to the great difficulty of providing a satisfactory joint in the rubber belting. Mr. de Burgh, who designed the works, is, however, satisfied that this construction is not to be recommended. The task of getting the long belts into place, which necessitated the unshipping of the idlers and pulleys, was a very serious one, and the danger of a complete and prolonged interruption of the working of the plant following an accident to a portion of the belt is so great as to make it most desirable that jointed belts should be used. However, one of the loading-arm belts needing repairs has been cut out and a new belt jointed with so-called alligator steel clips has been introduced. If it proves satisfactory the like can be used in the main belts if required.

These rubber belts have been in operation since April 1915, and had up till the beginning of September last loaded 231,514 tons of coal and 47,635 tons of coke, and their condi-

tion was then excellent. Not only were immense lumps of coal delivered from the collieries, but pieces of broken machinery and even sleepers with dog spikes protruding from them came through the chutes. No serious damage, however, resulted from these causes, and, while small abrasions of the surface of the belt occurred, it has not yet been necessary to cut out a length of the main belt. To make surface repairs cheaply and rapidly, a small portable vulcanizing plant has been provided.

The conveyor belts are operated at a speed of 360 ft. per min. This speed may be increased to 500 ft. per min. by a simple alteration of the gearing, but it has been found that the speed of the plant was sufficient, particularly as the speed of coaling is controlled by the trimming time of the vessels. In the case of one vessel, S. S. *Winfield*, 5420 tons were loaded in a total working time of 27 hr. 40 min., giving a loading speed of 196 tons per hour. The actual working time of the conveyor was, however, 11 hr. 32 min., or 58 per cent of the total time, and the quantity of coal loaded per hour of running time was 467 tons. While loading this vessel, 178 cars containing approximately 10 tons each were discharged, sent on to the empty roads, and the contents loaded in 182 min. running time. Further, during an uninterrupted run of one hour with a single chute discharging into one hatch, 500 tons were loaded, and in a similar run of one hour with two chutes working into two hatches, 647 tons were loaded, which is a very high rate for loading.

The whole plant is electrically operated. The total cost of the Port Kembla jetty coal-loading machinery and power house, including the concrete foundations of the latter, also of flight-conveyor pit and in the belt subways, but excluding all railway lines in approach, may be taken at £83,000. (Paper read by E. M. de Burgh before the *Northern Engineering Society of New South Wales*, September 13, 1916, abstracted from a report in *The Engineer*, vol. 123, no. 3184, January 5, 1917, pp. 5-8, 5 figs. *d*)

Corrosion

A Method for Practical Elimination of Corrosion in Hot-Water-Supply Pipe, F. N. Speller

Discussion of a method for " fixation " of oxygen and carbon dioxide in water previous to the latter entering the pipes, and description of two experimental plants and of results obtained.

Two methods may be used for removing from water gases producing corrosion. One is, reducing the pressure of the heated water, and the other, keeping the hot water in contact with a large surface of iron under pressure for a sufficient length of time to remove and fix the oxygen and carbon dioxide. The latter method has been in use at two plants during the past year: the research laboratory and hospital building of the National Tube Company, McKeesport, Pa., and the Irene Kaufmann Settlement, Pittsburgh, Pa. It is claimed that both installations have demonstrated that the corrosion of iron or steel pipe can be arrested and practically eliminated by this process.

The Irene Kaufmann Settlement was built in 1910, using wrought iron and steel pipe for the hot- and cold-water lines with storage tanks and gas heaters. All the hot-water piping was showing signs of serious corrosion by 1915 and a number of pieces had to be replaced with brass pipe. Every week or two replacements and repairs had to be made, which constituted a source of serious inconvenience.

The experimental plant which was put into use in December, 1915, consisted of a storage tank filled with alternate pieces of corrugated and plain steel sheets No. 26 gage, arranged radially around the filter. The water was heated by a heater with a capacity of 3 gal. per min., and passed downward between these plates, being thereby deoxidized to a large extent. The water then flowed upwards through pipes to the top of the filter and downwards again through the filter and finally up through the central pipe to the system.

It is of course necessary before use to filter the fine rust out of water so treated, and it is also necessary that the filter be so designed in connection with the heater as to be kept hot when no water is being drawn. An illustration shows the course of the water circulating between the heater and storage tank, and the arrangement by means of which the temperature of the filter is maintained the same as that of the water in the storage.

For use as deoxidizers disks of Cambridge metal lath were placed. Strips of this or other suitable form of sheet iron may be used provided they are spaced so as to fill the chamber and yet leave a cellular structure with openings not over $1/4$ or $3/8$ in. through which the water can freely circulate. Steel turnings cannot be used because they get packed tight after a while. Rust occupies a space several times that of metallic iron and this must be provided for.

The average oxygen content of the water at the Irene Kaufmann Settlement before treatment was about 8 cc. per liter, and after treatment 0.5 cc. per liter. Since the treatment was installed, for nearly a year there has been no trouble with the old piping, even though it was in very bad shape at the time of the installation of the new plant.

Numerous corrosion tests were run by the Pittsburgh Testing Laboratory. Among other things it was found that there is no practical difference between the best grades of so-called " genuine " wrought-iron and steel pipe under the conditions of the test. These experiments also indicated that the water which had been in contact with the plates in the deoxidizer still carried considerable gas in solution, but this gas consisted mainly of hydrogen and nitrogen; in fact, the hydrogen frequently ran as high as 20 per cent.

From gas analyses and oxygen determinations made from time to time, it has been found that the rate of removal of oxygen has not diminished with length of service. Plates which were removed from the McKeesport plant after eight months' service had a thick layer of rust over the surface, but the efficiency of the tank was even greater after use. (*Journal of the American Society of Heating and Ventilating Engineers*, vol. 23, no. 9, January 1917, pp. 149-160, 6 figs. *e*)

Drying

Drying in Industrial Plants, J. O. Ross

Discussion of the fundamental principles underlying the design of drying systems.

It is generally true that as much drying out of the water should be done mechanically as is possible, by such means as pressing the material or by removing the water in centrifugals, as mechanical drying is cheaper than drying by heat. On material which would not be retained by the shell of a centrifugal, or which is not adaptable to the filter press, mechanical drying may be done in the settling tank. This system is in general use in the starch industry in Europe. The solid matter is allowed to settle to the bottom, and the water removed from the tank. In this way sludge forms on the bottom

containing about 50 to 60 per cent water, which is afterwards completely dried out in the heat driers.

As regards artificial drying, the simplest type is the one using direct application of heat, such as evaporating kettles to heat the material and vaporize the water. The next consists in placing the material in a heated room and allowing it to dry as best it may.

The design of driers is most essentially affected by the consideration of whether the drier should handle the material continuously or in batches. A progressive drier in which material moves gradually or continuously either on trucks or conveyors offers many advantages in cost of labor and economy of heat, as is well exemplified in the tunnel method of drying bricks. In addition to its economy, however, this method presents several other advantages. The wet "green" brick encounters only air which is comparatively cool and moist and it does not receive a harsh, quick surface drying which is so injurious. Another advantage is that each cubic foot of air is in intimate contact with the material throughout the entire length of the tunnel and picks up much more water than if it merely struck it and bounced off into space as it ordinarily would in a room drier.

There are, however, many cases when a progressive drier has drawbacks. This happens,

1 When the material comes from the machine in batches:
2 When the variety of the material differs widely in drying requirements;
3 When the material requires different treatment than a gradual increase in temperature and decrease in humidity of the air.

As regards the third condition, its importance grows as more study is given to the drying problem from the standpoint of quality of material.

As regards "apartment" driers, one of the main troubles connected with their operation can be overcome by decreasing the capacity of the compartments and increasing their number. The greater the number of compartments, the more nearly does an apartment drier approach the efficiency of a progressive drier. In lumber mills making products varying from 1 in. thick to 4 in. thick, an apartment drier presents many advantages, even if it is necessary to put the different thicknesses of material in the same compartment.

As a general rule, material which dries fast is more adaptable to a progressive drier than a material which dries slowly. Indeed, in extreme cases where the material requires a long drying, it would be found that a progressive system would travel so slowly as to be troublesome.

The entire efficiency of the drier usually depends on how intimate the contact is between the air and the material. From this point of view, a progressive drier is probably several times as efficient as drying in a room by simply blowing in warm air.

A very common type of drier of the simple order is the so-called bed or screen type. This usually consists of a horizontal screen on which loose material is thrown. Air is applied under pressure to the under side of the screen and forced up through the material, which usually means a very intimate contact and a very high efficiency. This method is applied to the drying of grain, scrap rubber, wool, cotton, and similar materials.

The cylindrical drier gives a very intimate contact between the drying medium and the material to be dried. In the more common type this consists of a round cylinder, usually on an incline. The material is fed in at one end and as the cylinder revolves the material is thrown around in such a way that it presents a large amount of surface to the warm air which passes through the cylinder. Baffles and paddles are placed inside so as to aid in this throwing, and the incline should be made such that the material will travel at a fixed rate of speed through the cylinder.

In general, in designing a drying system, considerable study should be given to the material and the drier designed in such a way that the warm air will come into the most intimate contact possible with the material. It should be borne in mind that there is a certain limit to the speed of drying of all material, and this limit should be determined. The writer has known materials that would dry in 40 hours in a very crude drier, but, even when placed in a first-class drier, would not dry in less than 36 hours. This is the big problem that an engineer encounters on a drying proposition—as to how long he may expect it to take to dry, as this determines the highest speed possible in the movement of the material. (*Journal of the American Society of Heating and Ventilating Engineers*, vol. 23, no. 2, January 1917, pp. 201-207, *g*)

Engineering Materials

An Investigation of the Brittleness Produced in Steel Springs by Electroplating, M. DeKay Thompson and C. N. Richardson

Several years ago Dr. W. H. Whitney called attention to the fact that small steel springs become brittle when plated in a copper-cyanide bath. The writer undertook to find the cause of this deterioration and to establish under what conditions it does and does not occur.

While no explanation of the brittleness produced in a spring wire when used as a cathode in a hot cyanide solution could be found, results of considerable interest were, nevertheless, obtained. These results are summarized by the authors as follows:

1 Spring steel becomes britfle when used as cathode in a hot cyanide solution, either sodium cuprocyanide or simply sodium cyanide. The effect is more pronounced with the simple salt. Brass and phosphor bronze are not affected.

2 Brittleness was not produced by the liberation of hydrogen on the steel.

3 The carbon content is not changed by electrolysis.

4 The crystalline structure is not changed by electrolysis.

5 The brittleness is not produced in annealed wire.

6 The brittleness is produced by use as cathode whether the wire is coiled or not bent in any way.

7 The brittleness is not produced when the wire is used as anode or when it is suspended in the solution without the passage of electricity. (*Metallurgical and Chemical Engineering*, vol. 16, no. 2, January 15, 1916, pp. 83-84, *e*)

Cast Iron for Engine Cylinders, J. Edgar Hurst

The paper was divided into three sections, the first dealing with the wearing of cast iron, its structure, hardness and machining considerations. Section 2 was on growth and dealt with heat treatment of gray cast iron and the effect of heat treatment on engine pistons. Section 3 was devoted to the chemical constitution of the metal.

Under a given load and speed it would appear that wear in engine cylinders was proportional to the tensile strength of the iron. Cast iron of the highest tensile strength at normal temperatures was that having the closest-grained structure and the

free carbon constituent existing in a very finely divided or, alternatively, in a rosette form. In so far as pure surface disintegration was concerned, the identity of the micro constituents of cast iron is of little moment, but it becomes of importance in view of the effect of the action of alternating stresses on the character of the surface grains and the effect of the differential polishing of these grains.

With regard to hardness tests, the method of applying Brinell hardness numbers to cast iron in the case of engine cylinders is far from satisfactory. Cast irons giving the same hardness numerically often wore at widely different rates, and, furthermore, the influence of the presence of such elements as manganese and chromium, which in normal percentages were not detected by the hardness numeral, was most important.

There is a great amount of uncertainty in the definition of hardness and it is very doubtful whether the methods of determining hardness actually do determine this property in its entirety. The author states that in his opinion in a homogeneous material a true hardness property is its resistance to wear. From this, therefore, the resistance to wear becomes a function of the cohesion of the particles, or, rather, becomes the resistance to deformation, and therefore he suggests tentatively that the yield point is a more correct indication of the true hardness.

As regards cast iron, the author said it was extremely probable that wear due to surface disintegration was really a function of the brittleness of cast iron. The abrasion or relief polishing was the true wear, in that it depended upon the resistance to deformation of the individual component grains.

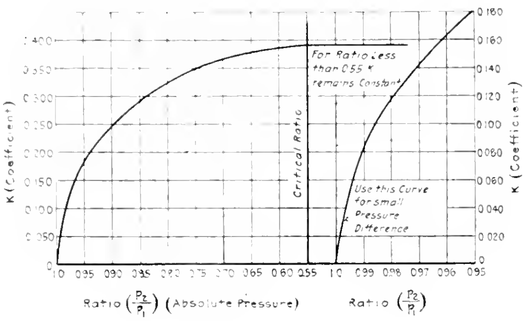


Fig. 5 Curve of K (coefficient) for Flow of Natural Gas Through Standard Orifices

The temperature at which growth appeared to commence was about 650 deg. cent. and it reached a maximum at about 750 deg. cent. After prolonged heating, in addition to a gradual increase in volume a gradual increase in weight was also noted. The facts are established that:

1. Alloys not containing graphite do not grow.
2. Alloys containing graphite are, under suitable conditions, capable of growing; and, further, the total growth is roughly proportional to the silicon content.

In this connection the author discussed piston troubles with Diesel engines. He believes that the ultimate cracking of Diesel-engine piston tops could as a general rule be traced to the phosphorus content of the cast iron, and the cracking was practically eliminated when this was kept sufficiently low. Specimens taken from the center of a star crack in a piston showed liquation of the phosphide eutectic. This would undoubtedly increase the magnitude of the internal strains and, in addition, at points in the region of the center this same eutectic would at these temperatures be dangerously near its liquation point. Both phosphorus and silicon had a profound influence on the swelling out of the graphite plates. (Paper read before the *Manchester Association of Engineers*, December 9, 1916, abstracted through *The Engineer*, vol. 122, no. 3182, December 22, 1916, pp. 549-550, 1 fig. *te*)

Gas Engineering

Measuring Gases by a Standard Orifice

Prof. Thomas G. Estep, Jr., of the Carnegie Institute of Technology, gave the following formula for weight of gases discharged through an orifice in pounds per second:

$$W = \frac{A P_1 K}{\sqrt{T_1}}$$

where A = area of orifice in square inches; P_1 = pressure just ahead of the orifice, pounds per second absolute; K = coefficient from curve for flow of air through standard orifice, Fig. 5; and T_1 = initial temperature of gas, degrees fahrenheit absolute.

For K the paper gives a rather involved formula. H. G. Geissinger, in his article in Blast Furnace and Steel Plant for February, 1917, offers simplified expressions for the constant K. He gives the following as a general formula for determining the value of K corresponding to value of d less than the maximum from the characteristics of the gas expressed by the values of R and n as

$$W = \frac{A P' K}{\sqrt{T}}$$

where W is discharge in pounds per second; A = net area orifice in square inches; P' = pressure on orifice, pounds per square inch absolute; d, drop in pressure across orifice, pounds per square inch; T = absolute temperature of entering gas in degrees fahrenheit; n = ratio of specific heats, constant pressure to constant volume; R = a constant for the gas in question. As an example of the use of this formula, H. G. Geissinger offers the following:

Determine K for a drop ratio of d = 0.25 (pressure ratio 0.75), in natural gas, where n = 1.27 and R = 4. From this data we find:

$$r = \frac{64.3}{94} = 0.683$$

$$f = 1 - \frac{(1.4 - 1.27)}{10} = 1 - 0.013 = 0.987$$

$$\text{and } p = 0.55 + \frac{0.72}{1.27} = 0.55 + 0.565 = 1.115$$

Therefore,

$$K = \sqrt{0.675\ (0.25 - (1.115 \times 0.0625)} = \sqrt{0.122} = 0.35$$

(Composite abstract of a paper by Prof. Thomas G. Estep, Jr., in *Blast Furnace and Steel Plant*, vol. 5, no. 1, January 1917, pp. 16-18 and 31, 2 figs; and paper by H. G. Geissinger in *Blast Furnace and Steel Plant*, vol. 5, no. 2, February, 1917, pp. 55-56. *et*)

A Method of Determining the Density of Flue Gases, Jas. Alex. Smith

It is often desirable to ascertain the density of a gas without making a chemical analysis. In the present paper the writer describes a novel method for determining gas density by gage reading.

The basic theory on which this method is founded is that the densities of gases and their pressures per unit of area of bases are directly proportional when the gas columns are of equal height. Hence if a column of air in a vertical tube

of known height is displaced by a given gas, the barometric and thermometric conditions remaining constant, the densities are in the simple ratio

$$D = \frac{P \pm P'}{P}$$

where D = density of the given gas referred to air taken as unity; P = known air pressure due to column height; P' = difference ($\pm$) of pressure due to gaseous displacement.

In his apparatus shown in Fig. 6, the writer shows a two-liquid differential gage which he has previously described in another article. The gas tube is simply a piece of 1/8-in. wrought-iron gas barrel A, 100 in. in height. At the bottom two stopcocks, B and C, permit alternate connection to a gas source or to the gage E. To check diffusion, the passage through the latter cock should be reduced to a pinhole. At the top a third cock, D, opening into the air, permits the tube to be gas-flushed and filled, and when the main passage is closed, continues the connection by a minute by-pass large enough to preclude any possible barometric difference of pressure between the gas inside and the air outside the tube, yet so small that the diffusion is negligibly slow. The surface of the liquid in the gage system and the bottom of the gas tube must be approximately at the same level.

The writer describes the method of calibration and the required corrections. (*The Mechanical Engineer*, vol. 38, no. 988, December 29, 1916, pp 509-510, 1 fig., *d*)

Machine Shop

Gas-Heated and Oil-Furnace-Heated Rivets, William F. Croston

Though the fuel costs are greater and the time of run longer, the Newport News Shipbuilding & Dry Dock Company prefers the gas furnace for heating rivets over the oil-fired type formerly used.

A test was recently run to check the cost of operating by gas as against the oil furnace formerly in use. Four hundred pounds of rivets were heated in each furnace. These were heated by the oil furnace in 44 min. and by the gas furnace in 57 min. The cost of heating the rivets by oil, with oil at 6 cents per gal., was 52.5 cents. The cost of heating a similar amount of rivets in a gas furnace, with gas at 55 cents, was 53.6 cents.

The rivets heated in the gas furnace were far superior to those heated in the oil furnace, as there was practically no scale on them, while the oil-heated rivets in same cases were badly scaled.

It is claimed that the gas-heated rivets stay hot enough to drive longer than those heated in the oil furnace, which is explained by the fact that the gas-heated rivets are heated evenly all the way through, while those heated in the oil furnace are extremely hot on the outside but not hot in the center, and thus cool more quickly than the gas-heated rivets. (*Bulletin of the Southern Gas Association*, January 1917, abstracted through the *American Gas Engineering Journal*, vol. 106, no. 4/3072, January 20, 1917, p. 87, 1 fig., *de*.)

Pumps

Motor Drive of Hydraulic-Elevator Pumps, Charles J. Carlsen

Data on the use of electric power for operating elevator pumps in important Chicago buildings and in particular in Hillman's Department Store, covering a period of three years.

The building was provided with 13 elevators, nine being hydraulic passenger elevators in two banks, four in one and five in another, and four steam elevators, two for passenger service and two for freight.

The hydraulic elevators are provided with vertical cylinders and plunger equipment 13 in. in diameter and 30 ft. long, with a maximum lift of about 80 ft. and a speed of about 400 ft. per min.; cars are operated on about one-half minute schedule; maximum pressure on the hydraulic system is 160 lb.

The steam equipment used for operating elevators was a 14 x 22-in., 14 x 20-in. Burnham simplex compound pump; a 14 x 20-in., 9 x 18-in. duplex compound pump, and a 16 x 9 x 18-in. duplex simple pump. On test, these combined pumps as operated consumed from 120 to 160 lb. of steam per i.hp-hr.

In September, 1913, a contract was entered into for supplying steam to the adjacent Reliance Building for the operation of various steam-driven devices. The amount supplied under this contract reached about 25,000,000 lb. of steam per year, as measured by a St. John meter.

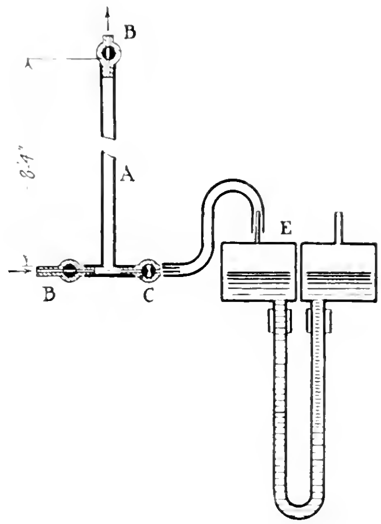


Fig. 6 Two-Liquid Differential Gage

All condensation excepting hot-water requirements is wasted to the sewer, there being no means provided for delivering these returns to the hot well of the boiler plant.

The bare cost for steam production per 1000 lb. based on a year's average and including only coal, ash removal, water for making and boiler compound, but not including any labor, maintenance or repairs, or overhead investments on plant, was found to be 24 cents per 1000 lb. with coal at \$2.85 to \$3.05 per ton. The writer gives the following figures to show the saving which he claims would be due to electric operation (Table 1).

This table is based on the assumption that a steam pump in fairly good condition will consume 120 lb. of steam per i.hp-hr., which is equivalent to 160 lb. per kw-hr.

In another office building, the Western Union Telegraph Building in Chicago, there was installed an equipment similar to that in the Hillman store, but using three three-stage, 350-gal.-per-min. Chicago Pump Company's turbine pumps, each direct-connected on a common subbase to a General Electric motor, and each controlled by a Cutler-Hammer control panel. Here the steam pumps are operated during the winter months

TABLE 1 HYDRAULIC ELEVATOR OPERATION, SUMMER MONTHS

	1913	1914	1915
Estimated Steam Operation Cost	$4,732.03	6,094.08	5,575.30
Actual Electrical Operation Cost	1,523.90	1,731.40	1,652.36
Annual Saving due to Electric Operation	$3,208.13	1,362.68	3,922.94

when exhaust steam is used for heating, but during the summer months the entire boiler plant is shut down and only a small boiler is run, of sufficient capacity to serve the building with the necessary hot water requirements.

The article briefly mentions also other buildings in Chicago, St. Louis and New York City using motor-driven pumps in the operation of their hydraulic elevators. (*Electrical Review and Western Electrician*, vol. 69, no. 25, December 16, 1916, pp. 1046-1049, 4 figs. *eg*)

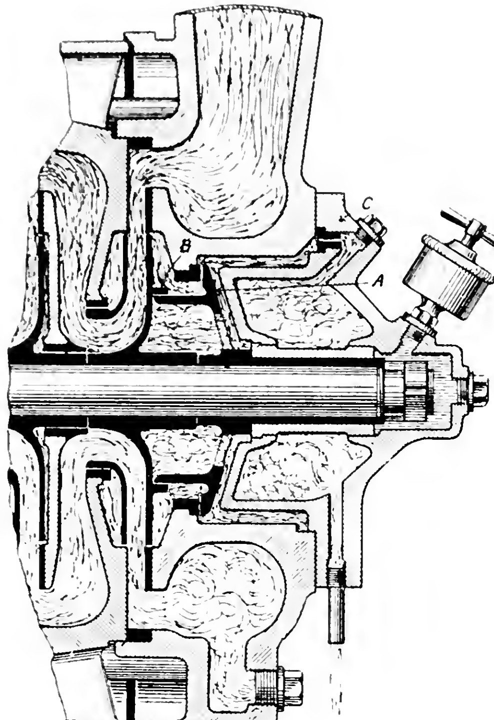


Fig. 7 Automatic Hydraulic Balancing Arrangement for High-Lift Centrifugal Pump

High-Lift Centrifugal Pump

Description of a centrifugal high-lift pumping set recently built in England for delivering 200 gal. of water per min. against a total head of 1250 ft.

In designing the set the makers were restricted to the use of direct current for the electric-motor drive. Hence the speed of rotation was limited and the number of stages in the pump correspondingly increased. The difficulty was overcome by arranging two four-stage pumps in line and driving them by a common motor which runs at 1400 r.p.m.

The pumps work in series, each giving a head of 625 ft. The automatic hydraulic balancing arrangement shown in Fig. 7 enables the makers to dispense with thrust bearings. This is effected in the following manner: A valve *A* carried from the shaft by means of arms is so constructed that it fits into a ring *B* on the delivery side of the last impeller. The diameter of the ring is such that were there no hydraulic pressure on its inner area there would be an axial thrust towards the delivery end of the pump. The load necessary to balance the thrust on the impellers is taken on the back of the last impeller itself, as this forms one wall of the balancing chamber. The water required for balancing passes from the periphery of the last impeller to the balancing valve and thence to the balancing chamber, the outlet from which is controlled by the fixed orifice *B*. The latter connects with a drain. (*The Engineer*, vol. 122, no. 3182, December 22, 1916, p. 560, 2 figs., *d*.)

Railroad Engineering

Experimental Refrigerator Cars, Pennsylvania Railroad

The Pennsylvania Railroad has recently built at its Altoona shops two refrigerator cars to be used experimentally in milk-train service. The cars are essentially of all-steel construction.

In the design of these cars it was intended to utilize every means available, regardless of past practice, to provide a car that would furnish and maintain adequate refrigeration for milk and cream, either with ice placed in the ice bunkers or placed on top of the cans or boxes. Past experience indicated certain basic requirements enumerated in the original article.

The cars have trucks of special construction. The side frames are of cast steel. The side-frame center opening, the spring plank, and the wheelbase of 5 ft. 10 in. are the same as in freight trucks. The elliptical springs and bolster are the same as used on tenders. The axles are of the passenger type and the wheels are rolled steel, 33 in. in diameter. The journal boxes are pedestal-type passenger-car boxes. The truck, except for the bolster side motion, represents, therefore, a combination of passenger- and freight-truck features.

The end frame also combines passenger and freight principles. On the end sills and crossbearers oak blocks are placed to support the steel box forming the inside lining. The spaces between these blocks are filled with insulation consisting of four layers of 3/4-in. Keystone hair felt, separated by wooden grids to form air spaces.

The inside lining consists of 3/16-in. floor plates, 1/8-in. side sheets and 3/32-in. ceiling sheets, all reinforced with U-shaped braces riveted to the outside. It forms a box which can be built up complete on the floor and then lifted to its proper location on the oak supports. A 3/4-in. Keystone hair felt of as great width as can conveniently be manufactured and cut to the proper length is then lifted to the top of the lining box and unrolled to drop down the sides to meet and join the insulation under the floor. A continuous blanket is thus formed all around the inside box. There are four such blankets running transversely, separated with grids made of 1/2-in. strips of soft wood. Two additional layers separated with wooden grids are placed longitudinally on the top of the box and four layers are placed at the car ends to correspond with the sides. The Keystone hair felt consists of 1/4-in. hair felt placed between two sheets of 90-lb.-specification paper and securely sewed together.

The sides, ends, and roof are also reinforced with U-shaped braces and are so designed that the riveting can all be done from the outside. This also permits removing a side, end, or roof for repairs without thereby disturbing any other part of the car.

No data are given as to the results obtained with these cars. (*Railway Review*, vol. 60, no. 5, February 3, 1917, pp. 155-157, 8 figs. *d*)

Refrigeration

Refrigeration and Refrigerator Insulation on Board Ship. Robert F. Massa

Paper discusses the construction and insulation of refrigerators "built in" on board ship.

Difficulty has been encountered with the use of cork that had not been sufficiently pressed previous to baking. This cork was not as dense as it should have been, and had not the mechanical strength it should have had.

As to refrigerator doors, the idea seems to prevail that they should have beveled edges and that such edges make a very tight door. The writer claims, however, that as soon as the moisture begins to have its effect, such a door cannot be tight any more. Further, if the hinges yield at all, as they are likely to do with such a heavy door, it will never be tight.

In the writer's opinion, the way to make a tight refrigerator door is to have a plain surface come up against a plain surface with a flexible gasket between them, or two pairs of such surfaces with gaskets between them, making an air pocket between the two sills. If this arrangement is used the door can sag considerably without causing any serious binding or failure in tightness.

As regards estimating the capacity of the refrigerating machine required to take care of the given refrigerator, it is not sufficient to calculate on heat loss through the insulation of the refrigerator, as it is only a part of the total loss. The other losses are due to heat entering in warm goods, by the interchange of air through the opening of doors, and by leaks through defective insulation or defective doors; to lights, or to the heat of the bodies of workers; to any change of state occurring in the goods, such as freezing, fermenting, etc. (Paper read at the Annual Meeting of the Society of Naval Architects and Marine Engineers, November 1916, abstracted from *International Marine Engineering*, vol. 21, no. 12, December 1916, pp. 546-547. *p*)

Steam Engineering

Forced Lubrication for Marine Turbines

With the more or less general adoption of geared turbines on all classes of ocean-going vessels, in most of which, unlike the Navy, there are only two engineers on watch, it has become necessary to give the subject of lubrication considerable thought with a view to obtaining a degree of simplicity and dependability which will reduce attention to a minimum. As every trade route has its own conditions, it is impossible to devise a system suitable for every class of ship, but the following system is claimed to meet the requirements of many single-screw cargo-carrying vessels in the ordinary trade routes.

A combined gravity and forced system offers the greatest advantages and consists simply of a pump taking oil from a drain tank and discharging it through a cooler to a gravity tank, from which it falls to the turbine bearings, etc., and back to the drain tank; or it can be by-passed, in which case it does not enter the gravity tank but is forced direct to the machinery.

The following main fittings would be required for such a system, and are stated in the order in which the oil would pass through them when traveling from the drain tank to the turbines: one drain tank; two oil strainers (one for each pump); two pumps, one working and one stand-by; one oil cooler; two gravity tanks; one combined oil distributor and water-and-sludge collector.

The drain tank should be of sufficient capacity when full to supply oil for fifteen minutes, assuming that none is returning to the drain tank. It should be a self-contained unit placed in a cofferdam in the double bottom rather than built into it, and should be easy of removal for examination. The top should be not less than six inches below the bottom of the gear case to insure a ready drain, and not less than three inches above the double-bottom tank to clear bilge water. In addition to the drain- and suction-pipe connections a float-level indicator can be fitted so as to be easily observed from the starting platform, also an air pipe and manhole.

The body of the oil strainer may be of cast iron, having a cover easy of removal. The straining grid may be a gun-metal casting or a steel tube perforated with holes, say, one inch in diameter, but in either case the area through the grid should be about ten times that of the suction pipe. A suitable straining medium is a 24-mesh wire gauze, which should be properly secured to the grid. The gauze will, however, reduce the effective area through the grid by about one-half.

The oil cooler may take the same form as a steam condenser, with similar tubes and packing, but with the water circulating around the outside of the tubes with preferably a four or six flow to insure good circulation. As, however, it is economically impossible to render the flow of oil turbulent, which makes the rate of heat transfer low, certain firms construct their coolers in a different way. The water is passed through the tubes, and the oil outside. Numerous baffles are fitted to cause the oil to flow up and down in zigzag fashion across the cooling tubes, and at each abrupt change in direction a certain disturbance is produced in the laminar flow of the oil, which facilitates the interchange of heat. At present, knowledge of oil coolers is in its infancy and there is much room for research and careful design. The present practice admits of oil discharging to turbines at 80 deg. fahr. and leaving them at a maximum of 120 deg. fahr.

The combined oil lubricator and water-and-sludge collector need be nothing more than a cylindrical casting of sufficient depth to admit of water and sludge gathering at the bottom while oil flows out at the top to the bearings and gear sprayers. It is desirable to fit separate connections from the distributor to the bearings and gear sprayers with a controlling valve at each, which facilitates adjustments whereby bearings and sprayers will each receive their proper share of the oil. A water draw-off cock placed about twelve inches from the bottom and a door for removal of sludge are to be provided.

The turbine pipes and fittings should be tested to 50 lb. per sq. in., with the exception of the tanks, for which a 5-lb. test is sufficient. A relief valve should be provided near the pump, set to blow off at 50 lb. per sq. in. and having an outlet led to the pump suction. (*Engineering*, vol. 103, no. 2662, January 5, 1917, p. 12, Editorial, *dp*)

Doust Joints

The Doust patent expansion joint (made in England) is entirely telescopic in its action and has neither gland, packing, nor rings. It has been standardized by the Board of Trade for steam working pressures up to 215 lb. per sq. in. and is approved by Lloyd's. It has two outer shells and two inner liners with flanges on the ends; bolts pass through the flanges of the pipes. With any alteration of length of range of pipes due to expansion or contraction they are free to work telescopically.

In addition to the original Doust joint which has four sleeves, a new joint has been developed with three sleeves

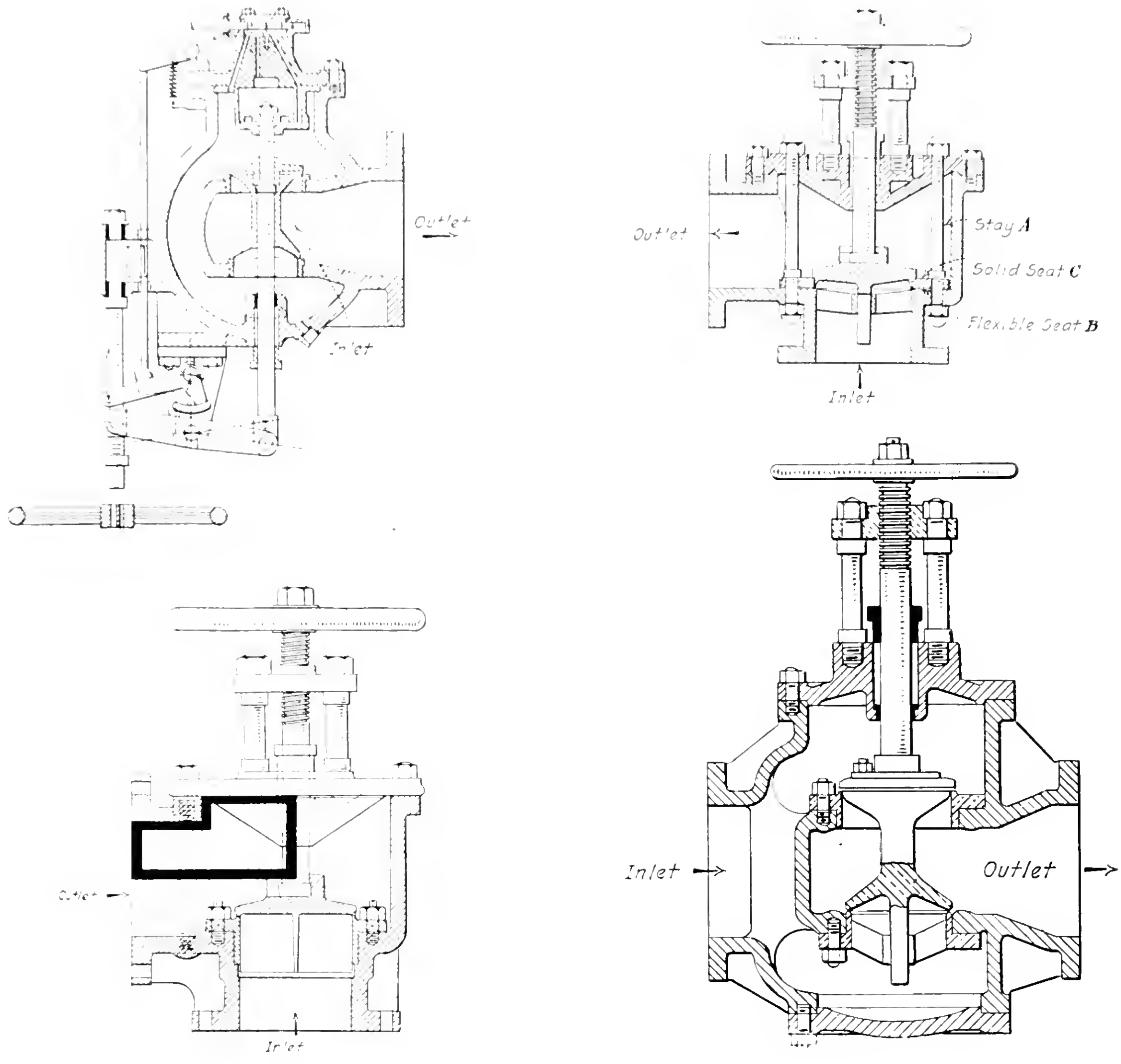
and is now under test to establish its suitability for steam. (*Steamship*, vol. 28, no. 331, January 1917, pp. 147-148, 2 figs. *d*)

The Design and Construction of High Pressure Steam Stop Valves, D. Macnicoll

Description of the essentials of design and sources of trouble in high pressure steam stop valves.

Fig. 9 shows a type of single-beat unbalanced stop valve frequently used as a boiler stop. This is not a very good design, because of the unequal distribution of stresses. Assuming that the pressure is present throughout the chest and acting at right angles to the plane of section shown, the stress on the part marked *A* is much higher than on the other portions. The pressure on the portion outlined in black is approximately 8950 lb., which stresses the section on the top left-hand side to 1061 lb. per sq. in., whereas the average stress for the aggregate section is only 891 lb. It is true that the cover takes a portion of this stress, but this simply transfers the stress on to the studs and therefore does not improve the overall strength of the valve.

The stresses resulting from excessive hardening down are in many cases exceptionally high. In fact, if the valve lid did not give way in nearly every such case, there might be far more fatal accidents in this connection. In valves over 4 in. in diameter a flexible seating in conjunction with a solid face is of advantage, as with this arrangement leakage from distortion is obviated, and, in addition, there are two faces, so that if one is leaking from any cause outside of distortion, there is always the other one to fall back upon.



Figs. 8-11 8, Left Hand, Top: Modified Double-Beat Valve for Regulating Purposes in Reciprocating Work. 9, Left Hand, Bottom: Single-Beat Unbalanced Stop Valve Used as a Boiler Stop. 10, Right Hand, Top: An Improvement on the Last Type of Valve. 11, Right Hand, Bottom: Double-Beat-Type Experimental Valve

Another source of high stress is when the valve has been shut down hard when cold and afterwards steam from other boilers is admitted to top portion of body. An actual experience of the author is illustrated in Fig. 10. This was a double-beat type of valve and the bottom seat was attached as shown. The valve was hardened down for steam test, with the result that after the test a number of manganese-bronze studs from the bottom seat were found lying broken in the bottom of the chest, and all showed signs of fracture caused by the expan-

sion of the spindle. One method of counteracting the damage from expansion is by fitting a spring crosshead. In Fig. 9 stays are sometimes fitted as indicated by the dotted lines. These only serve, however, to stiffen the cover and still further reduce the section of metal at an already weak section.

The rotation of the winged valves when steam is flowing is due either to a slight angle of the wings or to eddies in the steam. The valve can be prevented from rotating by means of a pin or otherwise. The damage done to valves from this rotation is hardly credible, and calls for the adoption generally of pintle- or center-guided valves.

Another source of trouble is the fracture of seat-securing pins or studs. In large sizes generally and in all sizes when superheated steam is present, seats driven in and secured by side pins become quite slack and allow leakage to occur. The seats in larger sizes are therefore secured in the manner shown in Fig. 9. The only way to avoid serious trouble with this design is to run a wire through the heads of all pins or through split-pin holes if studs are fitted. This prevents fractured portions being carried to some part where serious damage may be caused.

In Fig. 10 a type of valve is shown which is suggested as an improvement on that shown in Fig. 1. Attention is drawn to the method employed with a view to having the cover take up a measure of the bursting pressure which acts at right angles to the axis of the spindle. This consists of a tapered spigot on the chest with a corresponding tapered recess in the cover, making a metal-to-metal joint. The stresses from hardening down and expansion are mainly taken up by the four stays *A*, which also serve to secure the seatings. With this arrangement no loose parts are situated inside the chest, with the consequent prevention of damage from this source. The valve is centrally guided, thus preventing rotation. A flexible seat is shown at *B*, and when this and the corresponding valve face engage, the solid seat *C* and its corresponding valve face are 1/100 in. open, so that when this latter seat and face engage, the flexible seat is deflected 1/100 in.

Next is described a flexible disk to one of the beats of the solid double-beat valve, the purpose of which is to prevent leakage due to differences of expansion between the valve and the seat in the chest.

As regards double-beat types of valve used in reciprocating work for regulating purposes and as throttle valves, the writer states that in the future it is intended to make valves of the type shown in Fig. 8. Here a constant closing effort is present and will allow of perfect regulation under all circumstances and will not necessitate the adoption of saw-formation spigots on the beats. The slide valve is returned from position III to positions II and I by a spring assisted by the inlet pressure on the area of the slide-valve spindle where it passes through its stuffing box. Special types of ahead and astern double-beat regulating valves for turbine and reciprocating machinery are shown and described. (Paper read before the *Institute of Marine Engineers,* December 12, 1916, abstracted through the *Mechanical Engineer,* vol. 39, nos. 989-990, January 5 & 12, 1917, pp. 8-9 and 20-22, 13 figs. *d.* The original paper is not available.)

Thermodynamics

Heat Density. George P. Pearce

We hear a great deal about the B.t.u. value of fuels, that is, the B.t.u.'s of potential chemical energy contained in 1 lb. of various substances, but how many have considered the number of B.t.u.'s of heat there are in a cubic foot of space under various conditions? Let us assume 0 deg. fahr. as a base and see approximately what the heat density is for various conditions and substances. On a hot summer day, with the thermometer registering 110 deg., there seems to be plenty of heat everywhere, yet a simple calculation will show that there is only 1.8 B.t.u. to the cubic foot.

The gasoline blast torch is generally looked upon as a very hot flame, but in the hottest part of that flame the heat density is less than expected; it is 10 B.t.u per cu. ft. Hydrogen gas, with its enormous heat value, might be expected to make a better record than that, yet in the hottest part of a hydrogen flame burned in the air the B.t.u.'s per cu. ft. are just about 10.1: it has a heat density 1 per cent better than the gasoline flame in air. Not much is expected of carbon burned in air with its much lower heat value, so we are surprised when it shows a density of 12.3 B.t.u. per cu. ft. This, of course, is due to the greater density of the products of combustion. Incidentally, we note why coal is such a satisfactory source of heat for boilers; it develops a high heat density and thus rapidly heats the tubes; of course, other things enter into consideration as well. A great deal is said about acetylene, and it deserves credit, for this gas burned in air produces a heat density of 13.1 B.t.u. per cu. ft. So far the heat produced has been diluted by the presence of the inert gas nitrogen in the air. Eliminate this and burn acetylene in oxygen and a great change takes place, for now there are 24 B.t.u. in every cubic foot of the intense flame. Burn hydrogen in oxygen and there are 20 B.t.u. to the cubic foot.

It might be supposed that the limits for heated gases and vapors are being rapidly reached. However, ordinary steam just as it boils off water into the atmosphere contains 44 B.t.u. to the cubic foot. The oxy-acetylene flame takes a poor second place when compared with steam under these conditions. Some experimental high-pressure, high-efficiency, steam engines use superheated steam at 240 lb. per sq. in. and 300 deg. of superheat, and every cubic foot of this steam contains over 500 B. t. u. Strange as it may seem, saturated high-pressure steam at 235 lb. per sq. in. contains over 650 B.t.u. per cu. ft., and for carrying heat is superior in this respect to superheated steam. More astounding still is the humble cake of ice, which at 32 deg. is prepared to deliver 937 B.t.u. per cu. ft. when cooled down to zero. Boiling water is common enough, and as a heat container it holds over 12,000 B.t.u. per cu. ft.

Melted sulphur at 800 deg. fahr. has a heat density about twice that of boiling water, or over 22,000 B.t.u. to the cubic foot. Melted aluminum at 1214 deg. fahr. almost doubles this, with nearly 43,000 B.t.u. per cu. ft. Melted glass at 2377 deg. fahr. has nearly 75,000 B.t.u. in every cubic foot. Platinum, at 3300 deg. fahr., makes a big jump with its 182,200 B.t.u. per cu. ft. But common melted iron, at 2700 deg. fahr., leaves platinum away behind with 207,000 B.t.u. per cu. ft. However, they are all surpassed if a cubic foot of carbon is heated almost to its vaporizing temperature, say to 7000 deg. fahr., as a heat density of 700,000 B.t.u. per cu. ft. is then obtained. It is impossible for a person to look at this heated carbon or stand near it, and probably it represents the greatest heat density known. It is found in every arc lamp. Perhaps, when we obtain more data on this remarkable metal tungsten, which takes 5432 deg. fahr. to melt it and an unknown temperature to vaporize it, a still greater heat density may be had in melted tungsten just before it commences vaporizing. (Reprinted from *Machinery,* vol. 23, no. 6, February, 1917, p. 471-2. *g*)

The Determination of Free Energy by the Clausius Equation of State, E. Aries

For a body considered from the point of view of its molecular weight, the Clausius equation can be written as

$$P = \frac{RT}{v - \alpha} - \frac{\phi(T)}{(v + \beta)^2} \quad [1]$$

If the latter of the two constants is zero and the function ϕ is reduced to a constant K, the Van der Waals equation is obtained.

The above equation has a remarkable property which in the opinion of the author has not been perceived, in that it gives in a very simple manner an expression for the free energy I as a function of its usual variables, volume and temperature. We know that this energy expressed in this manner is one of the four Massieu functions, each of which is sufficient to determine all the properties of a body. We know that

$$-\left(\frac{\partial I}{\partial v}\right)_T = P = \frac{RT}{v - \alpha} - \frac{\phi(T)}{(v + \beta)^2} \ldots\ldots\ldots\ldots [2]$$

from which, by integration with respect to v, we obtain

$$-I = RT \log (v - \alpha) + \frac{\phi(T)}{v + \beta} - \Phi \ldots\ldots\ldots\ldots [3]$$

where Φ is a function of the temperature introduced by the integration and may be determined from the theory of perfect gases.

If we assume that the volume v progressively increases at constant temperature, the body tends toward the state of a perfect gas. α becomes finally neglible as compared with v, and the equation [3] is reduced to the following (which is the equation given by the theory of perfect gases):

$$-I = RT \log v - \Phi \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [4]$$

From this equation may be derived the following expressions, first, for the entropy S, and next for the molecular heat capacity at constant volume c (which constant is the same for all perfect gases of the same molecular complexity):

$$S = -\left(\frac{\partial I}{\partial T}\right)_v = R \log v - \frac{\delta \Phi}{\delta T}; \quad c = T\left(\frac{\partial S}{\partial T}\right)_v = -T\frac{\partial^2 \Phi}{\partial T^2} \ldots [5]$$

By double integration of the equation for c, one obtains

$$-\frac{\delta \Phi}{\delta T} = c \log AT; \quad -\Phi = c\, T \log AT - B \ldots\ldots\ldots [6$$

The value for Φ thus obtained transferred into equation [3] completely determines the free energy of a body subject to the equation of state [1]. From this follow important consequences.

Equation [3] in its turn gives by derivation the following equations for entropy S and heat capacity at constant volume C_v:

$$S = -\left(\frac{\partial I}{\partial T}\right)_v = R \log (v - \alpha) + \frac{\frac{\partial \phi}{\partial T}}{v + \beta} + c \log AT$$

$$C_v = T\left(\frac{\partial S}{\partial T}\right)_v = \frac{T\frac{\partial^2 \phi}{\partial T^2}}{v + \beta} + c \ldots\ldots\ldots\ldots [7]$$

This expression for C_v would *a priori* indicate that the Van der Waals equation cannot agree with facts as observed. If ϕ reduces not only a constant but, what is more, to a linear function of temperature, then $\frac{\partial^2 \phi}{\partial T^2}$ becomes zero, and C_v becomes constant, a conclusion clearly inacceptable except, perhaps, for monatomic bodies.

The application of equation [7] to the state of saturated fluids is of particular interest. If S_1, v_1 and S_2, v_2 represent the entropy and volume of a body in the state of a vapor and in the state of a liquid respectively, under tensions P and T, then the heat of vaporization of the liquid is equal to $T\ (S_1 - S_2)$, whence the following equation is derived, which indicates the heat of vaporization L:

$$\frac{L}{T} = S_1 - S_2 = R \log \frac{v_1 - \alpha}{v_2 - \alpha} + \frac{\partial \phi}{\partial T}\left(\frac{1}{v_1 + \beta} - \frac{1}{v_2 + \beta}\right) \ldots\ldots [8]$$

v_1, v_2 and P are determined as functions of temperature by the three known relations

$$\frac{P}{(v_1 - \alpha)(v_2 - \alpha) - (\alpha + \beta)^2} = \frac{\phi T}{(v_1 + \beta)^2 (v_2 + \beta)^2}$$

$$= \frac{RT}{(v_1 - \alpha)(v_2 - \alpha)(v_1 + v_2 + 2\beta')} \ldots [9]$$

$$\frac{1}{v_1 - v_2} \log \frac{v_1 - \alpha}{v_2 - \alpha} = \frac{(v_1 - \alpha)(v_2 - \alpha)(-\alpha + \beta)^3 + (v_1 + \beta)(v_2 + \beta)}{(v_1 - \alpha)(v_2 - \alpha)(v_1 + v_2 + 2\beta)} [10]$$

which unfortunately cannot be solved with respect to the unknowns v_1, v_2 and P. But Clausius has published a table which meets this difficulty in so far as equations of state of the type shown in [1] are concerned, by permitting them to be evaluated directly.

The author shows that equation [8] can be written as

$$\frac{L}{T} = R\lambda + \frac{1}{y}\frac{\partial \phi}{\partial T}\left(\frac{1}{y_1 + 1} - \frac{1}{y_2 + 1}\right) \ldots\ldots\ldots\ldots [11]$$

and hence the heat of vaporization can be easily calculated for any given temperature by the Clausius table. The value of this temperature transferred into the first of the following three equations

$$x = \frac{27}{8}\frac{\gamma RT,}{\alpha(T)} \quad y = \frac{v - \alpha}{\gamma}, \quad z = \frac{8\gamma P}{RT} \ldots\ldots\ldots\ldots [12]$$

giving x, and once the value of x is known the Clausius table will give all the other magnitudes.

If the function ϕ be replaced by a constant as in the Van der Waals equation, [11] takes the very simple form

$$L = \lambda\, R\, T \ldots\ldots\ldots\ldots\ldots\ldots\ldots [13]$$

the value of λ being, according to the first of the equations [12], the one which corresponds to the reduced temperature $x = T/T_c$, so that it is only necessary to know the critical temperature T_c of a body in order to determine the heat of vaporization at any temperature.

The writer discusses the application of this equation to monatomic bodies but, because of lack of experimental data, comes to no definite conclusions (Sur la détermination de l'énergie libre par l'équation d'état de Clausius, E. Ariès, *Comptes Rendus des Séances de l'Académie des Sciences*, vol. 163, no. 24, December 11, 1916, pp. 737-741, *t*).

The report of the meeting of the Society of Automotive Engineers in the February issue of the Journal (p. 183) was written by John Younger, Mem.Am.Soc.M.E. By a regrettable error, his signature was omitted.

Motor Boat Show

The Thirteenth Annual Motor Boat Show was held under the auspices of the National Association of Engine and Boat Manufacturers in New York City, at the Grand Central Palace, from January 27 to February 3, 1917.

It did not show anything revolutionary in the way of either boats or engines, but was a good proof of the steady progress made in this line of engineering in the United States. As compared with the last year's show at the Grand Central Palace and the previous shows at Madison Square Garden, one was impressed by the apparent change from a trade which aimed mainly to serve the amateur and sportsman, to one which is apparently coming to relate to straight commercial work. The number of small engines exhibited was less than at any previous show, but there were many large engines, apparently intended for either large pleasure boats or heavy- and medium-duty commercial boats.

The general design of the engines also showed undoubted signs of improvement. In the majority of cases the workmanship is better, the wiring properly enclosed, magnetos take the place of dry-cell batteries and spark coils, more attention is paid to the balancing of the engine, and a decided improvement in the design of the lubricating system is noticeable.

Considerable attention was attracted at the show by the U. S. Navy patrol-type boats. These boats are about 45 ft. long and 10 ft. deep and have been indicated as a sample of what the U. S. Government would like yachtsmen to build as a combination yacht and patrol boat. One type exhibited at the show is powered with a pair of 150-hp. (each), six-cylinder, 6-in. x 6-in. Van Blerck motors, capable of driving the boat fully loaded at a speed of 25 mi. per hr. Her fuel capacity is about 500 gal., which gives her a cruising radius of 300 miles.

Two Duesenberg motors were shown, one for motorboat use and the other an aeronautical type. For the latter an output of 1 hp. per 3 lb. of overall weight is claimed.

An interesting type is the silent-valve Driggs marine engine, exhibited by the Driggs Ordnance Co., of New York City. Fig. 12 shows the valve employed in the 4-in. x 6-in. six-cylinder engine. The inlet and exhaust ports have many times the area of valve openings of poppet-valve motors of equal bore and stroke. The gas passages are comparatively unrestricted, as there are no sharp turns or sharp corners to retard the flow of gas. This helps to obtain not only a full charge on the intake stroke but also complete scavenging on the exhaust stroke. The valve shaft is driven by means of a gear from the time shaft. A steep-pitch adjusting screw engages in a thread in the valve. The valve driving spring forms the driving connection between the valve drive shaft and the valve. As the valve heats it expands and requires greater effort to drive it. This extra effort causes the valve shaft to advance angularly a fraction of a degree relatively to the valve against the action of the spring. In so doing the screw tends to screw out of the thread of the valve and move the valve upward in its tapered seat. The valve lifts only enough to make the driving effort normal. This effort is normal when clearance is such that there is a film of oil of almost infinitesimal thickness between the valve and its seat. The adjusting mechanism controls this gradually so that the oil film is maintained at a constant thickness.

A shallow-draft boat of the vacuum tunnel type has been exhibited in model. In this boat the propeller does not project beneath the bottom of the boat, and the blades are therefore fully protected at all times. Above the propeller chamber and connecting with it is placed a standpipe or vacuum chamber. From the top of this standpipe the air is exhausted by a small vacuum pump, which needs only to be operated for a moment in order to fill the tunnel and vacuum chamber. Atmospheric pressure forces the water up, filling the tunnel or wheel chamber and the standpipe or vacuum chamber above it. This column of water can be raised and maintained at any desired height from a few inches up to about 28 ft., the limit of atmospheric pressure. For every foot that the water is raised over the wheel the propeller is given solid, hard water of substantially the same characteristics that it would have if the propeller were operating the same number of feet below the water level. No data were given out as to any tests of the efficiency of this type of boat.

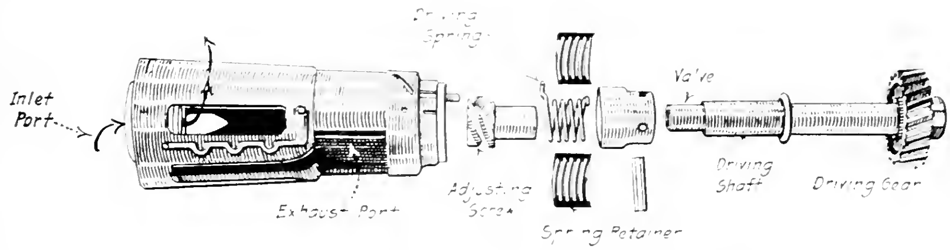


Fig. 12 Russell Silent Valve for Marine Engines

First Pan-American Aeronautic Exposition

The First Pan-American Aeronautic Exposition was held in New York City, February 8-15, and represented broadly the great progress made in American aeronautical engineering since the day when Wilbur Wright flew the first heavier-than-air machine in the world at Kitty Hawk. The original Wright machine was included among the exhibits, and was fittingly located right opposite the entrance to the exhibition. So great has been the progress in the thirteen years which have elapsed since the historic day of its flight, however, that in many respects the machine would be taken for a freak nowadays. It is remarkable, however, that in the essentials of construction comparatively little progress has been made: the location of the engine, the arrangement of the planes, the system of control, the methods of balancing, are fundamentally the same in the machines of today as in the old Wright biplane. But a tremendous progress has been achieved in those engineering details which convert a rough experiment into a practical success, to which fact the exhibits of present types of machines testified.

While the number of machines and engines exhibited was comparatively small, the quality of the products of American manufacturers was apparently as high as that of manufacturers in Europe, in so far as we are allowed to know of the progress there. It is true, however, that both the planes and the motors shown were smaller than what we understand to be the best European products of the same kind.

Very little was exhibited which was not known from previous published descriptions. A construction which attracted considerable attention was the aero-limousine at the stand of the Curtiss Aeroplane Corporation. This is a car

designed to run on the ground but also able to rise in the air. It is provided with small diameter disk wheels or rubber tires and also aeroplane planes and controls. From an engineering point of view there is considerable doubt as to the practicability of the machine. No spring suspension is provided for the carriage and it is by no means clear how long such a vehicle would be able to run on the ground without having the motor shaken all to pieces. No provision is made for steering the vehicle on the ground; this, however, is not very important, because a considerable amount of steering can be carried out by means of the aero controls. No means for braking the vehicle on the ground are provided. From statements made in the press, however, it appears that this aero-limousine has been built for use in inspecting extensive sheep ranges in the West, which would indicate that the conditions of operation of the vehicle may be such as to make it possible to dispense with either high precision in steering on the ground or the necessity for braking.

The Aeromarine Plane & Motor Co. exhibited a new aluminum motor with cast-iron liners, a special distributor, and an electric starter weighing only 20 lb.

An apparent effort has been made to handle the exhaust from the engines in somewhat novel ways. The Witteman-Lewis machine proposes to deliver the exhaust downwards through the bottom plate of the engine. The L. W. F. Co. showed a machine in which the exhaust is delivered rearwards through two pipes about 4 in. in diameter and about 6 ft. long, bending downwards at about half length and then straightening out again and running along the sides of the fuselage. No attempt appears to have been made to provide any kind of a muffler for the machines.

On the whole, while no revolutionary inventions have been exhibited, the exposition shows a healthy state of development of the American aeronautical industry. No machines which could be used for heavy military work or long-range flying were exhibited, which does not, however, mean that American makers cannot build them.

SOCIETY OF AUTOMOTIVE ENGINEERS

In connection with the first Pan-American Aeronautic Exposition, the S.A.E. arranged on February 9 an aeronautic meeting, the first to be devoted entirely to the consideration of aeronautic-engineering subjects.

The morning session was devoted essentially to matters of standardization. The program comprised the reading and discussion of two papers, of which only one was actually read.

Jno. J. Rooney, of the Wright-Martin Aircraft Corporation, presented a paper (read by title) on Suggestions For Standard Tests of Aeroplanes. The matter of standard tests becomes of considerable importance in view of the fact that it appears that during the past year manufacturers have had considerable difficulty in obtaining with their machines the performance guaranteed to the Government in their contracts, a condition which in war time might become a national calamity.

In discussing this subject the author stated that it is the policy of some of the manufacturers to force successful performance regardless of the number of alterations in design required for the accomplishment, which the writer considers to be a grave mistake. As the testing field is usually at some distance from the factory and reliable records of engineering value are seldom kept on the field, the engineers often are deceived regarding the performance of the machine, especially as they are ignorant of changes that have been made in the machine to make it come up to expectations—changes often important enough to alter radically the original design.

The author suggests, therefore, the standardization of field tests. He proposes to use standard test forms for the aeroplane itself, the engine, propeller and for recording aeroplane data; and emphasizes the necessity of keeping track of the conditions under which machines are tested, with due regard to conditions under which they are to be flown.

The author comes to the conclusion that performance productions can be made more reliable by satisfactorily checking laboratory experiments with actual field tests, and advocates means for increasing the value of field tests.

The paper personally read by F. G. Diffin, of the Erie Specialty Co., Erie, Pa., on Standardization of Metal Parts for Aeronautic Use, told of some of the troubles of the manufacturer of metal fittings for aeroplanes and of some ways of minimizing if not entirely eliminating them.

The troubles of the part manufacturers are in the first place due to the multiplicity of the parts. Of screw-machine products alone on a well-known type of machine there are over three thousand separate parts. Many of these call for from two or three to as many as ten operations looking to their completion. Factories have today orders for one specific size of bolt for practically the same use on various makes of machines calling for the use of six different metals. They are asked also to make these bolts in over sixty different lengths, and practically the same condition exists in eight different diameters. It will thus be seen that should such specifications become general it would be necessary on hexagon-head bolts alone to manufacture 2880 separate items in order to fill aeroplane requirements. An additional bolt complication is the varying thickness of head called for by the different manufacturers. The same situation exists in rod and yoke-end points as well as in castle nuts.

This divergence in size and material called for creates troubles and delays not only for the manufacturer of parts but also for the aeroplane and engine manufacturer and user, and could the metal fittings become standardized the aeroplane manufacturer would find that the cost of many of these parts would be but a small fraction of the present cost.

In conclusion, the writer made specific recommendations for standardization, covering bolt dimensions and materials, rod and yoke-end points, and nut requirements.

In the discussion which followed an important difference between fittings for aircraft and automobiles was brought out, viz., that while in automobiles the matter of weight is practically entirely neglected and the matter of cost is preëminent (secondary of course only to that of safety), in the aeroplane, at least at present, the matter of weight is of greater importance than that of cost. Further, the shape of the fittings, which is scarcely considered at all in automobile construction, becomes of importance on aeroplanes as it affects unfavorably or otherwise the harmful air resistance of the machine. On the whole, however, all the discussors expressed themselves in favor of the adoption of some means towards the standardization of parts.

Henry Souther, Mem.Am.Soc.M.E., Chairman of the afternoon meeting, introduced the subject by a brief talk on the progress of aviation in this country and called attention to the urgent necessity of greater publicity for this new branch of locomotion. He called attention to the often neglected fact that actually a very large number of flights are made every day, flights of which not a mention appears in the papers.

On the other hand, the comparatively few mishaps and accidents are given wide publicity, with the result that in the minds of the public an entirely erroneous impression is created, both as to the state of the art and as to the work actually carried on.

American Society of Heating and Ventilating Engineers

The Thirty-Third Annual Meeting of the American Society of Heating and Ventilating Engineers was held at the Engineering Societies Building, New York City, on January 16-18, 1917. J. Irvine Lyle was elected president.

An amendment to the constitution was offered by chapters to provide for chapters to be represented in the council, the representative to have no vote.

Of the reports presented the most interesting one was that of the committee appointed by the New York Chapter to consider a standard test for heating boilers. The purpose of this test is stated to be the determination of the capacity and efficiency of heating boilers under conditions approaching as nearly as possible those under which the boiler is to be installed. The specific object is the determination of the amount of steam which a boiler will furnish when burning a definite capacity of coal per hour in the manner for which it was designed. Therefore the schedule covering the report of tests will provide only for those items which are essential to determine the proper capacity of the boiler for commercial or sales purposes. No suggestions are made on this question of commercial rating or capacity except that as a basis of comparison the item "fuel available" should be calculated from area of firebox and depth to center of firedoor not exceeding 20 in. less 20 per cent for reserve; and item "time fuel available will last" figured on the basis of 8 hours.

The present report endorses the formula for calculating the rate given by the 1913 Committee in their report, in the following modified form:

Let C represent the pounds of fuel available for one firing period; let T represent the time fuel available will last; let E equal the total B.t.u. considered available per pound of fuel at boiler outlet, not exceeding results shown by tests.

Then CE/T represents the boiler capacity per hour in B.t.u. If rating is desired in equivalent square feet of direct radiation, divide the capacity in B.t.u. by 250 for steam and 150 for hot water.

American Institute of Electrical Engineers

The fifth annual mid-winter convention was held February 14-16 in the Engineering Societies Building, New York City.

The majority of the papers were on strictly electrical subjects, but in addition to these Major John H. Finney and Captain J. H. Cuntz read addresses on the part which engineers in general and electrical engineers in particular may take in military preparedness in its broad sense.

Professor R. A. Millikan of the University of Chicago read a paper on Modern Physics in which he spoke of the relations between physical research and electrical engineering.

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* *practical;* *s* statistical; *t* theoretical. Articles of especial merit are rated *A by the reviewer.* Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

The Interisland Steam Navigation Company of Honolulu, is preparing to replace the old steam engine and boilers of its large passenger and freight steamer *Mikahala* with a single 320-hp. Type M Bolinder engine, which is equivalent in power to a steam engine of 440 indicated horsepower. (*Motorship*, December 1916)

A substitute for platinum, according to *The Ironmonger* (Jan. 27, 1917), is an alloy having the following percentage composition: copper, 6.42; manganese, 0.98; silicon, 1.04; tungsten, 2.13; nickel, 60.65; aluminum, 1.09; iron, 0.76; chromium, 21.07; molybdenum, 4.6. This alloy is said to have a high melting point and to be highly resistant to acids, making it capable of replacing platinum in many cases.

Castings of nichrome intended to withstand temperatures of from 1000 deg. fahr. up, without corroding, are covered by U. S. patent No. 1,190,652. The alloy contains 60 per cent of nickel, 26 per cent of iron, 12 per cent of chromium, and 15 per cent of manganese, the latter being incidental and not essential. If the carbon content is under 0.40 per cent, the alloy can be machined, rolled or forged. It is said to be suitable for valves and valve seats of internal-combustion engines.

John D. Northrop, of the United States Geological Survey, Department of the Interior, estimates that during the year just closed 292,300,000 barrels of crude petroleum was produced and marketed in the oil fields of this country. This quantity is greater by 11,000,000 barrels, or 4 per cent, than the output in 1915. In addition to the quantity of oil produced and marketed in 1916, several million barrels were produced and placed in temporary field storage in Kansas and Oklahoma.

Three 3000-kw. power plants are now operated by volcanic steam at Larderello, in Central Italy, according to *The Electrical World* (Dec. 23, 1916), and supply three-phase energy for transmission to Florence, Leghorn and many smaller cities. The natural steam, which is obtained from 12-in. to 20-in. pipes sunk from 300 to 500 ft. below the surface of the ground, is of a corrosive nature and is not used directly in the turbo-generators; instead, it is applied like fuel in specially constructed multitubular boilers, generating therein steam that after use in the turbo-generators is condensed and pumped back into the boilers.

In anticipation of the day when, on account of the advancing cost of gasoline and other products obtained from petroleum, it might be found commercially profitable to utilize some of the enormous supply of petroleum to be derived from the distillation of the vast deposits of so-called hydrocarbon shales of the Green River formation of northwestern Colorado and northeastern Utah, the U. S. Geological Survey has for three years been making field investigations of them.

Very rough but cautious calculations of the contents of the shale in parts of the area examined indicate that the distillation of shale from beds over 3 ft. thick in Colorado alone will yield more than 20,000,000,000 barrels of crude oil, from which more than 2,000,000,000 barrels of gasoline can be extracted by ordinary methods.

SELECTED TITLES OF ENGINEERING ARTICLES

AERONAUTICS

ZEPPELIN POWER PLANT ENGINEERING, PART I. The Automobile, vol. 36, no. 3, January 18, 1917, pp. 179-182, 11 figs.

NOTES ON SPEED INDICATORS FOR AIRPLANES, Winslow H. Herschel. Aviation and Aeronautical Engineering, vol. 1, no. 12, January 15, 1917, pp. 381-385, 1 fig.

THE LONGITUDINAL INITIAL MOTION AND FORCED OSCILLATIONS OF A DISTURBED AEROPLANE, S. Brodetsky. The Aeronautical Journal, vol. 20, no. 80, October-December 1916, pp. 139-156.

FIRST REPORT OF AERONAUTIC DIVISION, S. A. E. Bulletin, vol. 11, no. 4, January 1917, pp. 422-424, 3 figs.

† STANDARDIZATION OF METAL PARTS FOR AERONAUTIC USE, F. G. Diffin. S. A. E. Bulletin, vol. 11, no. 4, January 1917, pp. 417-421.

AIR ENGINEERING

THE PHYSICAL PROPERTIES OF AIR IN RELATION TO PRACTICAL PROBLEMS, H. Eisert. Monthly Journal of the Engineers' Club of Baltimore, vol. 6, no. 8, February 1917, pp. 190-204.

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† MAGAZINE OILING IN FAGEOL, A NEW CALIFORNIA TRUCK. The Commercial Vehicle, vol. 16, no. 1, February 1, 1917, pp. 22-23, 5 figs.

† UNIQUE FAGEOL TRUCK SPRING LUBRICATION. The Automobile, vol. 36, no. 3, January 18, 1917, p. 185, illustrated.

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ANNUAL MEETING. Bulletin of The American Association of University Professors, vol. 3, no. 1, January 1917, pp. 5-7.

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ALUMINUM CASTINGS AND FORGINGS, P. E. McKinney. The Metal Industry, vol. 15, no. 2, February 1917, pp. 65-66.

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Cold working and expansion of Invar.

MEMORANDUM ON TESTS OF HARDNESS AND RESISTANCE TO WEAR—Appendix I, W. Cawthorne Unwin. The Metal Industry, vol. 10, no. 27, January 5, 1917, pp. 6-9.

ESSAIS DE DIVERS SABLES POUR MORTIERS, M. R. Feret. Annales des Ponts et Chaussées, Series 9, Tome 34, vol. 4, July-August 1916, pp. 70-80.
Tests of various sands for use in mortars.

SOME THOUGHTS ON THE DURABILITY OF MATERIALS CONVEYING STEAM, AIR AND WATER. Journal of the American Society of Heating & Ventilating Engineers, vol. 23, no. 2, January 1917, pp. 253-264, 6 figs.

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COAL AND ITS ECONOMIC UTILISATION, John S. S. Brame. Journal of the Royal Society of Arts, vol. 65, no. 3346, January 5, 1917, pp. 136-143, 2 figs.

SAVING FUEL IN A LARGE INDUSTRIAL BOILER PLANT, David Moffat Myers. Industrial Management, vol. 52, no. 5, February 1917, pp. 639-650.
The author of this paper is known to our readers as an authority on power-plant practice. He describes the economies that were effected in a large, comparatively modern plant which is noted for the progressiveness of its management. Economies in such a plant, therefore, indicate to some degree what savings might be obtained in the average industrial plant. By no means the least important of the methods used was the establishment of a bonus system for firemen.

UEBER ROHÖLFEUERUNGEN IN HÜTTENWERKEN, Von Direktor L. Schweitzer. Stahl und Eisen, 36 Jahrgang, nr. 49, December 7, 1916, pp. 1174-1180, 13 figs.
Crude oil firing in metallurgical plants.

THE WATER CONTENT OF COAL, WITH SOME IDEAS ON THE GENESIS AND NATURE OF COAL, Edward Mack and G. A. Hulett. The American Journal of Science, vol. 43, no. 254, February, 1917, pp. 7-110, 10 figs.

COAL AND ITS ECONOMIC UTILISATION, John S. S. Brame. Journal of the Royal Society of Arts, vol. 65, no. 3348, January 19, 1917, pp. 163-172.

THE USE OF COKE AND COKE-BREEZE FOR STEAM GENERATION, John B. C. Kershaw. The Engineer, vol. 123, no. 3186, January 19, 1917, pp. 51-52.

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VERTICAL FURNACE. Aeronautics, vol. 12, no. 170, January 17, 1917, p. 55, 1 fig.

GAS ENGINEERING

AN ORIGINAL DESIGN FOR A GAS VALVE, D. E. Keppelmann. The Gas Age, vol. 39, no. 3, February 1, 1917, pp. 121-123, 6 figs.

A STUDY OF THE THIN PLATE ORIFICE, V. R. Gage. The Sibley Journal of Engineering, vol. 31, no. 5, February 1917, pp. 120-124, 3 figs.

FORMULAE FOR FINDING LARGE GAS VOLUMES, H. G. Geissinger. The Blast Furnace and Steel Plant, vol. 5, no. 2, February 1917, pp. 55-56.

SOME ASPECTS OF RECENT HIGH PRESSURE INVESTIGATION, John Johnston. The Journal of The Franklin Institute, vol. 183, no. 1, January 1917, pp. 1-33, 14 figs.

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REQUIREMENTS FOR THE HEATING AND VENTILATION OF INDUSTRIAL BUILDINGS. The Heating & Ventilating Magazine, vol. 14, no. 1, pp. 35-43, 1 fig.
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† Abstracted in the Engineering Survey in this issue.

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A Pelton Wheel, B. Wilding. The Model Engineer and Electrician, vol. 36, no. 820, January 11, 1917, pp. 17-18, 2 figs.

Les Machines Hydrauliques à l'Exposition Nationale Suisse de Berne, en 1914, R. Neeser. Bulletin Technique de la Suisse Romande, 43 anné, no. 1, January 13, 1917, pp. 1-5, 5 figs.
Hydraulic Machinery at the Swiss National Exposition.

INTERNAL-COMBUSTION ENGINEERING

Will the Future Double-Acting Engine Be the Marine Diesel? Motorship, vol. 2, no. 1, January 1917, p. 9, 1 fig.

Piston Rods for High-Power Internal-Combustion Engines. The Mechanical Engineer, vol. 39, no. 990, January 12, 1917, p. 16, 4 figs.

Testing Variable-Speed Engines by a New Method, Daniel Roesch. S. A. E. Bulletin, vol. II, no. 4, January 1917, pp. 360-368, 9 figs.

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Crankshaft Problems in Automobile Engines, A. P. Brush. S. A. E. Bulletin, vol. II, no. 4, January 1917, pp. 397-416, 6 figs.

The Strength of Pistons, etc., IV. C. C. Pounder. Mechanical World, vol. 61, no. 1567, January 12. 1917, pp. 22-23.

Note on Bolted Timber Joints, Wm. Alexander. The Journal of the South African Institution of Engineers, vol. 15, no. 5, December 1916, pp. 76-79, 4 figs.

Worm-Gear Theory and Practice, Part II. The Automobile, vol. 36, no. 5, February 1, 1917, pp. 303-306, 6 figs.

Worm-Gear Theory and Practice, Part III. The Automobile. vol. 36, no. 6, February 8, 1917, pp. 344-347, 11 figs.

Worm Gear and Worm Gear Mounting, F. W. Lanchester. Part III. Engineering, vol. 103, no. 2664, January 19, 1917, pp. 65-67, 8 figs.

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Gage Grinding, Charles F. Schlegel. Machinery, vol. 23, no. 6, February 1917, pp. 468-469, 5 figs.

The Sand Blast: Its History and Development. Frederick George. Cassier's Engineering Mnthly, vol. 51, no. 1, January, 1917, pp. 9-19, 16 figs.

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Gaging and Inspecting Threads—I. Douglas T. Hamilton. Machinery, vol. 23, no. 6, February 1917, pp. 477-486, 15 figs.

Lubrication of Cutting Tools—2, Edward Hammond. Machinery, vol. 23, no. 6, February 1917, pp. 490-499, 16 figs.

Multiple Tools for the Lathe, Henry M. Wood. Machinery, vol. 23, no. 6, February 1917, pp. 506-513, 28 figs.

Grinding Wheels and Grinding Machines, C. W. Blakeslee. Industrial Management, vol. 52, no. 5, February 1917, pp. 697-710, 21 figs.

Power Required to Drive Machine Tools. Machinery, vol. 9, no. 224, January 11, 1917, p. 394.

† Gas-Heated Rivets Retain Temperature Longer Than Do Those Heated in Oil Furnace. American Gas Engineering Journal, vol. 106, no. 4, January 20, 1917, p. 87, 1 fig.
William F. Croston Explains Peculiar Condition Discovered at Works of Newport News Shipbuilding and Dry Dock Company.

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The Equivalent Mass in Rigid Dynamics, with Applications to Gyroscopes and Screw Propellers, A. F. Zahm, with diagram and data by W. P. Loo. Journal of The Franklin Institute, vol. 183, no. 2, February 1917, pp. 207-210.

Die Ermittlung der Umlaufzahlen und Kurbelschleife, Von H. Guttwein, Berlin. Werkstatts-Technik, vol. 10, no. 22, November 15, 1916, pp. 460-462.
Determination of speed of rotation.

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Air Conditioning Problem in the Manufacture of Ammunition, J. I. Lyle. The Heating & Ventilating Magazine, vol. 14, no. 1, January 1917, pp. 15-19, 4 figs.

Heat Treating Shrapnel Forgings. The Iron Trade Review, vol. 60, no. 6, February 8, 1917, pp. 365-368, 6 figs.

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Tests of Irrigation Pumping Plants, F. C. Piatt. Journal of Electricity, vol. 38, no. 3, February 1, 1917, pp. 79-82, 3 tables.

RAILROAD ENGINEERING

The Southern Locomotive Valve Gear. Railway & Locomotive Engineering, vol. 30, no. 2, February 1917, pp. 46-48, 5 figs.

The Maintenance of Air Brakes on Freight Car Equipment, H. S. Walton. New England Railroad Club, January 9, 1917, pp. 244-268.

Walschaert Valve Gear Design, H. A. Wels. Railway Mechanical Engineer, vol. 91, no. 2, February 1917, pp. 71-75, 10 figs.
Mathematical Determination of the Proportions of Moving Parts to Meet Locomotive Conditions.

Water Treatment on the Missouri Pacific Railway. Railway Review, vol. 60, no. 2, January 13, 1917, pp. 63-65, 1 fig.

Duplex Locomotives on the Southern Railway. Railway Review, vol. 60, no. 2, January 13, 1917, pp. 59-61, 3 figs.

Triplex Articulated Compound Locomotive for the Virginian Railway. Railway Review, vol. 60, no. 4, January 27, 1917, pp. 123-127, 4 figs.

† Refrigerator Cars, Pennsylvania Railroad. Railway Review, vol. 60, no. 5, February 3, 1917, pp. 155-157, 5 figs.

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Scientific Research in Its Relation to the Industries, Charles P. Steinmetz. General Electric Review, vol. 20, no. 2, February 1917, pp. 110-113.

Independent Laboratories in the Engineering Industries, Clayton H. Sharp. Journal of The Franklin Institute, vol. 183, no. 2, February 1917, pp. 221-228.

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Analysing a Marine Steam Plant, E. N. Percy. Mechanical World, vol. 61, no. 1567, January 12, 1917, pp. 23-24, 2 figs.

† "Doust" Joints. Steamship, vol. 28, no. 331, January 1917, pp. 147-148, 2 figs.

† The Design and Construction of High-Pressure Steam Stop Valves, D. Macnicoll. The Mechanical Engineer, vol. 39, no. 989, January 5, 1917, pp. 8-9, 4 figs.

† Forced Lubrication for Marine Turbines. Engineering, vol. 103, no. 2662, January 5, 1917, p. 12.

Heat Distribution and Economics in a Steam Power Plant, James M. Taggart. Steam, vol. 19, no. 1, January 1917, pp. 10-11, 5 figs.

Correcting Turbine Vibration, Eustis H. Thompson. Practical Engineer, vol. 21, no. 2, January 15, 1917, pp. 107-110, 4 figs.

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† Sur la Détermination de l'Energie Libre par l'Equation d'Etat de Clausius, M. E. Aries. Comptes Rendus des Séances de L'Académie des Sciences, vol. 163, no. 24, December 11, 1916, pp. 737-741.

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How Does Industrial Valuation Differ from Public-Utility Valuation? John H. Gray. The Utilities Magazine, vol. 2, no. 1, January 1917, pp. 26-40.

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The Asphalt Industry. Proceedings of the Engineers' Club of Philadelphia, vol. 34, no. 146, January 1917, pp. 11-17, illustrated.

Reinforced Concrete Coaling Stations on the St. Louis-San Francisco Ry. Railway Review, vol. 60, no. 3, January 20, 1917, pp. 97-99, 4 figs.

Etude sur un nouveau système de pont suspendu rigide, G. Leinekugel Le Cocq. Le Génie Civil, vol. 70, no. 1, January 6, 1917, pp. 5-10, 6 figs.

Man's Mechanical Efficiency in Work Performance and the Cost of the Movements Involved (Treated Separately), J. S. Macdonald. Proceedings of the Royal Society, Series B, vol. 89, no. B 618, January 1, 1917, pp. 394-410.

Development in Chemical Engineering Equipment, H. D. Miles. Metallurgical & Chemical Engineering, vol. 16, no. 3, February 1, 1917, pp. 154-158, 4 figs.

De-Tinning Apparatus. Aeronautics, vol. 12, no. 170, January 17, 1917, p. 55, 1 fig.

The Use and Abuse of Statistics, and Pictures with Punch, E. P. Roberts. Journal of The Cleveland Engineering Society, vol. 9, no. 4, January 1917, pp. 211-241, 19 plates.

Allegheny River Mining Co.'s Cadogan Tipple, H. Reisser. Coal Age, vol. 11, no. 5, February 3, 1917, pp. 218-221, 6 figs.

LIBRARY NOTES

From the Library of the United Engineering Society, Engineering Societies Building, New York. Includes Accessions to the Libraries of the Four Founder Societies

According to an agreement made by the thoughtful kindness of Mr. Theodore N. Vail, such volumes of the large Dering collection of early books on electricity which he presented to the Massachusetts Institute of Technology several years ago as were found to be duplicated in their library have now been offered to the American Institute of Electrical Engineers as a gift. Such as are not already in the Institute's collections will be added to the Library.

The Library has acquired by purchase at auction an extensive collection of early works on technical subjects, especially the metallurgy of iron and steel, from the library of the late John B. Pearse. Mr. Pearse was associated with Alexander Holley and others in early steel manufacture, making the first Bessemer steel for rails in this country. Among the purchases was an edition in Latin of Pliny's "Historia Naturale," printed in Venice in 1489; John Webster's "Metallographia," London, 1671; Schonberg's "Ausfuehrliche Berginformation," Leipzig, 1693; Pomet's "Histoire Naturale des Drogues," Paris, 1694; Paracelsus' "Buecher und Schriften," Basle, 1589-91; John Muller's "Treatise of Artillery," Philadelphia, 1779; Libavius' "De Metallorum," Frankfort, 1599; Jacob Leupold's "Schauplatz des Grundes Mechanischer Wissenschaften" in nine volumes with copper plates, Leipzig, 1724-39; Beyer's "Theatrum Machinarum Molarum," Leipzig, 1735; and a large collection of works on varnish.

Reference lists on the following subjects have recently been compiled in the Library:

Bauxite and Aluminum Sulphate
Metric System
Mining in China
Wooden vs. Steel Water Pipe
Standardizing Rates of Pay
Disposal of Tailings by Electric Power
Electrolytic Zinc
Aluminum
Barium Chlorate
Street Traffic Regulation
Central Station Accounting
Household Refrigeration
Tumbling

Copies of these lists are available. The library is now compiling an extensive bibliography on nickel.

The process of moving the collections of the American Society of Civil Engineers to the United Engineering Society shelves has begun; several weeks must elapse before it is completed.

Few members of the Founder Societies seem to realize the facilities offered by the Library Service Bureau for making translations. Any article in any European language can be translated for members. German, French, Spanish, Italian, Swedish, Danish, Dutch, Russian, Bohemian, Servian and Japanese, can be covered by regular translators employed by the Service Bureau. The rates are lower than those charged elsewhere for technical translation.

W. P. C.

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American Society of Mechanical Engineers Journal. vol. 38, 1916. *New York, 1916.*

American Society of Mechanical Engineers. Year Book 1917. *New York, 1917.*

American Society of Swedish Engineers. List of Members. Jan. 1, 1917. *Brooklyn, 1917.* Gift of Society.

Boiler Room Economics. By A. A. Potter and S. L. Simmering. Kansas State Agricultural College. Bulletin No. 2. *Manhattan, 1914.* Gift of Kansas State Agricultural College.

Centrifugal Fan Calculations by the "Specific Speed" Method. By M. C. Stuart. Reprinted from Journal of the American Society of Naval Engineers, Aug. 1916.

Centro Nacional de Ingenieros. Estatutos. *Buenos Aires, 1914.*

Comparative Friction Test of Two Types of Coal Mine Cars. By P. B. Liebermann. Reprinted from Bulletin, June, 1916, American Institute of Mining Engineers.

Elementary Course in Lagrange's Equations and Their Applications to Solutions of Problems of Dynamics. By N. W. Akimoff. *Philadelphia, 1917.*

John Fritz Medal Fund Corporation. Certificate of incorporation. May, 1903.

Insurance Society of New York. Membership, constitution, By-laws, Jan., 1917. *New York, 1917.* Gift of Society.

Leakage from Pipe Joints. By F. A. Barbour.

The Light Reflecting Value of Sanitary Wall Paints. Paint Manufacturers' Association of the U. S. Circular No. 43. *Philadelphia, 1916.* Gift of Paint Manufacturers' Association.

Lumbang and Perilla Oils. Paint Manufacturers' Association of the U. S. Circular No. 41. *Philadelphia, 1916.* Gift of Paint Manufacturers' Association.

Manuscript of Lecture of Wm. J. Durfee. n. d. Gift of Lindsay Swift.

A National Department of Public Works Our Nation's Need. By I. Randolph. Reprinted from the Journal of the Franklin Institute, Dec., 1916. Gift of C. W. Rice.

National Standard Specifications and Their Relation to Export Trade. By Wm. R. Webster. Reprint from Proceedings of the American Society for Testing Materials. vol. XVI, pt. II, 1916.

New Jersey Public Utility Commissioners. Statistics of Public Utilities. 1915. *Union Hill, N. J., 1916.* Gift of Public Utility Commissioners.

Public Engineering and Human Progress. By M. L. Cooke. Paper presented before the Cleveland Engineering Society, Nov. 14, 1916. Gift of C. W. Rice.

Quotations of Public Utility Securities, as of March 1, 1913, to assist in the preparation of Income Tax Reports together with full text of the Income Tax Law. Gift of Wm. P. Bonbright & Co.

Reducing the Time Limit in Concrete Building Construction. American Concrete Steel Company. *Newark, 1916.* Gift of C. W. Rice.

Self-Propelled Passenger Cars with the Edison Non-Acid Storage Battery for Motive Power on Steam Railroads and Electric Railways. *New York, 1916.* Gift of Railway Storage Battery Car Co.

State of New York at the Panama Pacific International Exposition, San Francisco, Cal., Feb. 20-Dec. 4, 1915. *Albany, J. B. Lyon Company, 1916.* Gift of Publisher.

Tests of Kansas Sands for Use in Mortar and Concrete. By R. A. Seaton and I. I. Taylor. Kansas State Agricultural College. Bulletin No. 3, Engineering Experiment Station. *Manhattan, 1916.* Gift of Kansas State Agricultural College.

The Thermodynamic Properties of Ammonia. By F. G. Keyes and R. B. Brownlee. *New York, J. Wiley & Sons, 1916.* Gift of Robert B. Brownlee.

These tables of the properties of saturated and superheated ammonia are based partially on an experimental investigation carried out at the Massachusetts Institute of Technology. The experimental meth-

ods and the details of the experiments will soon be published, but it was thought best to print the tables in advance. W. P. C.

Textiles—The Backbone of New England. Reprinted from the Bulletin of the National Association of Wool Manufacturers. *Boston, 1917*.

What Natural Gas Service Saves the People of Ohio. By Samuel S. Wyer. *Columbus, 1917*. Gift of author.

TRADE CATALOGUES

American Blower Company. Detroit, Mich.
Sirocco Service.

American District Steam Company. North Tonawanda, N. Y.
Catalogue and Price List No. 9. Heating Specialties.

Diamond Power Specialty Company. Detroit, Mich.
Power Notes. Dec. 1916, Jan. 1917.
Reducing Fuel Costs at the Schenectady Plant of the G. E. Co.

Flannery Bolt Co. Pittsburgh, Pa.
Staybolts. January 1917.

International Motor Company. New York, N. Y.
Mack truck aids science.
Power dump trucks. (Catalogue 1A.)

Ladd, G. T., Co. Pittsburgh, Pa.
Catalogue No. 17. Ladd water tube boiler.

Leeds & Northrup Co. Philadelphia, Pa.
Bulletin 866-A. Apparatus for the location of thermal transformation points.

Leschen, A. & Sons Rope Co. St. Louis, Mo.
Leschen's Hercules. January 1917.

Lindenmeyr, Henry & Sons. New York, N. Y.
Minton. Extra strong embossing coated cover.

Metaline Company. Long Island City, N. Y.
Metaline and metalined or oilless bearings.

Roebling, John A., Sons Company. Trenton, N. J.
Roebling Wire Rope. vol. 1, no. 4

Texas Company. New York, N. Y.
Lubrication. January, 1917.

Under-Feed Stoker Company of America. Chicago, Ill.
Publicity Magazine. December 1916, January 1917.

Wallace & Tiernan Company, Inc. New York, N. Y.
Chlorine control apparatus for water and sewage purification.

Goldschmidt Thermit Company. New York City.
Reactions. vol. 9, no. 4, 1916.

Harrison Safety Boiler Works. Philadelphia, Pa.
Catalogue 710. Cochrane Heaters.

Greenfield Tap and Die Corporation. Greenfield, Mass.
How to Measure Screw Threads. Bulletin No. 1.

This bulletin is issued as a step toward the promotion of standardized methods for both the casual measurement and continuous inspection of screw-cutting tools and their products. In theory, screw-cutting tools are supposed to reproduce their own threads. They do not always accomplish this in practice, largely because of the condition surrounding the application of power to them. Attention is therefore called to this fundamental idea, namely: it is not the tools that have to interchange, but the work done by them. W. P. C.

U. E. S. Accessions

Administration of Industrial Enterprises, with Special Reference to Factory Practice. By Edw. D. Jones. *New York, 1916*.

Aérodynamique. By N. Joukowski. *Paris, 1916*.

Alaska & Northwest Mining Journal. vols. 6-8. *Seattle, 1915-16*.

American Iron and Steel Institute. List of Officers, Directors, Members, Aug. 1, 1916. *New York, 1916*. Gift of Institute.

American Scenic and Historic Preservation Society, Annual Report. 21st, 1916. *Albany, 1916*. Gift of Society.

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Appalachian Engineering Association. Transactions. vol. VI. nos. 37, 39, 41-46. 1910. Gift of Library of Congress.

Bureau of Railway Economics. List of references to books and articles on the Adamson Law of September 1916.

List of references relating to the Eight-Hour Working Day and to limitations of working hours in the United States with special reference to Railway Labor.

Calcium Carbide and Acetylene. Ed. 3. By G. G. Pond. *State College, Pa., 1917*. Gift of Henry B. Koons.

California Mineral Production for 1915. California State Mining Bureau. Bulletin No. 71. *San Francisco, 1916*.

Canada Mines Department. Summary Report of the Mines Branch 1915. *Ottawa, 1916*.

Carnegie Steel Company. Standard Specifications. Steel for bridges, buildings, locomotives, etc. Ed. 6. *Pittsburgh, 1917*. Gift of Carnegie Steel Co.

Concrete Facts about Concrete Roads. *Chicago, 1916*. Gift of Portland Cement Association.

Coal Tar [illegible]. By J. M. Weiss. Reprint from Journal of Industrial and Engineering Chemistry, Sept. 1916. Gift of Barrett Manufacturing Co.

Concrete Sewers. *Chicago, 1916*. Gift of Portland Cement Association.

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Cornell University. President's Report, 1915-16. *Ithaca, 1916*.

The Eagle Almanac 1917. *Brooklyn, 1916*.

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Engineering Index Annual, 1916. *New York, Engineering Magazine Co., 1916*.

The Evening Post Japanese Supplement Dec. 30 1916. *New York, 1916*. Gift of C. H. Armstrong.

Experimental Researches on the Skin Effect in Steel Rails. By A. E. Kennelly, F. H. Achard and A. S. Dana. Reprinted from the Journal of the Franklin Institute, August 1916. Gift of Massachusetts Institute of Technology, Electrical Engineering Dept.

Farmer's Handbook on Concrete Construction. *Chicago, 1916*. Gift of Portland Cement Association.

Forests of Worcester County. The results of a forest survey of the fifty-nine towns in the County and a study of their lumber industry. *Boston, 1917*. Gift of Massachusetts State Forester.

General Summary of the Mineral Production of Canada During 1915. Canada. Department of Mines publication No. 421. *Ottawa, 1916*.

Geography of the Upper Illinois Valley and History of Development. Illinois Geological Survey. Bulletin No. 27. *Urbana, 1916*.

Geological Map of Mysore. 1915.

Georg. Agricola. De re Metallica. Liber Primus. n. p. n. d. Gift of E. P. Mathewson.

Glossopteris Beds of Betts's Creek, Northern Queensland. Queensland Geological Survey. Publication No. 254. *Brisbane, 1916*.

Great Britain. Committee of the Privy Council. Report for Scientific and Industrial Research. 1915-16. *London, 1916*.

Handbook of Technical Instruction for Wireless Telegraphists. Ed. 2. By J. C. Hawkhead and H. M. Dowsett. *London, 1915*.

Hearings Before Joint Committee of the Senate and House of Representatives on Interstate and Foreign Commerce Under Senate Joint Resolution, No. 60, to Investigate Government Control, Regulation and Ownership of Interstate Public Utilities. Oral Argument of Alfred P. Thom.

Hydro-Electric Power. By Lamar Lyndon. 2 vols. vol. i. Hydraulic Development and Equipment; vol. ii. Electrical Equipment and Transmission. *New York, McGraw Hill Book Co., 1916*.

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Catalogue 1 A. Westinghouse Distribution Transformers.
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Catalogue 7 A. Westinghouse Arc Lamps and Lighting Systems. *December 1916.*
Catalogue 7 B. Westinghouse Cooper Hewitt Mercury Rectifier Outfit. *December 1916.*
Catalogue 8 C. Westinghouse Electric Ware. *April 1916.*
Catalogue 8 D. Westinghouse Electric Ranges. *April 1916.*
Leaflet 1660. Automatic starters for Squirrel Cage Induction Motors.
Leaflet 1661. Automatic starters for wound rotor induction motors.
Leaflet 3668 B. Electric Arc Welding Equipments.
Leaflet 3814. Types CO and CR A. C. Relays.
Leaflet 3843. Auto starters for large squirrel cage induction motors.
Leaflet 3903. Alternating current grinder motors. Type CS.
Leaflet 3927. Feeder Voltage Regulators.

D. L. 3555 A. Westinghouse self-contained vertical shaft A. C. Generators.

Special Publication No. 1574. Maintenance of Equipment Harvard Shops, Cleveland Railway Co. *October 1916.*

White Fuel Oil Engineering Corporation. *New York, N. Y.* Low Pressure Mechanical Oil Burning System. *1916.*

Cement Gun Construction Company. *Chicago, Ill.* Bulletin no. 5. Gun-crete for protection. Illustrations of Gun-crete work.

De Laval Steam Turbine Co. *Trenton, N. J.* Catalog B. High Efficiency Centrifugal Pumps.

Lehigh Car, Wheel & Axle Works. *Catasauqua, Pa.* Catalogue 50. Fuller Quality Products. Price list covering face hardened sprocket and traction wheels. *1917.*
70. Fuller Lehigh Pulverizer Mill. *1917.*
71. Pulverized coal equipment. *1916.*

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary and items should be received by March 15 in order to appear in the April issue.

CHANGES OF POSITION

John O. Heinze, until recently identified with the John O. Heinz Company, Springfield, O., has become associated with The Simms Magneto Company, East Orange, N. J.

Wilbur C. Prior, formerly chief draftsman of The Morrow Machine Company, Hartford, Conn., has accepted a similar position with Eaton Crane and Pike Company of Pittsfield, Mass.

Royce L. Beers, until recently assistant fuel engineer with the U. S. Bureau of Mines, Pittsburgh, Pa., has become associated with the U. S. Radiator Corporation, of Detroit, Mich.

Alfred D. White has entered the employ of the Illinois Stoker Company, Alton, Ill. He was until recently district engineer of the Green Engineering Company, with offices in Denver, Colo.

William B. Corbett, designer with the Terry Steam Turbine Company, Hartford, Conn., has become affiliated with the General Electric Company, Lynn, Mass., in the capacity of draftsman.

Armin S. Hoffman, formerly assistant engineer with The Texas Company, New York, N. Y., has become affiliated with the [illegible] engineering department of the Griscom Russell Company, New York, N. Y.

Harold S. Lord has accepted a position with the Ruggles Machine Company, Poultney, Vt. He was until recently connected with the General Electric Company, Lynn, Mass., as mechanical engineer.

Henry E. Eagan, until recently manager of the Atlantic Ice and Coal Corporation, Dublin, Ga., has assumed the duties of chief engineer of the Harris Granite Quarries Company, Salisbury, N. C.

E. Nesdahl, formerly air-conditioning engineer with Warren Webster and Company, Camden, N. J., has become associated with the Braemes Air Conditioning Corporation of Philadelphia, Pa., in a similar capacity.

F. Wm. Hersche, formerly [illegible] foreman of the [illegible] department of the Newton Manufacturing Company, Lewis[illegible], Mass., has accepted a position with the American Locomotive Company, Schenectady, N. Y.

Forrest W. Manker, until recently associated with the B. F. Sturtevant Company, Cleveland, O., in the capacity of district manager, has become identified with the American Incandescent Heat Company, Boston, Mass.

Frank J. McCarty has become identified with the Rudel-Belnap Machinery Company, Ltd., Montreal, Canada. He was until recently in the employ of Tate, Jones and Company, Inc., Pittsburgh, Pa., as designing engineer.

D. W[illegible] M[illegible], formerly with the Montreal Rolling Mills Branch of the Steel Company of Canada, has become affiliated with the engineering department of the Algoma Steel Corporation, Ltd., Sault Ste. Marie, Canada.

Myron W. Rice, who was until recently in the employ of the American Engineering Company, Philadelphia, Pa., in the capacity of testing engineer, has become identified with the Columbia Chemical Company, of Barberton, O.

Albion R. Davis has joined the staff of the Stone and Webster Engineering Corporation, Boston, Mass., as mechanical engineer. Mr. Davis was formerly connected with Gray and Davis, Inc., in the capacity of chief draftsman.

John Airey, assistant professor of engineering mechanics at the University of Michigan, Ann Arbor, Mich., has accepted the position

[illegible] for munitions for the British Government with headquarters at Chicago, Ill.

Kenneth White, for the past seven years chief engineer of the By-Products Coke Corporation, Chicago, Ill., has assumed the duties of conveying-belt engineer of the Manhattan Rubber Manufacturing Company, Passaic, N. J.

Thomas F. [illegible], until recently in the employ of the American Synthetic Dyes, Inc., Newark, N. J., as assistant master mechanic, has become affiliated with the d[illegible]ning department of The Chile Exploration Company, New York.

L. C. W[illegible], for five years division superintendent of the Cygnet Division of The Buckeye Pipe Line Company at Cleveland and Lima, O., has resigned to accept a position with the Mid West Refining Company at Casper, Wyoming.

Claude M. Garland, formerly mechanical engineer with Woodmansee and Davidson, Chicago, Ill., has been placed in charge of the newly organized power department of the Allen and Garcia Company, with headquarters in Chicago, Ill.

A. L. Roberts has resigned his position as designing engineer with The Crown Cork and Seal Company, Baltimore, Md., and has accepted a similar position in the construction department of the Bethlehem Steel Company, South Bethlehem, Pa.

Ralph C. Chestnutt has become associated with the engineering department of the Willys-Overland Company, Toledo, O. He was formerly connected with the Maxwell Motor Compaany, Inc., Detroit, Mich., in the capacity of layout draftsman.

Joseph E. Sheedy has assumed the duties of assistant to the president of the Seattle Construction and Dry Dock Company, Seattle, Wash. He was formerly general superintendent of the Inter Island Steam Navigation Company, Ltd., Honolulu, Hawaii.

Harry H. Bates, recently connected with the Norfolk and Western Railway Company, Bramwell, West Va., as power director, has accepted the position of assistant boiler superintendent of the Hopewell, Va., works of the E. I. duPont de Nemours and Company.

R. K. Stockwell, who has been chief engineer and superintendent for the Braden Copper Company, of Rancagua, Chile, for the past five years, has opened an office in Salt Lake City, as engineering and sales representative of the Robins Conveying Belt Company.

Eric H. Peterson, formerly mechanical and refrigerating engineer with the Ford Motor Company, Detroit, Mich., has assumed the duties of chief engineer with the Vogt Brothers Manufacturing Company, formerly the National Foundry and Machine Company, of Louisville, Ky.

Dr. W. F. M. Goss, Past-President, Am.Soc.M.E., dean of the College of Engineering of the University of Illinois, has resigned to accept the presidency of the Railway Car Manufacturers' Association, of New York. The resignation will take effect as soon as Dr. Goss can be relieved.

W. H. Marshall, formerly president of the American Locomotive Company, is to become associated with J. P. Morgan and Company. It is understood that recognition of the successful execution of munition contracts by the American Locomotive Company during Mr. Marshall's administration has led to his new connection.

Paul H. Lange, for the last 6½ years chief engineer of the Niagara Machine and Tool Works, Buffalo, N. Y., formerly chief engineer of The Toledo Machine and Tool Company, Toledo, O., is now connected with the Max Ams Machine Company, Bridgeport, Conn., as engineer and manager of their press manufacturing department.

ANNOUNCEMENTS

Walter B. Gump has joined the staff of Armour and Company, Chicago, Ill., as mechanical engineer.

Max Friedlander has become associated with the American Radiator Company, Institute for Thermal Research, Buffalo, N. Y.

Fred W. Teele was elected vice-president and managing director of the Southern Canada Power Company, Montreal, Canada.

J. A. Malone, until recently connected with the New York office of the Allied Machinery Company of America, is now with the Paris office of the firm.

Sanford E. Thompson announces the formation of a partnership with William O. Lichtner under the name of Thompson and Lichtner, with offices in Boston, Mass.

Stanley D. Winger, sales engineer with The Prest-O-Lite Company, Inc., Chicago, Ill., has been placed in charge of the newly organized railway sales and service department of the company, with headquarters in Indianapolis, Ind.

Wm. A. Cattell, Henry S. Howard and Raymond Ashton announce their association under the firm name of Cattell, Howard and Ashton, Engineers, San Francisco, Cal.

Norman W. Storer, general engineer of the Westinghouse Electric and Manufacturing Company, was elected president of the Veteran Employees' Association of that company.

Elliott H. Whitlock has been recommended by the Chief of Engineers of the War Department for commission in the grade of Major in the Engineer Officers Reserve Corps.

A. L. Humphrey, first vice-president and general manager of the Westinghouse Air Brake Company, Pittsburgh, Pa., has been elected president of the Union Switch and Signal Company, in accordance with merger proceedings of the two companies. Hereafter he will assume the executive work of the two companies.

S. J. Gates, until recently commercial engineer with The Milwaukee Electric Light Company, Milwaukee, Wis., announces the organization of the Gates Engineering Company, commercial engineers. This company is prepared to investigate problems involving the supply of power, the development of new and additional business for municipally or privately owned electric and heating plants, the prospecting of new territory for electric power development, etc.

Charles R. Courteney and Robert E. Cahill, chief draftsman and superintendent, respectively, with the Watertown Engine Company and later with the New York Engine Company, have formed a partnership and will conduct business under the name of the Watertown Engine and Machine Company. The company will make a specialty of repairs and replacements to Watertown engines and boilers, and in addition will do engineering work along the line of testing and adjusting power-plant apparatus.

APPOINTMENTS

Warren D. Lewis has accepted an appointment as chief engineer of the Bradstreet Realty Corporation, New York, N. Y.

William J. Bailey has been appointed eastern sales manager of the United Coal Corporation, with headquarters in the Pennsylvania Building, Philadelphia, Pa.

William Ralph Webster has been appointed assistant chief engineer of the Cambria Steel Company, Johnstown, Pa. He was formerly chief draftsman of the company.

E. P. Roberts, consulting engineer, formerly Smoke Commissioner of Cleveland, O., has been appointed efficiency engineer of the Philadelphia Rubber Works Company, Akron, O.

Elmer F. Backer, formerly in charge of the new designs and experimental work at the Davenport Locomotive Works, Davenport, Ia., has been appointed chief draftsman of the company.

AUTHORS

Charles M. Horton is writing a series of articles on the Drafting Room for the *American Machinist*.

F. H. Newell addressed the February 1 meeting of the Engineers' Club of Trenton on Engineering Coöperation.

Albert A. Cary has contributed an article on Formation of Clinkers in Boiler Furnaces to the February 10 issue of the *Electrical World*.

F. A. Halsey has contributed an article on Metric System in Engineering to the February 1 issue of the *American Machinist*.

Frank Richards is the author of Drill-Sharpening Methods at the United Verde Mine, Arizona, which appears in the February 1 number of *Engineering News*.

Carl G. Barth is the author of Time Studies for Rate Setting as Originated by Dr. F. W. Taylor, which appears in the February 1 issue of the *American Machinist*.

Dwight V. Merrick has contributed an article entitled Object and Method of Taking Time Studies for Rate Setting to the February 8 issue of the *American Machinist*.

Walter Rautenstrauch is the author of Critical Speeds of Rotors Resting on Three Bearings, which is published in the February 1 number of the *American Machinist*.

THE NEW BOOKS

ALL books received by The Journal will be listed under this heading, generally accompanied by brief descriptive notes. Works of special importance to mechanical engineers will be commented on at length by members and others peculiarly qualified by reason of their experience and training. In this issue the list has been enlarged to include the chief publications brought out in the late summer and autumn of 1916.

AUTOMOBILES

Modern Starting, Lighting and Ignition Systems. By Victor W. Page. 5½ x 8 in., 509 pp., 295 illustrations. The Norman W. Henley Publishing Co., New York. $1.50.

BUILDING CONSTRUCTION AND EQUIPMENT

Mechanical Equipment of Buildings. By Louis A. Harding and Arthur C. Willard. Vol. I, Heating and Ventilation of Buildings. 7 x 9¼ in., 621 pp., illustrated. John Wiley & Sons, Inc., New York. $4 (To be reviewed later.)

Practical Safety Methods and Devices. By George A. Cowee. 5½ x 9 in., 434 pp., 128 illustrations. D. Van Nostrand Co., New York. $3. (To be reviewed later.)

Safety Engineering Applied to Scaffolds. 6 x 9 in., 339 pp., 127 illustrations. The Travelers Insurance Co., Hartford, Conn. $3.

ELECTRICAL ENGINEERING

A Laboratory Course of Practical Electricity. By Maurice J. Archbold. 7½ x 9¾ in., 211 pp., 98 illustrations. The Macmillan Co., New York. $1.10.

This book is made up of about one hundred loose-leaf blanks upon which to report the results of the experiments outlined therein, and is designed to be used in connection with any text-book. The experiments are intended to form four semesters of laboratory work, and, beginning with those on simple magnetic laws, range up through battery connections, resistance measurements, etc., to tests and measurements on d.c. and a.c. motors and generators and accessory apparatus. Diagrams showing the arrangement and connections of apparatus in the various experiments are given in an appendix.

Handbook of Machine Shop Electricity. By C. E. Clewell. 4 x 7 in., 461 pp., 315 illustrations. McGraw-Hill Book Co., New York. $3.

HOISTING AND CONVEYING

Elevators. By John J. Jallings. 5½ x 8½ in., 200 pp., 217 illustrations American Technical Society, Chicago, Ill. $1.50.

MACHINE ELEMENTS

Elementary Cams. By Franklin DeR. Furman. 5½ x 9 in., 87 pp., 69 illustrations. John Wiley & Sons, Inc., New York, $1.25.

The author first describes the various types of cams in common use, and then defines the terms employed in the solution of design problems. Following this come explanations of the methods of constructing the several generally used base curves for unit rise of the follower. In the third section, which comprises over half the book, the advantages of designing on a scientific basis instead of by cut-and-try methods are set forth, and illustrative problems are worked out in detail for each of the types dealt with earlier. Short sections on the timing and interference of multi-cam arrangements and on cam mechanisms for reproducing given curves and figures are also included.

Empirical Design. By Leslie D. Hayes. 6 x 9 in., 99 pp., 66 illustrations. Carpenter & Co., Ithaca, N. Y. $1.

Power Transmission by Leather Belting. By Robert T. Kent. 5¼ x 8 in., 120 pp., illustrated. John Wiley & Sons, Inc., New York. $1.25.

Valves and Valve Gears. By Franklin DeR. Furman. Second edition. 6 x 9 in., 253 pp., 237 illustrations. John Wiley & Sons, Inc., New York. $2.50.

MACHINE SHOP PRACTICE METAL WORKING

Automatic Screw Machines. By Douglas T. Hamilton and Franklin D. Jones. 6 x 9 in., 342 pp., 150 illustrations. Industrial Press, New York. $2.50. (Reviewed in this issue.)

English and American Tool Builders. By Joseph W. Roe. 6 x 9 in. 315 pp., 58 illustrations. Yale University Press, New Haven. Conn. $3. (To be reviewed later.)

Forging of Iron and Steel. By Wm. A. Richards. 5 x 8 in., 213 pp. 237 illustrations. D. Van Nostrand Co., New York. $1.50.

Grinding Machinery. By James J. Guest. 5½ x 8½ in., 440 pp. Longmans, Green & Co., New York. $4.

Lathe Design, Construction and Operation. By Oscar E. Perrigo. Revised edition. 6 x 9 in., 460 pp., 341 illustrations. The Norman W. Henley Publishing Co., New York. $2.50.

Oxy-Acetylene Welding. By S. W. Miller. 6 x 9 in., 287 pp., 192 illustrations. Industrial Press, New York. $2.50. (To be reviewed later.)

Plain and Ornamental Forging. By Ernst Schwarzkopf. 5¼ x 8 in. 264 pp., 400 illustrations. John Wiley & Sons, Inc., New York $1.50.

Practical Forging and Art Smithing. By Thomas F. Googerty. 5 x 7¾ in., 144 pp., 89 illustrations. The Bruce Publishing Co., Milwaukee, Wis. $1.

Treatise on Milling and Milling Machines. 6 x 9 in., 400 pp., 267 illustrations. Cincinnati Milling Machine Co., Cincinnati, O. $1.50

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Elliott's Weights of Steel. Flexible leather, 6 x 9 in., 662 pp. The Penton Publishing Co., Cleveland, O. $20.

Handbook for Machine Designers, Shop Men and Draftsmen. By F. A. Halsey. 8½ x 11 in., 561 pp., 750 illustrations. McGraw-Hill Book Co., New York. $5. (Reviewed in this issue.)

The "Mechanical World" Pocket Diary and Year Book for 1917. 3¾ x 5¾ in., 264 pp. text, and 52 pp. diary. The Norman, Remington Co., American Agents. $0.35.

This handy and inexpensive English compilation of mechanical-engineering information, now in its thirtieth year of publication, has, it is stated, been subjected to a thorough revision. The section dealing with steam and steam engines has been largely rewritten, and a new section on the heat treatment of steel has been added, as well as tables giving dimensions of piston rings and governors, and for the calculation of helical springs.

Mechanical Engineers' Handbook. By Lionel S. Marks. 4½ x 7 in., 1,800 pp., 1,000 illustrations. Flexible leather. McGraw-Hill Book Co., New York. $5. (To be reviewed later.)

Mechanical Engineers' Pocket Book. By William Kent. 4 x 6¾ in., 1,526 pp. John Wiley & Sons, Inc., New York. $5.

REFRIGERATION

Elements of Refrigeration. By Arthur M. Greene, Jr. 6 x 9 in., 478 pp., illustrated. John Wiley & Sons, Inc., New York. $4. (To be reviewed later.)

MISCELLANEOUS

Selling Your Services. 5½ x 8 in., 176 pp. The Sales Service Co., New York. $1.

It is the belief of the authors, whose names are not disclosed, that a man's services are to be marketed to the best advantage by employing the same selling principles that have proved successful in the disposition of other commodities, and with this in mind they have outlined the systematic methods of campaigning which they themselves followed in securing positions of responsibility. The volume includes numerous valuable suggestions regarding the advisability of changing employers and of hiring out to a competitor, hunting out opportunities for employment, the writing of cogent letters of application and situation-wanted advertisements, and procedure at an interview with a prospective employer. Examples of effective letters of application for positions as engineers, salesmen, foremen, correspondents, and accountants are given, which are easily susceptible of modification to suit particular requirements.

Handbook for Machine Designers

Handbok for Machine Designers, Shop Men and Draftsmen. By Frederick A. Halsey, B.M.E., Editor Emeritus of the American Machinist (Author of Slide Valve Gears, The Use of the Slide Rule, Worm and Spiral Gearing, The Metric Fallacy, etc.). McGraw-Hill Book Co., Inc., New York, 1916. Second Edition, revised and enlarged. Cloth, 8½ x 11 in., 561 pp., over 800 illustrations, including many full-page charts. $5.

This book places before the reader a large amount of information which heretofore had been spread over a great number of books, pamphlets, articles, papers, etc., and which for this reason was not available to those for whom this book was mainly written. It makes this information available to the practical man, whereas heretofore it has been available only to the student.

The book is quite broad in its scope and deals with all kinds of machine elements, as well as the strength of materials, mechanics, properties of the chief materials of construction, the study of heat, the steam engine, steam boilers, compressed air, etc., apparently with the aim of bringing together enough information in one volume to enable the designer to study, improve, and, in many cases, to even design a machine. In this the writer has succeeded admirably. Though more than one method or more than one set of formulae are often given, yet the author has succeeded in avoiding all confusion.

The book should be of considerable use to any engineer who has to deal with machinery, and should be of especial use to the draftsman and designer and also to the shop man who wants to be more than a machine operator. The information is given in such a shape that, as a rule, very little mathematical knowledge is required to thoroughly understand the subject, though the author did not make an attempt to leave out all reference to mathematics or the use of mathematical formulae. In many places graphical charts have been given, and many of these charts have been carefully analyzed.

The book is not exactly analytical, yet it offers enough analysis to lift it above a mere compilation and seems to aim to give not merely information but also understanding. Many concrete examples have been given, as well as many comparisons of existing mechanisms.

The material in the book is not original, nor does the author claim originality. An exception should be made as to those items which the author quotes from papers and books written at a previous period by himself, such as worm gears, helical gears, etc.

The book might be compared in its general get-up and its scope to the well known Reuleaux's Konstrukteur, covering somewhat the same ground and with the same thoroughness. Reuleaux's Konstrukteur has been out of date for many years, and no amount of effort would ever bring it again to the same position it once held. Halsey's Handbook will fill for the English-speaking engineers the place which was once occupied by the Reuleaux work.

There are certain chapters which could have been shortened without doing much harm to the book as a whole, among which is the chapter on Cone Pulleys and Back Gears. There are also many tables in the various chapters which, though doubtless of some value, make the book too bulky, and more would have been gained if either some of them had been omitted and thereby the book had been made handier, or else if all or most of the tabulations had been placed in a separate volume. There is considerable duplication in some of the mathematical tables, and it would be of advantage to have these tables thoroughly reviewed before the next reissue of the book.

These minor objections notwithstanding, Halsey's Handbook is an important addition to the engineer's library.

A. L. De Leeuw.

Automatic Screw Machines

Automatic Screw Machines. By Douglas T. Hamilton, Associate Editor of *Machinery* (Author of Automatic Screw Machine Practice, Shrapnel Shell Manufacture, Machine Forging, Bolt, Nut and Rivet Forging, etc.) and Franklin D. Jones, Associate Editor of *Machinery* (Author of Turning and Boring, Planing and Milling, Gaging Tools and Methods, etc.). The Industrial Press, New York, 1916. Cloth, 6 x 9 in., 342 pp., 150 illustrations. $2.[illegible]

The automatic screw machine as a factor in modern mechanical production has become so important and is so widely used that it seems fitting that a treatise specifically directed to it [illegible].

The technical press has of late given much attention to automatic screw machines, their methods of operation, and the class of work which can be economically done on such machines. While every day brings up new problems relating to their use, both the machines themselves and the work done on them have now been sufficiently standardized so that the public can be given some definite information regarding them which can be expected to be of more than transient value.

Such information has been brought together and with new material has been put in form for use by the authors of this book in a way to be of value both to the purchaser and owner of the machines and also to the operator, as well as to the designers of machines and of the tools and auxiliary

equipment required in their use. This work seems well adapted as a help to men who are employed to operate any of the types of machines described, from it they can obtain a better idea of the possibilities of the machine and its method of operation, thus enabling them to secure the best results in their work. It will also inform them as to the working of other makes of machines which at some time they may be called on to operate.

The authors have apparently given a comprehensive treatment of the subject, starting first with a detailed description of the mechanism of a number of well known types of machines, and emphasizing the particular advantages of each and the classes of work for which they are adapted. Thus the particular relative advantages of single- and multiple-spindle machines are discussed, the authors pointing out on what type of work the multiple-spindle machines may give better results by insuring a higher rate of production, and stating reasons why, other things being equal, the single-spindle machine can produce work of a higher degree of accuracy.

Then, following this general description, the authors go into details as to the various tools used in the machines, including instructions as to the correct clearance angles of the tools and as to their hardening; also as to the speeds and feeds required. A chapter also deals with the attachments found useful in extending the scope of the work which can be handled in automatic screw machines, and another gives a detailed description as to methods of laying out cams.

Specific cases are worked out for a variety of kinds of work and for work of different materials in such a detailed way as to be a guide for setting up for other work of similar character, and specific instructions are given as to the procedure of setting up and operating each of the types of machines described.

Finally, a number of special and unusual jobs are described, showing a great range of work which comprises much of a character not usually thought of as being screw-machine work. This, through the ingenuity of specialists, has been made a part of the product of the automatic screw machine, the use of which, for many of these jobs, now outclasses all other methods of production.

LUTHER D. BURLINGAME.

Engineering of Power Plants

Engineering of Power Plants. By Robert H. Fernald, M.E.,A.M.,Ph.D., Whitney Professor of Dynamical Engineering, University of Pennsylvania, and George A. Orrok, M.E., formerly Mechanical Engineer, New York Edison Company. McGraw-Hill Book Co., Inc., New York, 1916. Cloth, 6 x 9 in., 569 pp., 309 illustrations. $4.

"This is not a treatise on power plants. It is simply an epitome of the subject arranged by the authors for convenient classroom use."

These are the first sentences in the preface of this book and may be taken as representing the authors' final opinion of their production, for it is probable that the preface of a book is the last word of the authors.

The statement is clearly a true one. It is not a treatise, because it does not discuss the principles of design either of power-plant units or of power plants themselves. It is an epitome, because it points out just what one finds in power plants of large and small capacity, tells something of how the various units operate, tells much about their comparative economy, and more about the cost of installation and operation.

The authors have certainly accomplished their purpose in writing this book, and it appears at an opportune time.

The development of power engineering during the last decade has been as wonderful as it has been important. New prime movers have been born and have grown to large proportions. The teacher and student, the designing and operating engineer, have realized what a valuable fund of information has been published in the technical press concerning these developments. It has remained for the authors of this book to present the reader with the essentials of the best in power-engineering practice at the present time, not only in this country but abroad.

The authors do not use many words to present their facts; on the contrary, they use short and concise sentences, and the reviewer is impressed with the very large amount of information which the book contains. There are two things which appear peculiar: (a) The order in which the chapters are arranged; (b) the comparatively small space devoted to the electrical generator. The book is very largely descriptive. It contains only simple mathematical formulæ clearly explained and easily understood. It discusses no theories but contents itself with the presentation of facts. It presents the results obtained in the operation of many distinct appliances and many complete plants. It does not place in economic comparison types of equipment which should not be compared.

The book will undoubtedly be used as a textbook as one of the authors has used it—"for *all* senior engineering students"—and all engineering students must know something about the engineering of power plants. With this book as a text the teacher with experience will be able to develop an admirable course of instruction on power engineering in its broadest sense. A goodly number of problems are distributed throughout the book. The problems have a true power-plant flavor and one feels sure the authors have had to solve many of them in practice rather than manufacture them for a textbook.

This book should meet with much favor entirely outside the classroom. The designers, the builders, the operators of power plants will all find much information of value to them in it. The designer will profit by a study of the relative economic-performance curves of various units which he wishes to install, the builder will find the tables of cost extensive, the operator will be able to learn what others have done to reduce operating costs and to observe from the curves what conditions of operation tend toward best performance with a given combination of appliances under varied conditions.

The title Engineering of Power Plants seems to fit the book, for while perhaps two-thirds of its contents relate to burning fuel for making steam and then the use of steam for making power, electricity or heat, the other third takes up internal-combustion engines and gas producers, compressed air, and hydraulic power. A few pages are devoted to the power plant of the steam locomotive.

This is an excellent book: good material well presented; the faults and errors are few.

The names of the authors on the back of the book are a sufficient guarantee of its contents.

It is well when engineers and engineering teachers coöperate. Books will be better as they learn to do so.

It is doubtful if there could be found two engineers whose knowledge of the problems of the engineering of power plants and the teaching of the subject to engineering students, better fitted them for the coöperation which resulted in this work.

L. P. BRECKENRIDGE.

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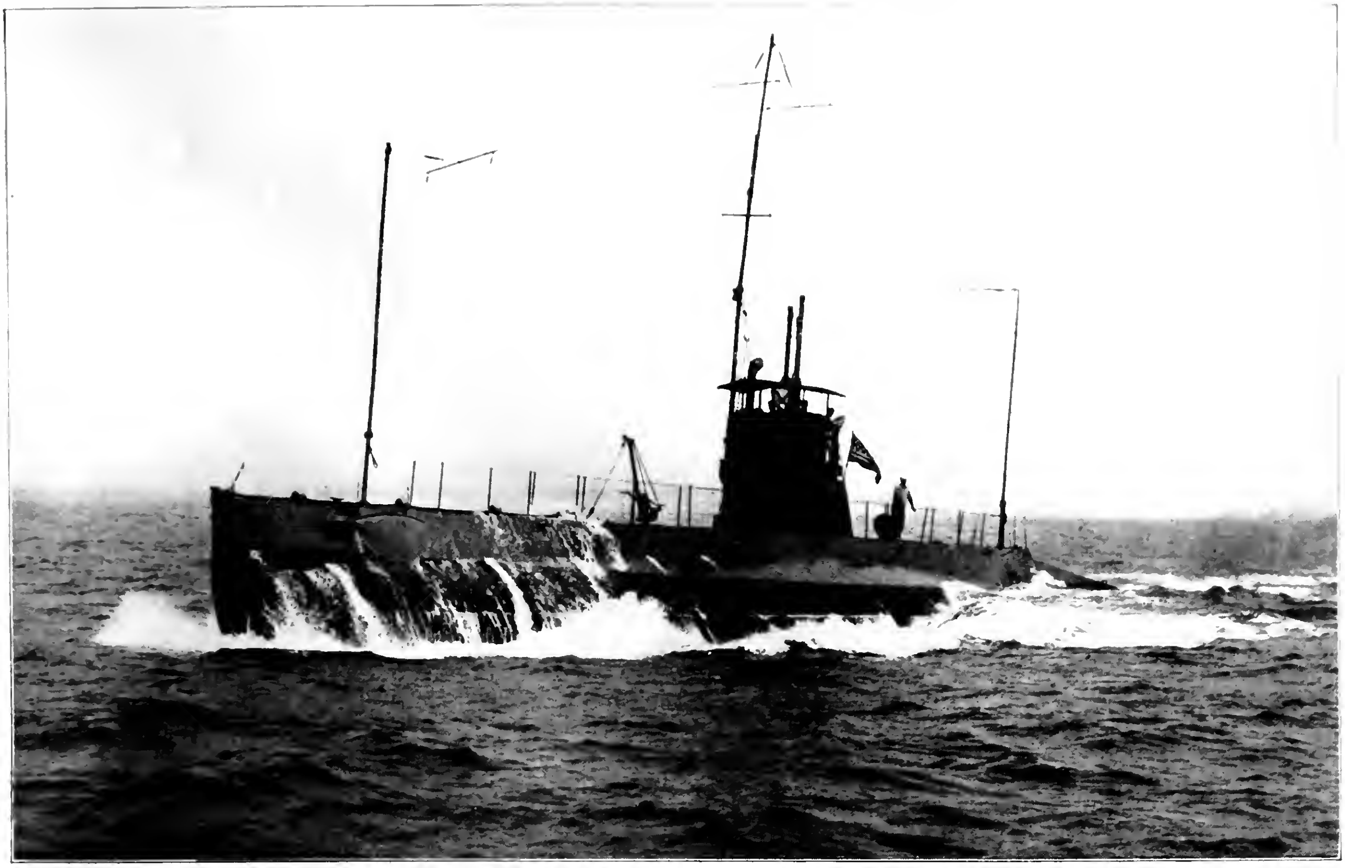

U. S. Submarine *K-1*, Just Emerged. The Wireless is Lowered for Submerged Work

THE SUBMARINE

By C. H. BEDELL,[1] GROTON, CONN.

RECENT events have forcibly brought to the attention of the entire world the capabilities of the little boat known as the submarine. All the characteristics of these boats are fascinating; to the engineer on account of the many unique problems that have to be solved; to all of us on account of the many dramatic possibilities in connection with submarine navigation. Since these dramatic possibilities are so great in number, it is surprising that our popular fiction writers have not made more extended use of the submarine. Probably this neglect of such a promising field has been due to lack of the necessary engineering knowledge to handle the subject properly. We have, however, one book on the submarine in the field of fiction that is well written and full of interesting scientific and engineering material. This book is Jules Verne's Twenty Thousand Leagues Under the Sea. I read it as a boy, when it was first published in about 1874, and was fascinated by the picture it gave of life beneath the wave, not imagining that it would ever be my privilege to journey thus in those depths of which we know so little. A short time ago I reread the book, and was again fascinated by it, because it gave me a chance to see how closely we have lived up to that imaginary picture of Jules Verne.

[1] Electrical Engineer, Electric Boat Co.

Presented at a meeting of the New York Section of The American Society of Mechanical Engineers, New York, November 14, 1916.

As far as the handling of a submarine is concerned, whether under way, on the surface or submerged, or at rest on the surface, poised at any depth or resting on the bottom, the boats of the present day are as perfect as the *Nautilus* of Jules Verne. We may even, if we so desire, make our boat so that, when it is at rest submerged, a man with a diving helmet, and entirely disconnected from the submarine or the surface, may pass from it into the sea and explore the ocean floor for an hour or more, as Captain Nemo of the *Nautilus* did. That such construction is not used is due to the fact that there seems to be no material need for such operations. The *Nautilus* was driven by electricity. We also use electricity when running submerged, but we obtain our electricity from storage batteries, while Captain Nemo obtained his in some mysterious way from the sea itself. The great difference between fiction and reality in this case is that the *Nautilus* was able to go around the world with one supply of energy, while we are obliged to come to the surface after one or two hundred miles for the purpose of recharging our storage batteries.

The men on the *Nautilus* are supposed to have been able to see objects at distances up to one-half or three-quarters of a mile by the light of the sun or by powerful electric lamps. While we at this time probably have more powerful electric lamps, it is impossible for us to see any great distance through water, no matter what method of lighting is used. This is true, at least, along our shores as far out as the Gulf Stream.

An enormous amount of sediment is continually being poured into the sea by our rivers and streams, and in addition the endless wash of the waves on our sandy shores constantly tends to maintain the turbidity of the water. I have frequently looked through the periscope of a submarine when resting on the bottom at a depth of 50 ft. The second periscope, some five or six feet away, could easily be seen, but the bow of the boat, 75 ft. away, could not be seen. The suspended matter in the water acts exactly as does fog in the air in preventing distant vision. On account of this fact, all running when totally submerged must be by distance runs, obtained by known speed and time. Of course, in certain waters the limit of vision may be materially increased, as, for example, among the islands of the West Indies or off the coast of Southern California, yet even in such waters it is not probable that one could see more than 100 or 200 ft., and such a distance is not sufficient for purposes of navigation. Thus at one stroke we take away the greatest factor that gives such a charm to Verne's work—the major portion of the control of the submarine must be by vision above the waves.

Another point interesting to consider is that of the pressure per square inch at different depths, for in this connection Jules Verne materially slipped up in his calculations. He tells about Captain Nemo forcing his boat to depths of 6000 or 7000 ft., not realizing that pressures increase nearly half a pound per square inch for each added foot of depth. At 6000 ft. the pressure is nearly 3000 lb. per sq. in., and the *Nautilus,* as described in Verne's work, would not have stood any such pressure. An illustration in the book shows a man seated before a large plate-glass window, and another man swimming in the water outside. This window must have been at least 25 ft. square, and at a depth of 200 ft. it would have to sustain a pressure of about 100 lb. per sq. in., or 175 tons on the window. At 6000 ft. the total pressure would be 5250 tons. Certainly no glass made of the form illustrated could sustain such a load. However, it makes a very pretty picture.

Another point shows Verne's misunderstanding. He states that they had to use all the enormous power of her engines to force the boat down against the great water pressure; the greater the pressure, the greater power it took. This is not according to fact, for if a body is once made heavier than sea water and starts to sink, it will continue until the bottom is reached, if the salt in the sea water remains a constant percentage, a condition which practically exists in the open sea. The question is frequently raised in our newspapers whether a ship sunk by collision or the like will sink to the bottom or go a certain distance and then remain poised. The question was raised at the time the *Titanic* was sunk. The solution of the question rests upon the compressibility of the material of the ship as compared with that of water. If the latter is greater than the former, and the depth is great enough, a point would be reached where the water would be as dense as the material of the ship, and there the ship would remain poised. For the purpose of calculation, let us take the extreme case of a solid steel ball dropped overboard in the open sea. Now, in general, we say that water is incompressible. This statement arose in comparing the compressibility of water with that of a gas, such as steam. When an engineer allows water to get from his boiler into his engine cylinder, and the piston striking this water on the return stroke drives off the cylinder head, he says the water is incompressible. As compared to a gas it is incompressible, but as compared to steel it is compressible; indeed, it is more compressible than steel. Therefore, our steel ball as it descends into the sea and is compressed has water around it that is being compressed at a more rapid rate under the increase of pressure than the steel is. If the depth, and therefore the pressure, is great enough, a point will be reached where the water will be as dense as the steel, and at that point the ball will remain suspended. A calculation based on the compressibility of steel and water shows that the required depth is about 100 miles. As the sea is only some five or six miles deep, it is evident that our steel ball will go to the bottom. Now let us take the case of the ship that has been sunk. When she starts to go down she is heavier than the water around her. The ship, as a whole, is far more compressible than the steel of our ball, and will get relatively heavier as she descends, that is, will sink faster and faster until the bottom is reached. Returning now to the submarine, where we have a hull that is perfectly watertight. Since this hull is composed of circular frames on which is mounted the hull plating, its compressibility is far greater than our steel ball; indeed, it is far greater than water. In consequence, if a submarine is so trimmed down that she is even slightly heavier than water, she will sink to the bottom. This has been conclusively proved in connection with our tests of submarines at 200 ft. Every submarine for the U. S. Government must be taken down to this depth and kept there for ten minutes. In making this test, it is the custom first to anchor the boat where the depth of the water is right, then trim the boat by admitting water into her tanks, trimming her down until she has only a few hundred pounds' buoyancy, then hauling in on the anchor rope. This operation draws the boat down until the desired depth is reached. In one or two cases, in the trimming-down operation, but a small amount of reserved buoyancy was given the boat, and as the boat descended and became compressed this reserved buoyancy was lost and the boat went the rest of the way to the bottom. From the above it will be readily seen that Verne's statement that it took all the power of the engines of the *Nautilus* to drive her into those great depths is not correct. There is one exception to the general statement that a body starting to sink will go to the bottom, and this is where the water is stratified, when large quantities of fresh water from rivers come in contact with the salt sea water. Such a condition exists in the St. Lawrence. Recently in making the 200-ft. depth test in those waters it was found necessary to add 5000 lb. to the water in the tanks after the boat had started to sink in order to get her down to 200 ft. This was due to the fresh water from the river being over the heavier salt sea water.

THE SUBMARINE IN HISTORY

The history of the submarine extends over quite a period of time, as there is a record of such a boat having been built about the year 1624. During the next 150 years the subject was frequently considered by marine engineers, but no construction was undertaken. At the time of our Revolutionary War, the interest in the subject was transferred from Europe to this country, due to the fact that a small submarine had been built by David Bushnell, of Connecticut. This boat was only large enough for one man and shaped like a flattened egg, with its major axis vertical. It was fitted with tanks and pumps, anchor operated from the inside of the boat, screw propeller in the front of the boat, another screw propeller at the top with its axis vertical, rudder and torpedo at the stern, and at the top of the boat a screw operated from within the boat. It is evident that this screw was intended to be worked into the planking of a ship at anchor. The torpedo was fastened to the screw by a line, and when the submarine was moved away the torpedo remained with the screw. The sep-

arating of the torpedo from the submarine started a clock, which in a certain time would explode the torpedo. Bushnell had to educate the public on two points in connection with his boat, the exploding of gunpowder under water and the use of the screw propeller. The propeller had been invented a short time before by another man, but evidently Bushnell's boat was the first on which it was used. During the Revolutionary War a chance at last came to make use of the boat, against a British war ship anchored off Governors Island. Unfortunately, the man who had been conducting the operations of the boat was sick at the time and another had to take his place. Floating down with the tide in the late hours of the night, the submarine was maneuvered until she came under the war ship. The operator in attempting to force the screw into the planking of the ship failed on account of striking metal fittings. Before he could relocate his boat the tide carried him away and he had to give up the attempt. Two other attempts were made against British ships anchored in the Hudson, but these also failed on account of the strong tide. If the anchor of the submarine had been used until the torpedo was attached to the ship, the attempt would have been successful. Public opinion did not support Bushnell in his work, and therefore nothing further was done.

The next submarine of interest is that of Robert Fulton, who launched the *Nautilus* in the Seine in 1801. He conducted many experiments with this boat, but not getting the necessary financial support in France, took the boat over to England. There he created quite a furor, and many experiments were conducted, even going so far as to the blowing up of an old hulk provided for the purpose. The people did not consider the time ripe for that method of warfare, and Fulton again failed to get support. He then came over to this country and succeeded in obtaining a grant of $50,000 from Congress for the conducting of experiments. It is understood that it was Fulton's submarine that was to make an attack on a British prison ship off New London, but the commander of the prison ship hid behind his prisoners and obtained the influence of their friends on shore to prevent the attack. The work with Fulton's submarine was discontinued, as again it seemed that popular opinion was not ready for the use of such ships.

The credit for the first actual service of a submarine in time of war will have to be given to a boat built by Wilhelm Bauer, a Bavarian, who built one such boat for Germany and one for Russia. The boat built for Germany succeeded in breaking up the blockade of the Danish fleet off Kiel. Later, this boat was sunk, due to the collapse of her hull from excessive water pressure, the crew luckily escaping. A few years ago the boat was located during certain dredging operations, was raised, and is now on exhibition in Berlin.

During our Civil War the South became quite interested in the submarine, and several of the boats, called "Davids," were built. These, as were the earlier boats, were all operated by man power, eight men being used to drive the propeller. Many accidents were experienced during the experiments on these boats and several crews were lost. These accidents, however, did not occur when the boats were operating submerged but when on the surface. The small conning tower used was very low, and waves from passing steamers and the like washed over it, causing the boat to sink. New crews were quickly found and experiments continued. At last a chance to use the boat came, and an attack was made on the U. S. frigate *Housatonic*, anchored off Charleston. The attack was made at night, and therefore the boat was operated on the surface only. A spar torpedo was used, as at that time the automobile torpedo had not been developed. It is reported that an officer on the deck of the *Housatonic* saw the submarine approaching the ship, but thought it was a plank floating with the tide. This idea was quickly dispelled, for after a terrific explosion the men who had been on deck found themselves in the water. The *Housatonic* was sunk, and carried down with her the submarine and all her brave crew. It is probable that the smaller boat was sucked into the hole in the larger ship, and held there by the water pressure.

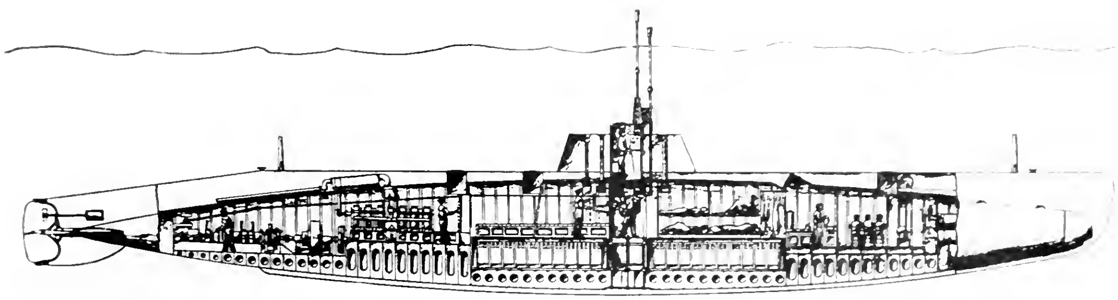

Fig. 1 Cross-Section of a Modern Submarine

Present Day Submarines

During the following twenty-five years many submarines were designed and a few built. None of these, however, proved to be successful. I am going, therefore, to jump to the time of John P. Holland, and describe the submarine of the present day. Holland was an Irishman who came to this country just before the Civil War, a man of but very little education but a bright mind. He was much interested in the fight between the *Monitor* and the *Merrimac*, and soon commenced to consider submarine work. At last he succeeded in getting support for his experiments and built two or three small submarines. His idea being to build a boat that would sink the British Navy, his trend of mind is shown by the name he gave one of his boats, the *Fenian Ram*. His first boats did not amount to much, but he acquired a great deal of experience, discovered what to do and what to avoid, and was then in shape to attempt more extended work. It was at this time that he joined forces with the Electric Boat Company, and the *Holland* was their first product.

Mr. Holland started his work at just the right time, for the internal-combustion gasoline engine giving large power with small space and weight had just been developed and large storage batteries with corresponding electric motors

were to be had. Without this material it is safe to say the submarine would still be in an experimental form.

The general arrangement of the modern submarine follows very closely the design given in sketch form in Fig.

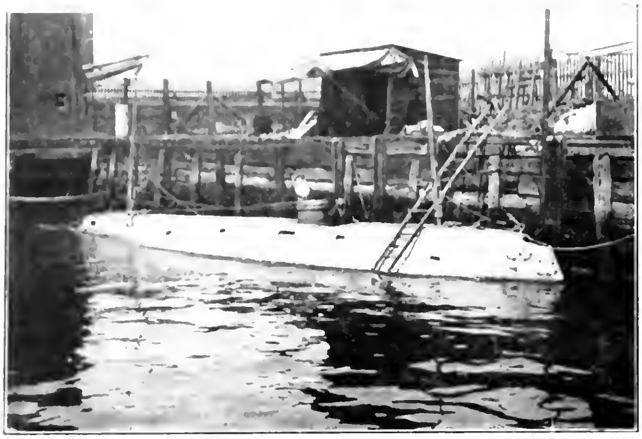

Fig. 2 U. S. Submarine *Holland*

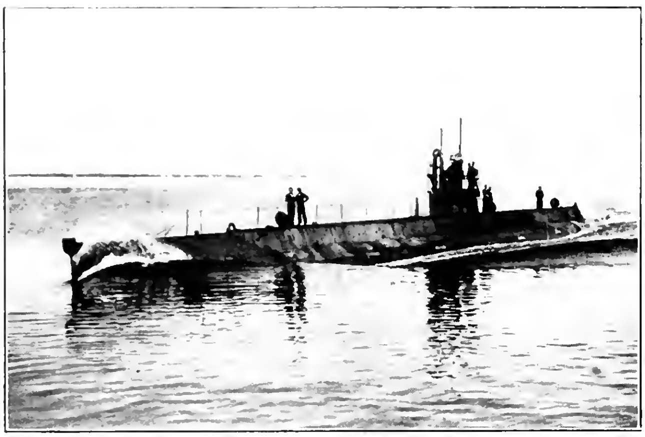

Fig. 3 U. S. Submarine *M-1*

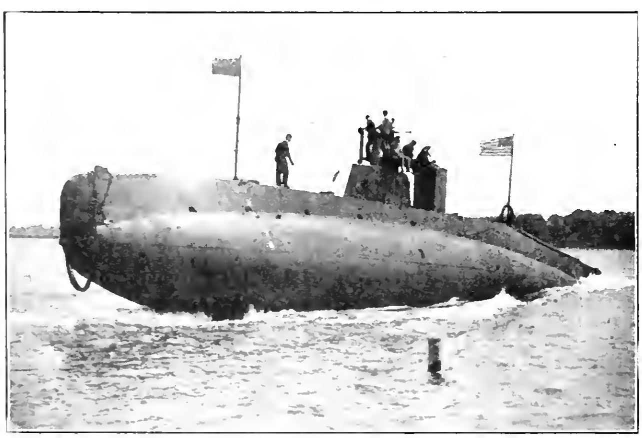

Fig. 4 Launching a Submarine

1. The hull proper is cigar-shaped, since this form is best suited to withstand the pressure of submergence. Above the main hull is a narrow superstructure extending from the bow nearly to the stern. This superstructure may be water-tight, but in general is open to the sea. It serves to house certain external fittings, and forms a deck for the use of the crew. At the bow just within the bow casting is the bow cap, covering the outer ends of four torpedo tubes; two open-

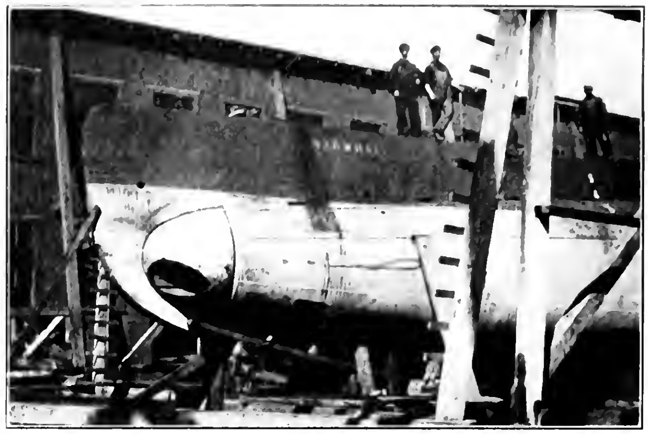

Fig. 5 Bow of Submarine with Bow Cap in Position for Torpedo Firing

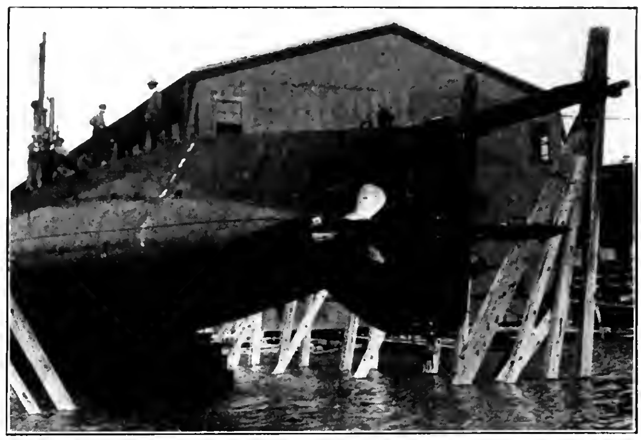

Fig. 6 Stern of a Submarine

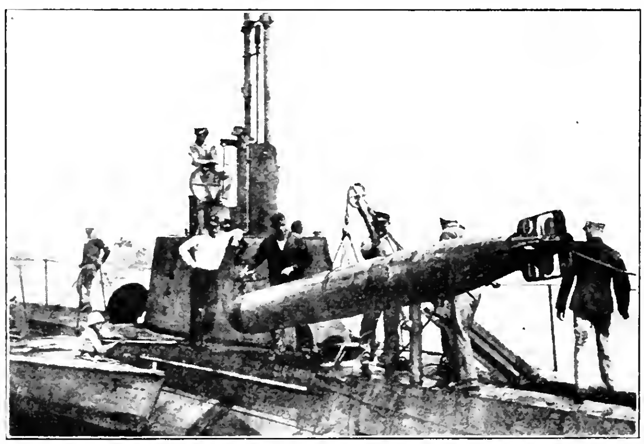

Fig. 7 Taking a Torpedo on Board

ings are made through this bow cap, and by rotating the cap the openings may be placed in line with the different torpedo tubes. These tubes at the inboard end are fitted with doors, so that after the tubes have had the water drained into the

trimming tank which surrounds them, the doors may be opened for the admission of spare torpedoes. Immediately abaft the tubes is space for spare torpedoes, and below the deck, tanks for fuel. In the design shown, the galley is also located in the compartment. In the central part of the boat is the main operating compartment, in which are the levers that control the main ballast, auxiliary ballast, and adjusting tanks, steering and diving wheels, control of all high pressure air lines, periscope and connection to the conning tower. In the two compartments ahead and abaft the central operating compartment are placed the two sections of the storage battery, these batteries being large enough to supply current to the main motors and drive the boat for one hour at $11\frac{1}{2}$ knots, or at low speed to give her a radius of about 100 miles. Around the storage battery are the main ballast tanks. It is in connection with the tanks of a submarine that Mr. Holland showed his genius, and no submarine can be considered a success that does not follow the lines of tank construction that he prescribed. In all the earlier submarines the tanks were constructed large enough to take the maximum amount of water that might be required, and therefore were almost never totally filled. In consequence, as the angle of the boat changed, the water was free to flow from one end of the tank to the other, making it almost impossible to keep the boat properly trimmed. Holland, realizing this condition made it a rule that the main ballast tanks should be of such a capacity that when entirely filled the boat would be brought to the awash condition only, and that the final adjusting of the buoyancy of the boat must be made by the use of a small tank which would have but a small free-water surface if not entirely filled. The main ballast tanks are therefore entirely empty or completely filled. Abaft the storage-battery compartment are the engines, main motors, pumps, air compressors, and at the stern are the after trimming tank, twin screw propellers and the steering and diving rudders. The conning tower is placed over the central operating compartment and in the sketch shown is fitted with one of the periscopes. Steering is done by means of an electric motor controlled by push buttons.

The operation of a boat submerged is quite different from one on the surface. On the surface if a man walks from amidships to the bow, the bow will be depressed, displacing a greater amount of water, and therefore able to sustain the increased weight. When the boat is submerged no change of displacement can occur, and consequently such shifting of weight will cause the boat to take a greater angle. A boat submerged may be likened to a pendulum having a length equal to the distance between the center of buoyancy of the boat and its center of gravity, generally a distance of about sixteen inches, and the weight of the pendulum being the weight of the boat, say 500 tons. A weight moved from amidships to one end of the boat would produce a leverage to swing this pendulum from the vertical, in other words, to cause the boat to take an angle by the bow or stern. As a submarine when submerged will go the way she is pointed, it will readily be seen that change of angle will cause her to change her depth. The man at the diving wheel not only has his wheel and depth gage before him, but also a clinometer, a sort of level by which he can tell the exact angle of the ship and therefore tell whether the boat will change her depth or not as she goes along. As a matter of fact, the boat is swinging up or down most of the time, and it is the duty of the man at the diving wheel to check these motions and control the boat so that she will remain at the depth

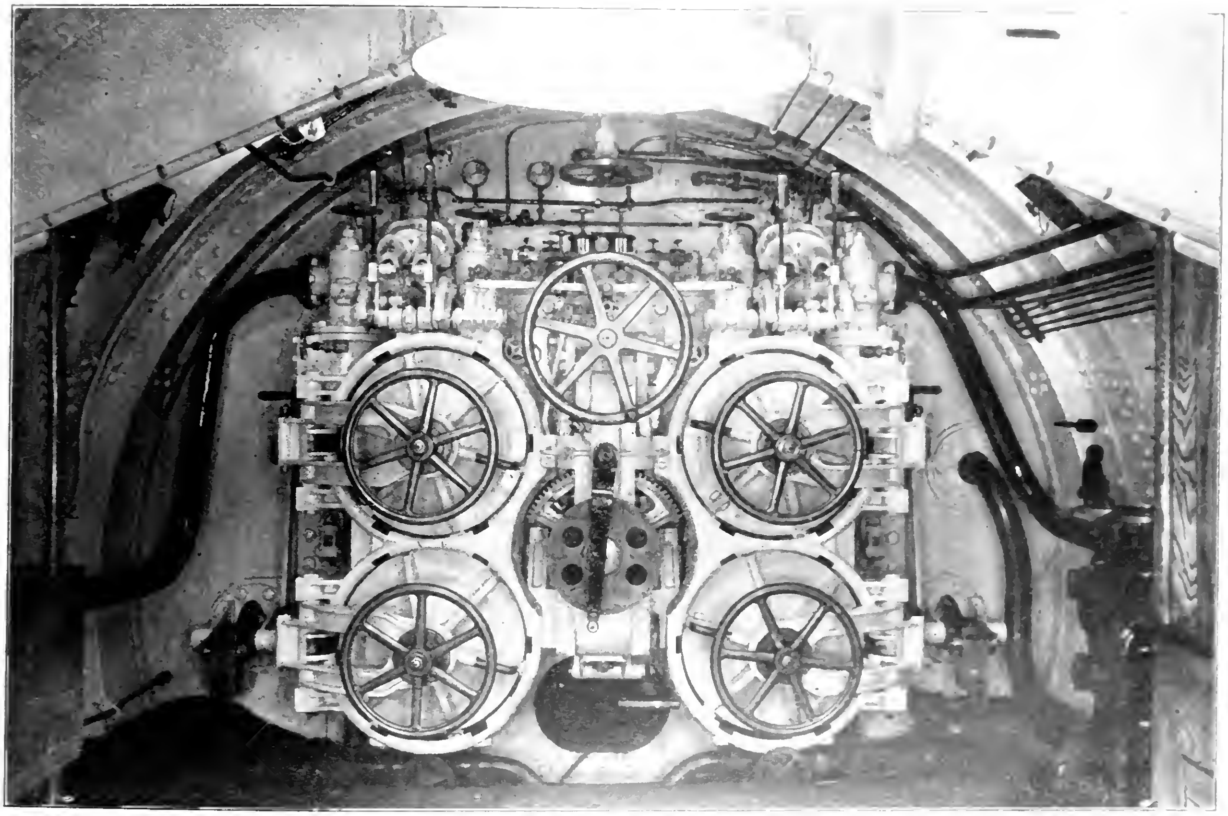

FIG. 8 INNER ENDS OF THE FOUR TORPEDO TUBES

[illegible] body requiring constant attention, and the [illegible] whole [illegible] performance of any duty. In the

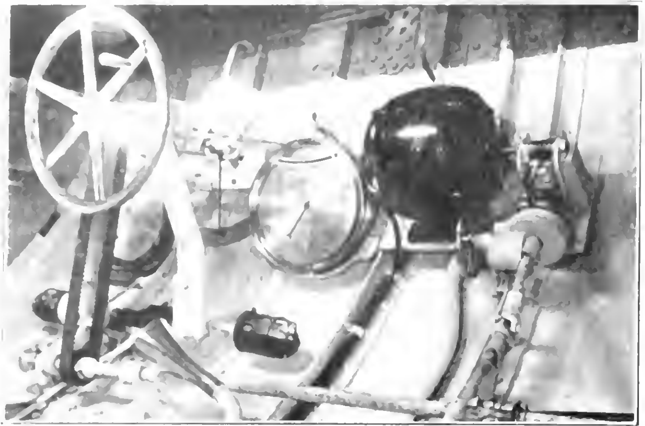

FIG. 9 DIVING CONTROL STATION

small boats first built, great care was exercised that there should be no shifting of weight when the boat was running submerged. In the large boats as now built the weight of a man is such a small percentage of the total weight that quite a change, yet a torpedo from a small boat, if it reaches its mark, is as effective as one from a large boat. It is the fact just mentioned that indicates why a submarine will

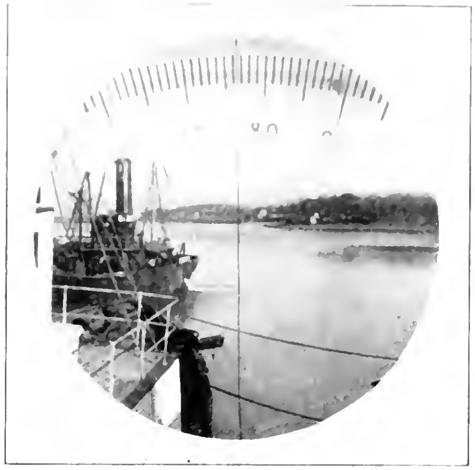

FIG. 10 VIEW TAKEN THROUGH PERISCOPE

retain her usefulness until she is literally worn out. She does not become obsolete as does a battleship as soon as a more

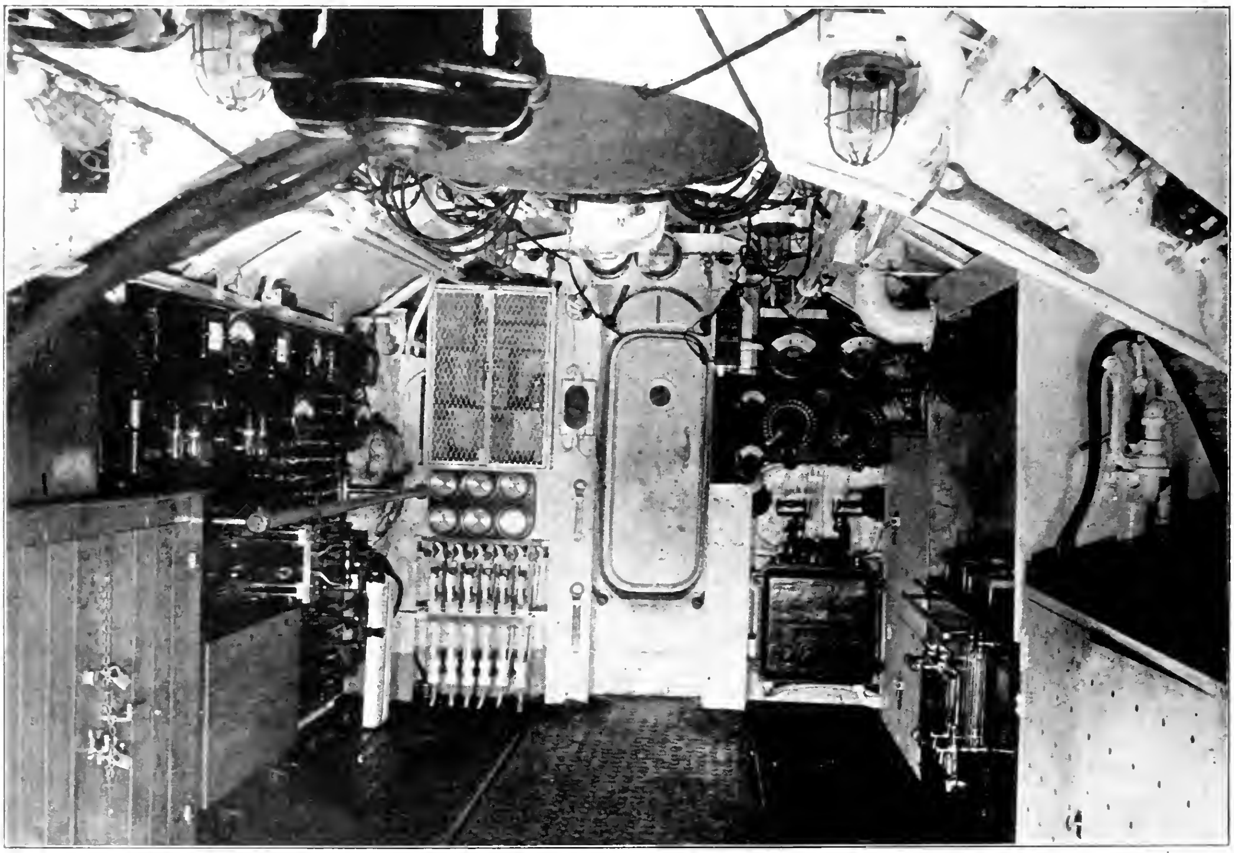

FIG. 11 AFTER END OF CENTRAL OPERATING COMPARTMENT

the momentary movements of the crew may be counteracted by the man at the diving wheel.

EQUIPMENT OF SUBMARINES

From the *Holland* (see Fig. 2) having a length of about 53 ft. to the *M-1* (Fig. 3) with a length about 200 ft. is powerful ship is constructed. The little *Holland* was thus in commission until worn out. Every other submarine built for the U. S. Government is in active service.

At the time the *Holland* was built we had no periscopes. In consequence, the boat had to be handled by "porpoising," that is, running a short distance submerged and then coming to the surface far enough to expose the conning tower, thus

getting a chance for a look around, and then diving. This porpoising can be done very quickly; the boat can pass from the depth of 30 ft. to the surface, line up on the target, have the torpedo fired, and be again below, all in 30 seconds. The advent of the periscope greatly aided submerged navigation, since at all times vision may be had without exposing the hull to the danger of a chance shot. The increased size of the boats has made them far more comfortable, and better sea boats (compare the freeboard of the *Holland* with that of the *M-1*), and better adapted for long service at sea. The development of wireless telegraphy now permits the submarine to keep in touch with the shore, and all submarines are now equipped with this wonderful apparatus, the tall masts required being so constructed that they may be quickly lowered for submerged work.

In the design of a submarine a far greater amount of preliminary work in the line of calculating of weights, disposal of equipment, etc., has to be done than with a surface boat, for not only is there a double motive-power equipment, but the boat must be designed for both surface and submerged work, with all the complicated control apparatus required. Some idea of this construction may be obtained from the illustrations given. Fig. 4 shows the launching of a submarine, the cigar shape of the main hull being of sufficient strength to withstand the pressure of 200 ft. submergence, that is, nearly 100 lb. per sq. in. Fig. 5 represents the bow of a submarine before launching; it shows the bow cap with opening in line with the torpedo tube. When it is desired to close the tubes, the openings of the bow cap are placed under the bow casting. In Fig. 6 we have the stern of a submarine. In addition to the twin screws and steering rudder as used on a surface boat, the submarine has the horizontal diving rudder for steering the boat in the vertical plane. Each submarine can carry at least eight torpedoes. Fig. 7 shows the taking of a torpedo on board, and Fig. 8 shows the inner ends of the four torpedo tubes and escape hatch.

A view of the diving station showing diving wheel and depth gages is given in Fig. 9. On the depth gage below the pointer is shown the curved glass tube of the clinometer. Fig. 10 reproduces a view taken through a periscope. The vertical line is the cross wire and shows the exact direction the periscope is pointed. The scale at the top is a portion of the card of the periscope and shows that the periscope was pointed $76\frac{1}{2}$ degrees from the north towards the east. The after end of the central operating compartment is shown in Fig. 11. This particular boat had an unusually large central operating compartment, at least four times as large as is usually constructed. The dark object at the top of the picture is the lower end of one of the periscopes. Behind this is an escape hatch, the ladder to it having been removed so as not to obstruct the view from the camera. In the left lower corner is the ice box, then comes the battery and auxiliary switchboards. In the center of the picture is the closed door leading into the engine room. To the right of the door is the control equipment of the two main motors and on the right are the electric cooking range and galley sink.

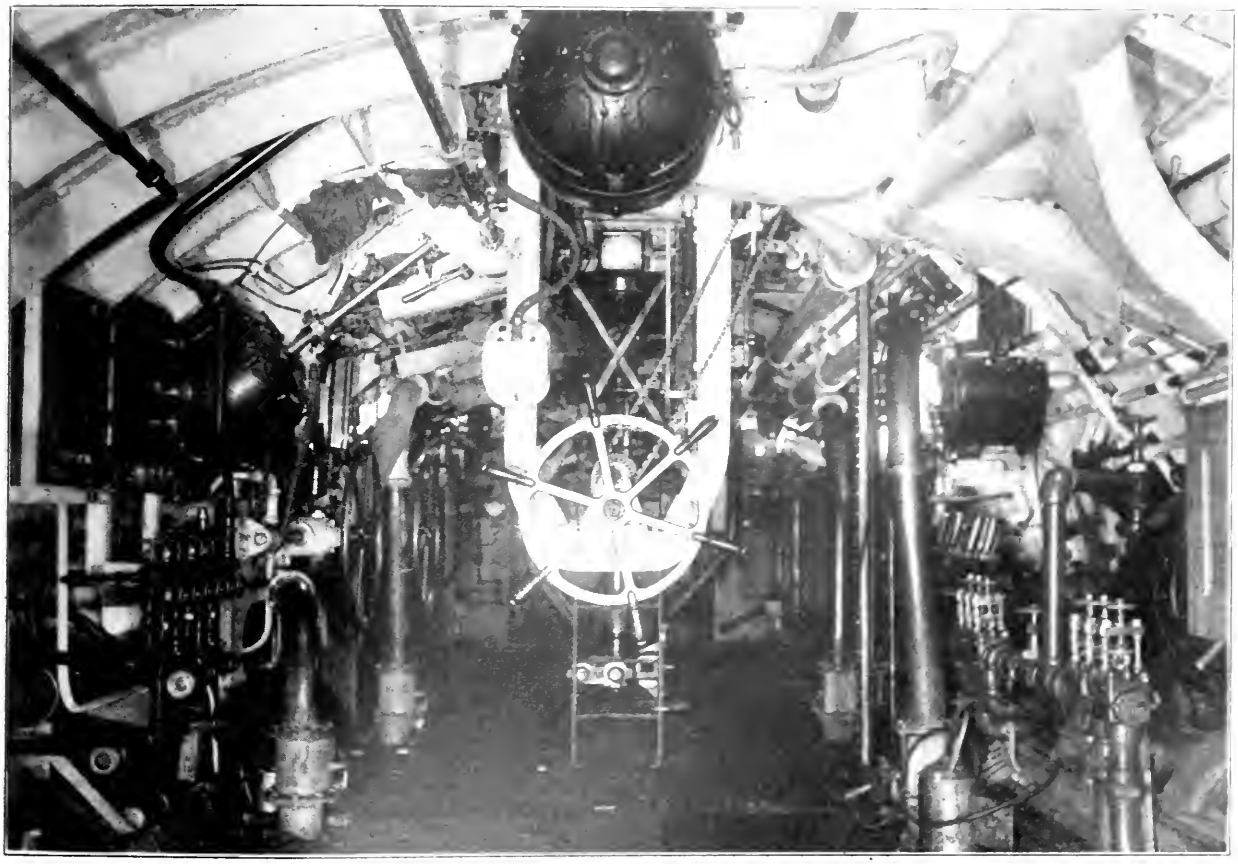

Fig. 12 From Amidships Looking Forward

Fig. 12 gives a good idea of the mass of equipment of a submarine, every part of the space being utilized. The picture is taken from amidships looking forward. In the center of the picture is shown the hand steering wheel. In general the steering is done by an electric motor, shown at the top of the picture. On the left is the air manifold,

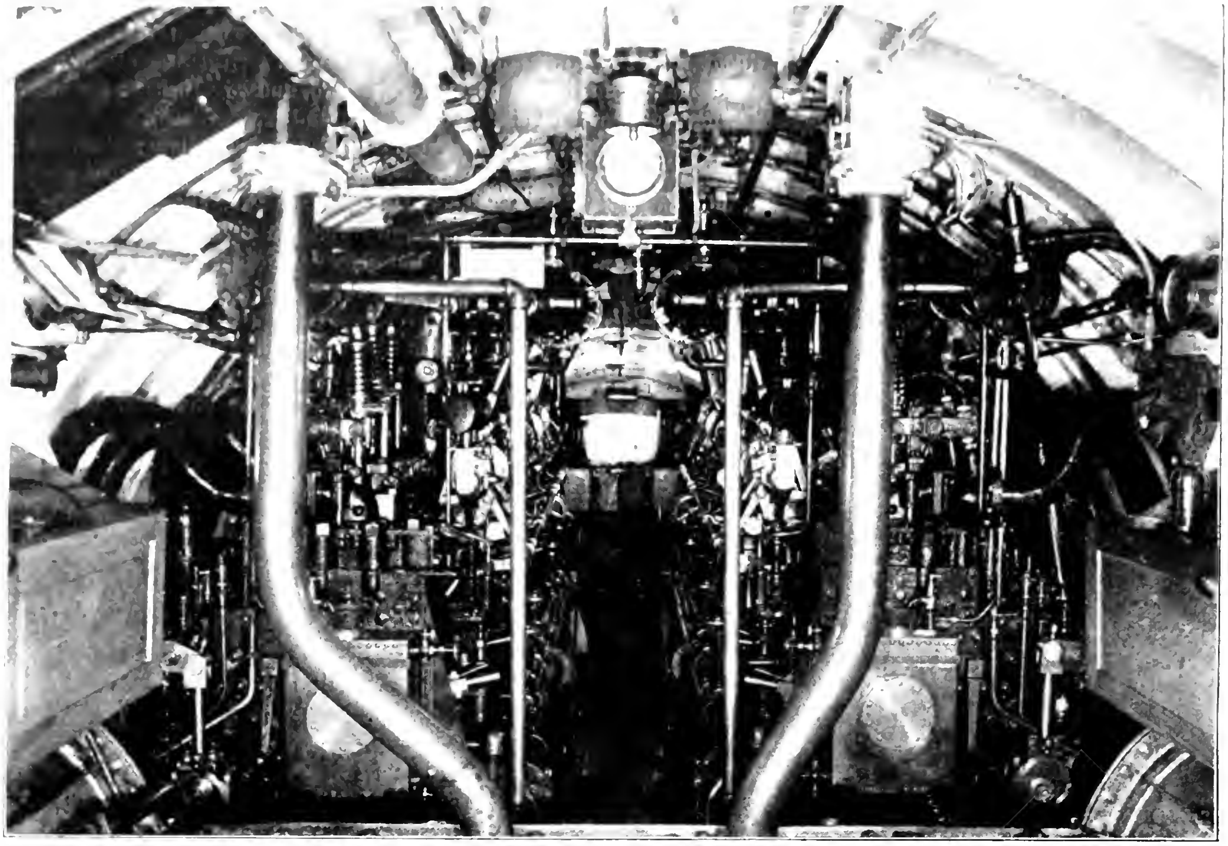

FIG. 13 FROM AMIDSHIPS LOOKING AFT

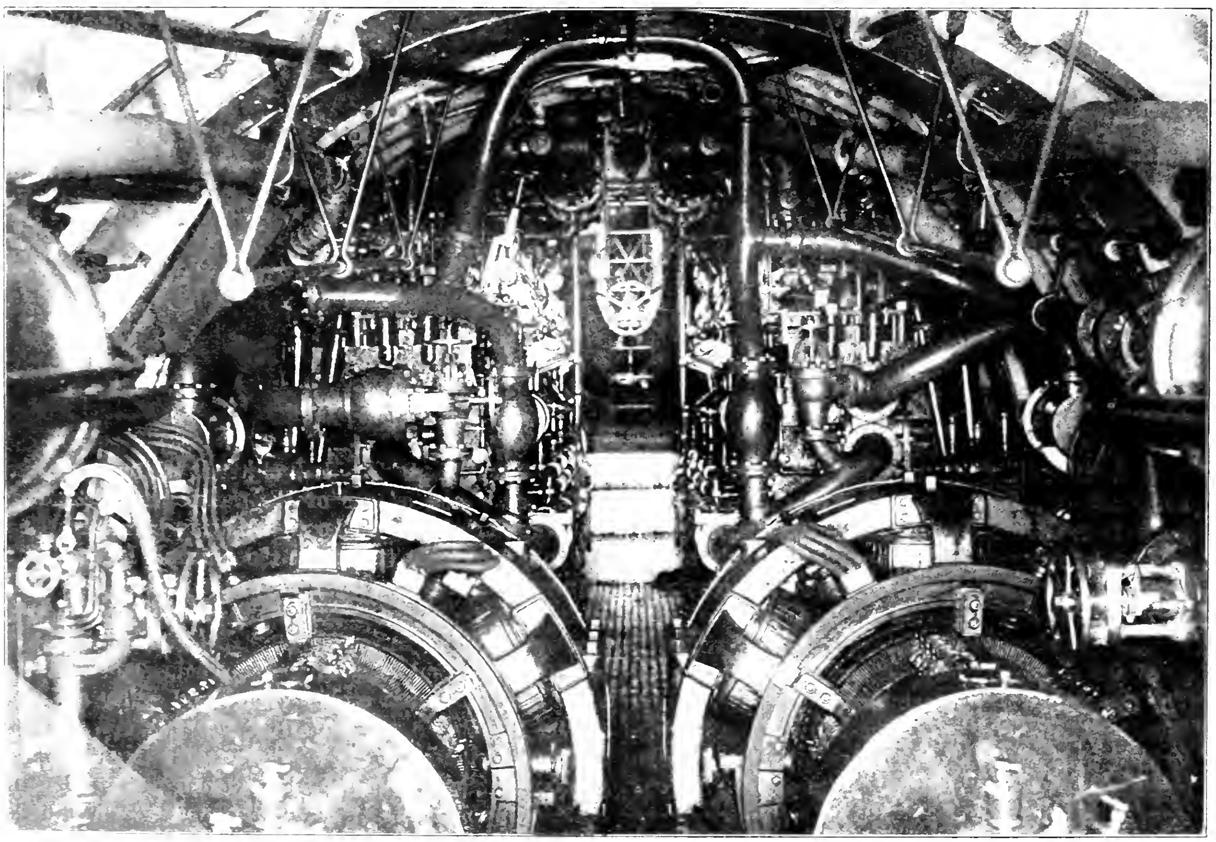

FIG. 14 FROM AFTER END LOOKING FORWARD

with valves [illegible] the high-pressure air. These valves connect [illegible] all the different tanks. By opening the valves to the [illegible] tanks, the water may be blown out in a short [illegible]. To the right is shown the water manifold which [illegible] the different tanks to the adjusting pump, also [illegible] large Kingston valves. Fig. 13 gives a view [illegible] and showing the main engines, and Fig. [illegible] looking forward, showing main motors [illegible].

One of the two engines for a submarine on the test stand is shown in Fig. 15. For many years the gasoline [illegible] was the best at our disposal, but as gasoline is a bad thing to handle in the confined space of a submarine, we were glad indeed when the Diesel heavy-oil engine became available for this work. The development of these engines was quite ad-

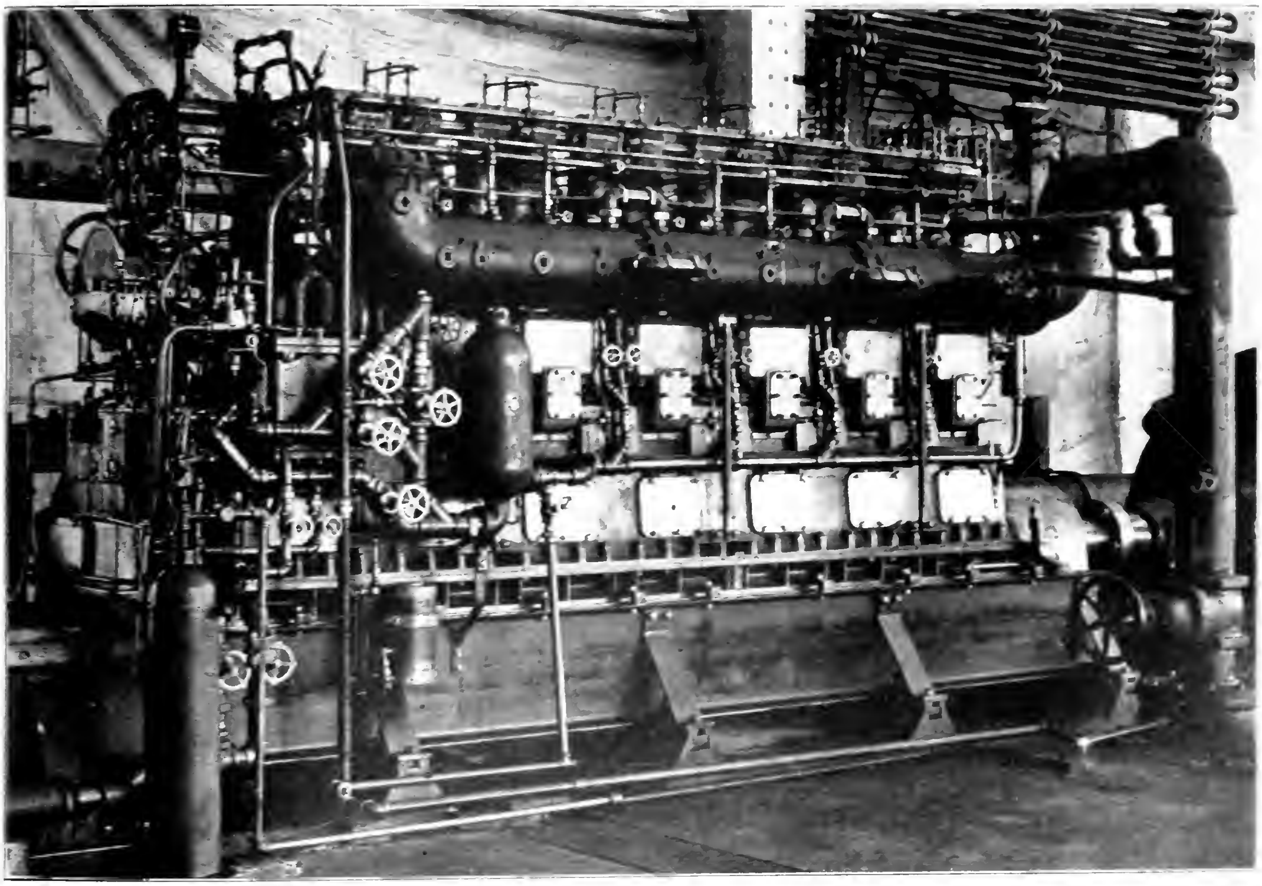

Fig. 16.—[illegible] Diesel Engine

vanced in Germany before [illegible] were built in this country. In [illegible] advance as rapidly as possible, all known [illegible] were examined by our engineers [illegible] engine built in Nuremberg [illegible]. Steps were immediately [illegible] country, and we were [illegible] submarines the best engine then developed. Many of these engines were built and are now in [illegible] our submarines. In the building and operating [illegible] and there were many things we [illegible] principal point being that they were very [illegible]. In consequence a new engine was designed—illustrated in Fig. 16. This is the type of engine used in many submarines recently built and has stood hard service with wonderfully good results. The change from gasoline to heavy oil has [illegible] interesting characteristic, that is, that with a given quantity of heavy oil twice the number of horsepower hours may be obtained as from a like quantity of gasoline. Thus with a boat having a given fuel tank capacity, double the radius of action [illegible] obtained when the change from gasoline to heavy oil is made. Another point is that heavy oil costs about one-fifth as much per gallon as gasoline; thus, for a given number of horsepower hours, the fuel of the Diesel engine costs but one-tenth that for the gasoline engine.

OPERATION OF SUBMARINES

The diving and behavior of the boat submerged is exceedingly interesting, and is shown in Figs. 17 to 23. In Fig. 17 we have the submarine stripped [illegible] deck [illegible] ready for submerged running. It takes but a few [illegible] take down the lines, [illegible] close [illegible] and [illegible] tanks. Fig. 18 shows the boat [illegible] trimmed down [illegible] for submerged running. The [illegible] when [illegible] is trimmed the boat [illegible] down [illegible] the diving rudders, exactly as the [illegible] steering rudder [illegible] a surface boat. If now the boat is started ahead with diving rudders kept at zero, the boat will rise as shown in Fig. 19. That is, the natural tendency of the boat is always to rise. If now the boat is given a diving rudder, the stern will rise, the bow will go down as shown in Fig. 20 and the boat will slide under. When this photograph was taken the boat was making a quick dive, and the angle of the boat is about five degrees. In general but three-degree angles are

ased in diving or rising, and for uniform running the boat angle will probably not change one degree. In Fig. 21 we see the boat well under, and in Fig. 22 she is running at a uniform depth. The actual distance of the boat from the camera when this picture was taken was but 91 yd., a very short distance over water. The control of depth even at high speed submerged is wonderfully accurate, runs being frequently made when for ten minutes at a stretch the depth will not change one foot.

If a submarine is resting on the surface and water is admitted to her tanks, she will gradually settle in the water. If care is exercised as the balancing point is reached the adjustment may be made so accurate that another gallon of water admitted to her tanks would cause the boat to sink. This is illustrated in Fig. 23, showing a boat weighing in the neighborhood of 100 tons thus evenly balanced. For the purpose of control of water in the tanks a small rotary pump is used, operated by a reversible electric motor. Thus water may be pumped either into or out of a tank. If when a boat is thus carefully balanced a little water is pumped into her tank, she will start to sink. Suppose after she has settled say to a depth of 40 ft. we pump out a little water. This will check her downward movement, and then she will start to rise. By watching the depth gage, and by careful control of the water by means of the pump, we may hold the boat suspended within a difference of depth of two feet. In general, after this test that of the automatic blow valve is made. This valve connects the high-pressure-air line with the main ballast tanks, and the control of the valve is by diaphragm in connection with the outside sea water. Thus if the pressure reaches too high a figure, the high-pressure air is automatically turned into the main ballast tanks. These tanks, it will be remembered, are entirely filled with water, whenever any is there, and therefore at such times the main Kingston valves are left open. The turning of the high-pressure air into these tanks is all the operation required to empty the tanks. In the test the automatic blow valve is set to some depth, say 50 ft., and the boat allowed to slowly sink. When this depth is reached the pressure outside operates the valve and some 75 tons of water are quickly blown out of the tanks. The boat immediately starts to rise, and in less than one minute will reach the surface, nearly jumping out of the water from the rapid rise. The automatic blow valve may be set for any depth that may be desired.

The subject of rescue of men from a sunken submarine seems to fascinate our inventors, as hardly a week passes but that some one comes forward with the same old method, that of a buoy of such a size that a man may get into it and then rise to the surface. It is not a question of getting a man to the surface—that is easily done, but of keeping him alive when he gets there. In this connection the statement should be made that there is only one cause that will prevent a submarine from coming to the surface, and that is a rupture of her hull. If now the hull is ruptured, the pressure of the outside sea is brought upon the men. In our respiration air is taken into the lungs, the oxygen taken up by the blood is used in the purifying of the blood, and a certain amount of nitrogen is retained in solution. This amount of nitrogen in solution in the blood is small at ordinary pressures, and in any case does no harm, for its quantity is a constant. If now a man is placed under heavy pressure, as would be the case if the hull of a submarine were ruptured say in 200 ft. of water, this pressure of about 100 lb. per sq. in. would cause the blood to absorb many times its normal quantity of nitrogen. This absorption takes place very rapidly, it requiring but a few minutes for the blood to become saturated to the point called for by the new pressure. If now a man so placed should enter a can buoy and rise to the outside air, the pressure would be quickly relieved and the excess nitrogen of the blood would be given off all through the system, given off in small bubbles which

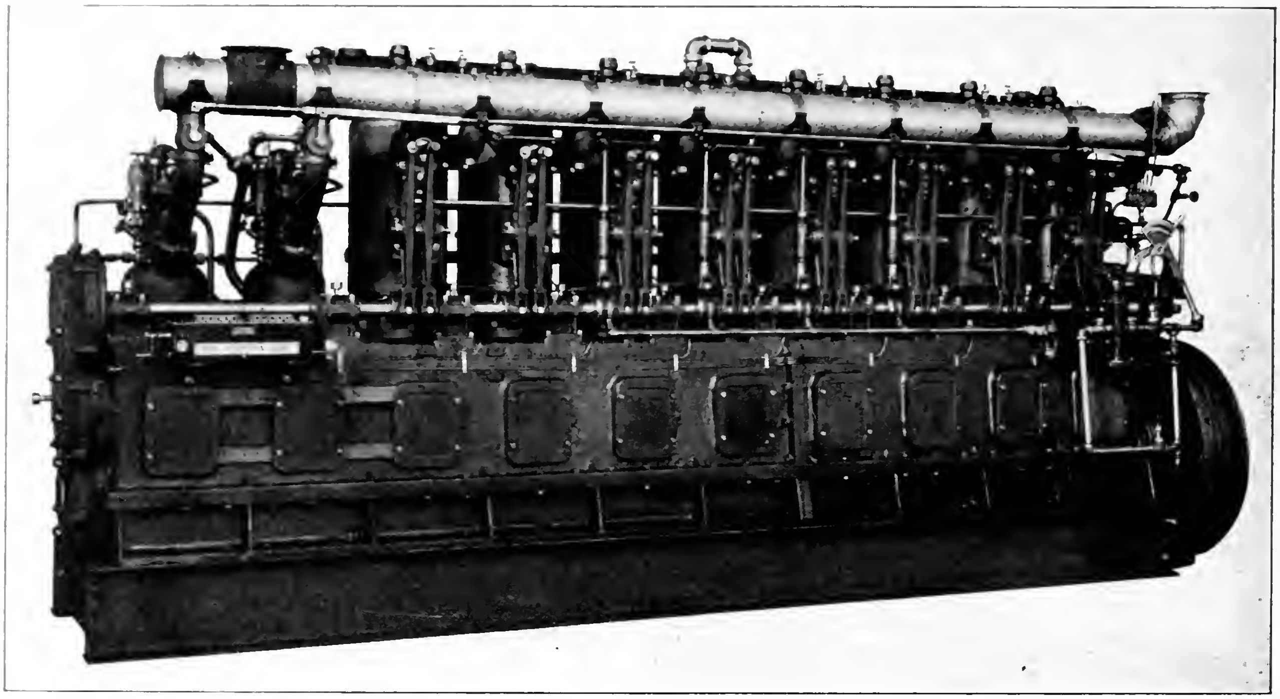

Fig. 16 240-hp. Four-Cycle Diesel Engine

would instantly stop all blood circulation and cause death. This action of the nitrogen is a familiar one to divers and all who are called upon to work under heavy air pressure. Thus it is not a question of the quick application of pressure, but the quick removal of that pressure. As an illustration, a few years ago a government diver went down some 280 ft. off New London. He took two minutes in going down, spent five minutes on the bottom, and then started for the surface. He came up a little way and then stopped, exercised his arms and legs thus encouraging activity of the blood in order to work the nitrogen off through his lungs. Then he would come up a little further and repeat the operation. The total time thus taken to reach the surface was one hour and thirty-five minutes, and even then as soon as he was taken out of his diving suit he was put into a recompression chamber so that the pressure might be still more slowly relieved. It will thus be seen how impossible it would be in the excitement of a wreck to go through any such procedure as outlined above.

Recent activities of submarines abroad have demonstrated the abilities of the boats, but generally the conditions are quite different from those that would pertain here in case we should be at war with one of the great foreign powers. Then the office of our submarines would be the breaking up of a blockade of our ports, or the preventing of an armed force from making a landing on our shores. Many times in naval maneuvers submarines have successfully attacked battleships, and where sufficient numbers of submarines are employed they may easily prevent a blockade by such ships. An interesting report was given some time ago of the breaking up of an entire expedition of a German army in its attempt to land at the south end of the Gulf of Riga, the work having been done entirely by two small submarines. If the report is true it shows wonderfully effective work by the submarines.

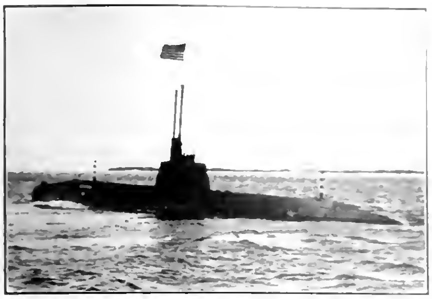

Fig. 17

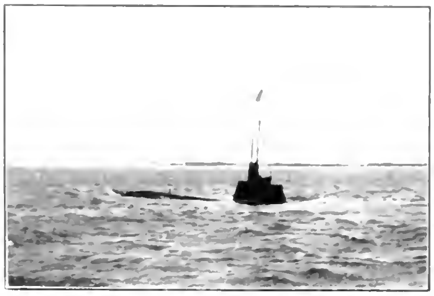

Fig. 18

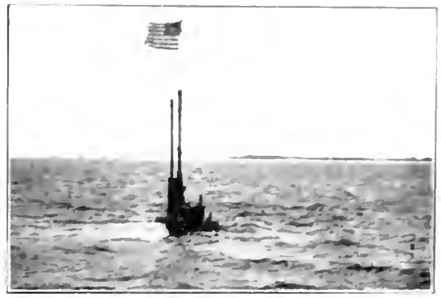

Fig. 19

Fig. 20

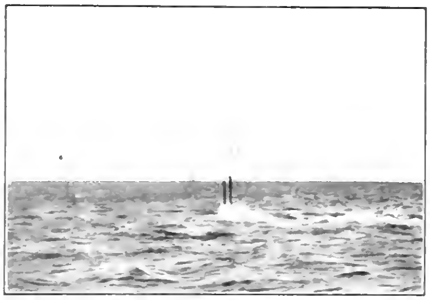

Fig. 21

Fig. 22

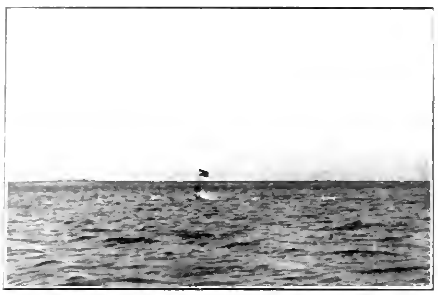

Fig. 23

Fig. 17 Stripped for Diving Operations

Fig. 18 Trimmed for Diving

Fig. 19 Starting Ahead with Diving Rudder at Zero

Fig. 20 Starting to Dive

Fig. 21 Diving

Fig. 22 Running Submerged

Fig. 23 Stationary Submerged

Engineering technological researches may be of great value to a country or to industries; but they inherently lack self-support. Any laboratory engaged in researches, the successful results of which are to be published, can only expect to be supported either by national institutions, by gifts, or by benevolent endowment. For this reason, although industrial researches are numerous and widespread, engineering researches are mainly restricted to universities, technical colleges and government laboratories.—*Science,* March 9, 1917.

THE MECHANICAL DEVELOPMENT OF AVIATION

By NEIL MACCOULL,[1] PITTSBURGH, PA.

The earliest systematic experiments with power-driven aeroplanes were started in 1889 by Sir Hiram Maxim, and from the data obtained he constructed a steam-driven twin propeller aeroplane in 1893. The span of the wings was 104 ft., which to this day is exceeded only by very few machines. The total wing area was over 6000 sq. ft., which is some twelve times as great as that of the average military aeroplane; but this was necessary because it was intended to fly at speeds of only 35 to 45 miles an hour. In the experiments with this machine, the running gear was provided with flanged wheels which ran on a straight level track of 9 ft. gage. Strong wooden guide rails of 3 x 9-in. Georgia pine were constructed along the track in such a way as to prevent the aeroplane from leaving it. This aeroplane not only lifted its own weight of 8000 lb. but also broke the stout plank guide rails which held it to the earth, and caused a wreck. But in spite of being able to support itself, it could not be called a successful aeroplane because its stability and airworthiness were never demonstrated in free flight. The power plant was the one part which was successful, and I doubt if there has ever been a steam plant of its size which weighed so little as 11 lb. per hp., including boiler, engines, condensers, pumps, and water supply. Each of the propellers, which were 17 ft. 10 in. in diameter, was direct-connected to a double-acting compound engine with cylinders of 5 and 8 in. bore and a stroke of 1 ft., high-pressure cut-off being at ¾ stroke and low-pressure at ⅝. These were constructed almost entirely of high-grade cast steel and weighed but 320 lb. each, complete. With a steam pressure of 320 lb. per sq. in. each developed 180 hp. at 375 r.p.m., a weight of only 1¾ lb. per hp. A safety valve discharged into the low-pressure cylinder, thus adding considerably to the power when there was an excess of steam. The boiler which supplied the steam for both these engines was constructed of a very large number of ⅜-in. copper tubes 1/50 in. thick, and had a heating surface of about 800 sq. ft., including the feedwater heater. Tubing such as this was quite a novelty in those days. A strong forced circulation of water was obtained by means of a spring-loaded valve in the boiler which held the feedwater at a pressure of 30 lb. per sq. in. in excess of the boiler pressure. This fall of 30 lb. in pressure acted upon the water in the tubes and forced it down through the large outside tubes. Although this boiler with the casing, dome, smokestack, and connections weighed less than 1000 lb., it supplied all the steam the engines could possibly use. The weight of the engines and boiler totaled 1640 lb. or about 4 1/3 lb. per hp. The condensers were made of very thin copper, the individual tubes being shaped somewhat like miniature aeroplane wings in section. By this means they were made to sustain more than their own weight when the aeroplane was traveling at its normal speed.

At almost the same time, Samuel Pierpont Langley, the real *father of aviation*, was learning the fundamentals of aerodynamics by means of models with rubber motors. After years of experimentation successful steam-driven models were constructed, and after nine years of strenuous work there was evolved a steam-driven model known as No. 5, which had a wing spread of 13 ft. and weighed 26 lb., complete. On May 6, 1896, this model was launched over the Potomac River with a steam pressure of 150 lb., and started directly ahead into the gentle breeze then blowing. After the lapse of one minute and twenty seconds, when at a height of 70 to 100 ft., the fuel was exhausted and the aeroplane gradually descended until it finally touched the water after a flight of over 3000 ft. This was the first time in history that a mechanical device had actually flown through the air under its own power. The engine of this model was a single-cylinder 1 5/16 by 2¾-in. double-acting type with piston valve, and drove the two propellers through bevel gears. It delivered about ¾ hp. and weighed barely 1 lb. The complete power plant, including engine, flash boiler, pumps, tanks, etc., weighed less than 8 lb., which is under 11 lb. per hp., an exceedingly creditable result.

Mr. Langley started his aeroplanes from a sort of catapult, in which the aeroplane was held to a carriage running on a track, and was released after traveling the length of the track under the impulse of coil springs. The man-carrying aeroplane, tried out in 1903, was launched from a similar device, and failed only on account of some accident which tripped the machine just as it was leaving the car and threw it into the water. This happened twice and caused so much ridicule in the press that Mr. Langley was unable to get any further financial aid. A few years after Mr. Langley's death, Glenn Curtiss repaired this aeroplane, and, by fitting it with pontoons so that it could rise from the water, was able to make a very pretty flight. It is interesting to recall that the Wright Brothers used in all their early experiments a launching device operated by falling weights, and a catapult similar to Langley's is now used for launching aeroplanes from battleships.

President McKinley became interested in the military possibilities of aircraft as a result of Langley's experiments, and in 1898 caused the Board of Ordnance and Fortification of the War Department to authorize the construction of a man-carrying aeroplane under Mr. Langley's direction. It was decided that the new machine should follow the general type of the models, because heart-rending difficulties experienced during the preceding eleven years had taught that even a slight departure from the type that had been successful might be very costly. The great difficulty was the power plant, which even today is the source of the greatest troubles with aeroplanes. Steam was seriously considered because of its success on the models, but the internal-combustion engine, just coming into prominence in automobiles, seemed to offer a more satisfactory solution. At that time flights of sufficient duration for the weight of fuel to become serious were not considered, otherwise little attention would have been given to steam, beause the most efficient plant yet constructed uses twice as much fuel as modern aeroplane engines, and when boilers and auxiliaries are included, are over twice as heavy as Langley's large internal-combustion engine made later. For this reason it is astonishing to hear rumors at present of responsible organizations contemplating the use of steam turbines for aeroplanes. The turbine itself can be made very light, but the weight saved over a reciprocating engine would be lost by the weight of the reduction gear required to drive the propeller at the proper speed.

[1] Westinghouse Machine Co.

Abstract of paper presented at a meeting of the Philadelphia Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, November 28, 1916.

In December, 1898, a contract was signed with an engine builder in New York City to supply a 12-hp. engine weighing not more than 100 lb., delivery to be made in 6½ *weeks.* The engine was completed before that time, but it was impossible to get it to deliver more than 4 hp. It was the first air-cooled revolving engine built, and the problems which developed were too much for the builder. A quarter-size model of this engine, when changed so as to have fixed cylinders with cooling ribs, performed excellently. In the meantime, European engine builders who were interviewed said that they did not care to undertake the work, and that they did not consider it possible to construct an engine of 12 hp. weighing less than 200 to 300 lb. If possible, they would already have done so, as they had had numerous inquiries for such engines. In spite of the discouragement, Charles Manly, assisting Mr. Langley, offered to undertake the construction of the required engine from the parts of the unsuccessful engines built in New York.

A five-cylinder, water-cooled radial engine (Fig. 1) was the outcome of his efforts. Each cylinder was drawn from a 3/16-in. steel plate by J. A. Stimmetz, and then machined inside and out, leaving a 1/16-in. shell. To this shell was brazed the valve chamber, which had been machined from a solid forging. The jackets, of sheet steel, only 0.020 in. thick, were brazed on by Mr. Manly himself, since no one else would undertake the work. In spite of the trouble involved, it was less difficult than to deposit copper jackets electrolytically, so undeveloped were these processes only fifteen years ago. To minimize the lubricating difficulties which might be experienced if the pistons were to bear directly against the steel cylinders, cast-iron liners 1/16 in. thick were shrunk in. Although engine builders had declared such construction impractical, if not impossible, no trouble was ever experienced with these liners, and they served their purpose admirably. The difficulties of attaching five connecting rods to one crankpin without sacrificing necessary bearing area were solved by the use of a "master rod"; one rod has a sleeve around the whole crankpin, as is usual with single cylinder engines, and the other four rods bear on the outside of this sleeve. In this way the small bearings between the four rods and the master rod receive none of the rubbing effect due to the rotation of the crankpin, except that of slipping a very short distance over the sleeve during each revolution, on account of the angularity of the rods. This construction was successful from the start and is now used in a slightly modified form in nearly all radial and revolving engines.

In order to get a reliable and equally hot spark in each cylinder, the scheme was originated of using one spark coil and vibrator for all cylinders, with a distributor to select the correct cylinder for each spark. All procurable spark plugs were very unreliable because of the frequency with which they became short-circuited with carbon; to correct this, a special plug was made. The pocket around the points which is now known to be so valuable, eliminated all this trouble. The intake valves were automatic, and the exhaust valves were operated from a central cam. This cam, which had two points 180 deg. apart, rotated at one-quarter engine speed in the opposite direction. The light weight of the whole valve mechanism is noteworthy. All parts were lubricated by oil cups. This engine was completed in December, 1901, and was given three 10-hr. runs while connected up to water dynamometers. At 950 r.p.m. 52.4 hp. was delivered, giving a weight of 2.37 lb. per hp., based on the stripped weight of the engine, which is 124 lb. The complete engine, including balance weights, ignition coil and batteries, carburetor, radiator, water and gasoline tanks, and all other accessories; and with radiator, water tank, and jackets filled with water, is only 3.65 lb. per hp. This is more than 20 per cent. lighter than present-day water-cooled engines.

Thus two Americans succeeded in producing the first man-carrying aeroplane which could support its own weight in stable flight; Samuel Langley produced the aeroplane, and Charles Manly produced the power plant. Those of us who blush with shame because our government possessed less than 50 military aeroplanes a few months ago while European countries were making daily use of tens of thousands, will do well to realize that this aeroplane was developed by the support of our own military authorities long before other governments did as much, and if it had not been for the ridicule of a hostile press and the sneers of a self-satisfied public, our government would have been the first to have possessed practical military aeroplanes. All this work of Langley's was terminated

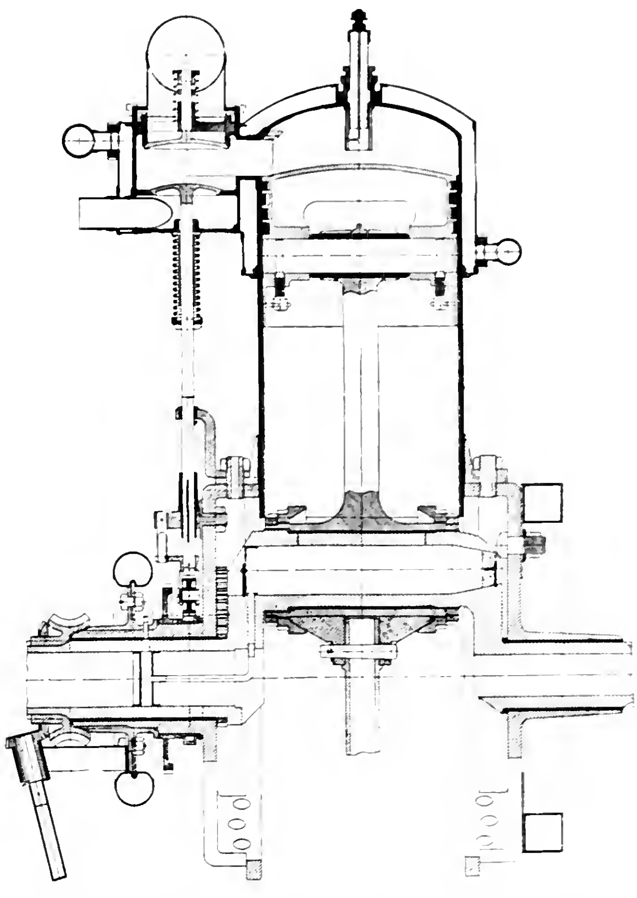

Fig. 1 Five-Cyl. Radial Engine (Fixed Cylinders) Built for Langley's Aeroplane in 1901. Cyls., 5 x 5½ in.

in 1903. Four years later Blériot constructed an aeroplane of the Langley type, and was able to make flights of a few hundred yards. The evolution of this machine resulted in the well-known Blériot type, now famous as the first to cross the English Channel.

Since then progress has been very rapid. Years elapsed from the time Langley solved the aerodynamic and mechanical details necessary for flight, before the Wright Brothers succeeded in flying for eleven minutes, and in 1914, only a few years later, the world's record for a non-stop flight was raised to 24 hr. and a distance of 1500 miles. This record still stands officially, for what has been done since the European War commenced is not accurately known by the public. Prèvost's speed record of 126 miles an hour made in

1915 still stands as official. An engineer just returned from Europe states that there are in France today 70,000 men wearing the uniform of the British Flying Corps, including pilots, mechanics, and other helpers. France and England together have about 14,000 licensed aviators, and Germany and Austria undoubtedly have as many. These 28,000 aviators do not include those of Russia and Italy. But even more astonishing is the statement made in the British House of Commons, that during the past two years Britain has spent $200,000,000 in aircraft. Another American engineer returning from Europe

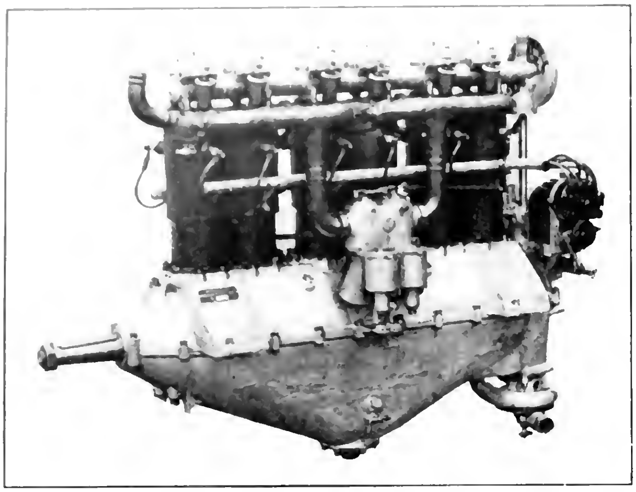

Fig. 2 The Famous Six-Cylinder Mercedes Engine Which Has Meant so Much to German Aviation

a year ago reported the sensations he experienced while flying several hundred miles in one of the Royal Flying Corps' giant triplanes which had a wing-spread of 135 ft., weighed just under 30,000 lb. and was propelled by over 1000 hp. in four water-cooled engines that it will always have value where speed and quick climbing are essentials and long flights are not desired, such as in defending cities and fortifications from enemy aircraft. The La Rhone, another engine of similar type, considerably improved, is now manufactured by the Gnome Company. The intake and exhaust valves are located in the cylinder heads and are both operated by a single rocker. The rocker for each cylinder is operated by a pull-and-push rod, which in turn is given motion by a large cam within the crankcase. This cam, which operates all push-and-pull rods for the nine cylinders, has five points, because it rotates at 9/10 engine speed and in the same direction as the cylinders. The ingenious valve-driving mechanisms of many of these revolving engines make a very interesting study.

The great majority of modern aeroplane engines are an outgrowth of conventional automobile practice. One of the most famous of this type is the German Mercedes (Fig. 2); many of the latest engines follow it in general design. The most noticeable feature is the method of operating the overhead valves by an overhead camshaft. While this general type of valve drive is now the prevailing style, it was an innovation when developed on the Mercedes. It follows the fundamental principles of accepted automobile practice throughout. In fact this very engine was used in racing automobiles and has given their drivers many enviable records. No very great effort has been taken to make this engine especially light except in the cylinder construction. The cylinders, which are in pairs, are built up from steel by welding the individual parts together. The strong point of these engines has always been their reliability rather than absence of weight. Their designers, instead of looking for radical departures from standard types, in order to save weight, were willing to apply minute attention to the development of recognized engineering principles in every infinitesimal detail. One of the characteristics which is now found on practically all aeroplane engines is the double car-

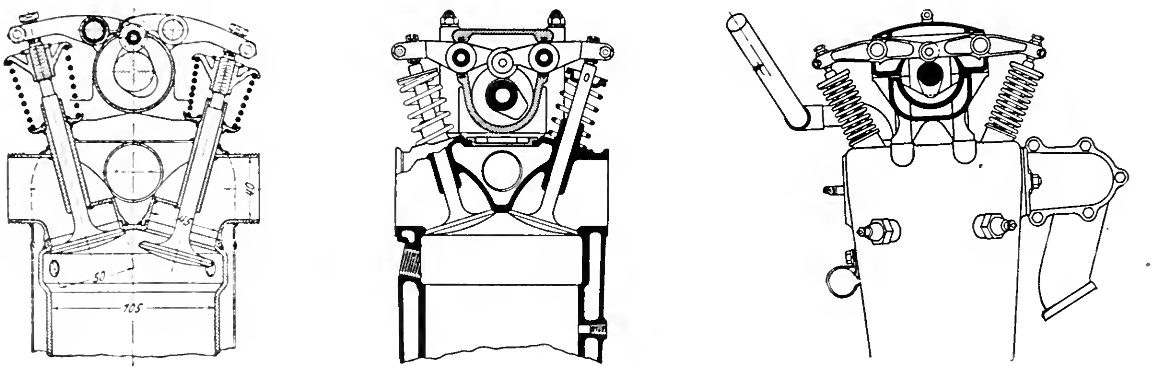

Fig. 3 Valve Mechanism of 3 Typical "Overhead Camshaft" Engines. Left, Mercedes; center, Hall Scott; right, Wisconsin

units. The world will be dumfounded at the status of the aeroplane when the veil of the censor is drawn after the war.

One of the first engines to spring into prominence during the early development of aviation was the Gnome. It is an air-cooled revolving type, somewhat resembling Mr. Langley's early though unsuccessful engine, and is an example of the most beautiful workmanship of which French mechanics are capable; which is one reason for the fact that even now it holds the world's altitude and speed records. Its outstanding faults are that it requires a great deal of fuel and skilled attention. Up to about 100 hp. it is so much lighter than the conventional

buretor for six cylinders. Surprising claims of gains in engine power, some over 20 per cent, are made for the use of two carburetors instead of one. Another feature is the use of a double ignition system; two independent magnetos and two sets of independent spark plugs to each cylinder. The deep oil sump with the oil pump at its lowest point is another characteristic. Practically no aeroplane engine is lubricated by splash, high-pressure lubrication being used exclusively. One of the chief points in which designers have a chance to show their ingenuity is in the combination of the camshaft drive with the drive for the magnetos and pumps. In this engine a

bevel gear on the crankshaft meshes with the bevel gears at the extremities of two vertical shafts, the upper driving the magnetos and camshaft through bevels, and the lower driving the centrifugal water pump at the lower extremity and in addition a horizontal shaft which in turn drives two oil pumps in the lowest part of the crankcase. It is a very neat arrangement.

From latest reports it seems that but few changes have been made in the designs of the Mercedes brought out since the European War commenced. The cylinders are increased in diameter from $4\frac{3}{4}$ to $5\frac{1}{2}$ in., so that the engine develops a maximum of 165 hp. instead of 100. They are now individual instead of in pairs but retain their welded-steel water jackets. The drive of the camshaft and auxiliaries has been modified so that the water pump is just below the camshaft bevels, the rotor being mounted on the vertical driveshaft which passes through it. This gives room for the oil pump where the water pump was formerly, and simplifies the drive of the former. These changes are design refinements which reduce the cost of manufacture and make the parts more accessible. The only departures in principle from former designs are the addition of cooling ribs on the bottom of the oil sump, and a set of decompression cams which are thrown into action by sliding the camshaft horizontally and make starting the engine by hand a fairly easy task, which is a matter of no small importance in an engine of this size.

One of the first American engines to follow the Mercedes is the Hall Scott. The cylinders, while individual as in the latest Mercedes, are cast with integral water jackets, giving a more rugged though heavier construction. The intake manifold and double-jet carburetor are water-and oil-jacketed, the oil jacketing not only warming the carburetor but cooling the oil. The valve mechanism of this engine is very nicely worked out. The camshaft housing is cast of aluminum and may be detached as a unit from the cylinders without disturbing the valve rockers. There are felt washers on each side of the rockers where they pass through the housing, and effective means are taken to lock the adjusting screws on the split end of the rockers. In all valve mechanisms of this type, the valves can be removed only by taking them out through the cylinders. The valve mechanism of this engine is shown in Fig. 3, in comparison with those of the Mercedes and Wisconsin.

Another six-cylinder engine of this general type is the Christofferson. The rocker arms are of different lengths as in the Mercedes, so that the valve has a 50 per cent greater lift than its cam. The whole valve mechanism is enclosed, which makes a very neat arrangement, and one that assures excellent lubrication of these parts, but it is doubtful if it is a wise policy to enclose the springs. It has been found very advantageous with many engines to allow the valve springs to project through the aeroplane hood so as to be sure that they will be well cooled. One of the most interesting features of this engine is a ring type of intake manifold, which allows each cylinder to draw its fuel mixture from two directions and would appear to give equal distribution to every cylinder without resorting to two carburetors. At the bottom of the crankcase is the oil radiator, which is beginning to be considered so valuable in preserving the proper lubrication of high-duty engines. The cylinders are made of steel and their jackets of aluminum, cast in pairs.

One of the well-known British engines is the Sunbeam. The 12-cylinder V-type rated at 220 hp. is the only L-head type of engine left on the aeroplane market now that the Sturtevant has been transformed. There are two carburetors for each row of cylinders, which are necessary to get the maximum power from the engine. It is of the high-speed type and runs normally at 2000 r.p.m., the propeller being driven at 1000 r.p.m. from the camshaft.

A new engine recently brought out by this company is a 12-cylinder V-type, rated at 320 hp. The L-head cylinders are abandoned, and the overhead valves are operated by 4 overhead camshafts. The valves are both mechanically opened and closed as in their racing automobiles, no springs being used.

For years the B. F. Sturtevant Co. has been a strong advocate of L-head cylinders, but has finally given in to the overhead type. The cylinders and heads are cast of aluminum and provided with steel liners and iron valve seats which are cast in

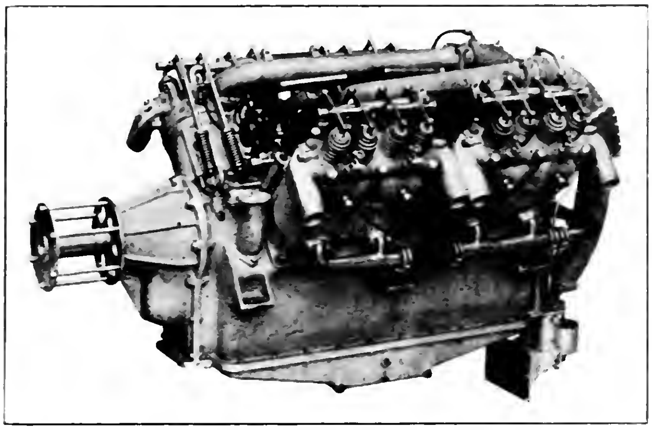

Fig. 4 The New Sturtevant 8-Cyl. "Aluminum" Engine with Overhead Valves and Geared Propeller Shaft. Normal Speed, 2000 r.p.m.; Cyls., $4 \times 5\frac{1}{2}$ in.; Rated at 140 hp.

the aluminum. The use of detachable cylinder heads is quite an innovation in the aeroplane world and shows a desire to make accessibility a stronger factor. As in the great majority of aeroplane and automobile racing engines, aluminum pistons are used, i. e., aluminum alloy, for pure aluminum is no more like its alloy than iron is like alloy steel, and in its unalloyed state would be absolutely worthless in this service. This engine is of the high-speed type with geared-down propeller, running normally at 2000 r.p.m. It is shown in Fig. 4.

The manufacturers of the new water-cooled Renault have supported the twelve-cylinder V-type with forced-draft air cooling for years, and it is interesting to note that in their new 200-hp. engine, Fig. 5, they have adopted water cooling. They have also dropped the high-speed feature with geared-down propeller shaft, and the valve mechanism with camshaft in the crankcase, which have been characteristic features of Renault aeroplane engines. The valve mechanism is now strikingly like that of the Mercedes. Use is made of two double carburetors and four six-cylinder magnetos. The connecting rods are of the type in which one rod is pinned to a boss on the rod opposite it. This is used on no other engine except the new Wisconsin "twelve," though it must have given good results, because Renault has used it for so many years.

A 300-hp. engine just brought out by the Knox Motors Co. shows an innovation in aeroplane-engine valve mechanisms. Not only are the rockers unusually compact because of being bell cranks, but each arm which operates the valves is forked so as to open two valves from a single cam. There are two intake and two exhaust valves to each cylinder, which feature

very considerably reduces the stresses in these parts on account of lower inertia forces for a given valve area and results in much greater reliability and longer life. The cylinders are cast of aluminum, with cast iron liners 1/8 in. thick. The pistons and the cylinder heads are of aluminum, the iron valve seats being cast integral. The oil pump at the bottom of the crankcase has a drive from bevel gears on the camshaft

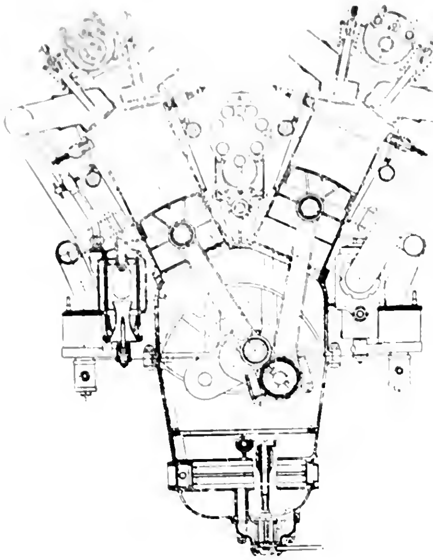

Fig. 5 12-Cylinder Water-Cooled Renault Engine. Cylinders, 4.9 x 5.9 in. 200 hp.

layshafts which are driven by spiral gears. This engine is shown in Fig. 6.

The Wisconsin engine (Fig. 7) has been brought out recently by the same company that manufactured the engines for the famous Stutz racing automobiles, and embodies many of their best features. It is another instance of the intimate relations existing between aeronautical and racing automobile engines. The cylinders, pistons, and crankcase are of aluminum. The cylinders have hardened-steel liners 1/16 in. thick and the iron valve seats are cast integral with the aluminum. The magnetos are driven by spiral gears. Nothing is contained in the lower part of the crankcase except the usual oil filters. The twelve-cylinder engine is made up of two sets of the cylinders and valve mechanisms of the six-cylinder model, and is rated at 280 hp. Instead of driving the camshaft by layshafts and bevel gears, two trains of spur gears are used, and four six-cylinder magnetos are arranged across the front of the engine. Provision is made on most of these large engines for mechanical or electric starters and the electric generators for searchlights and wireless sets which are often carried.

So far the development of the aeroplane power plant has been dealt with, but engines do not cover all the mechanical parts of modern aeroplanes by any means. Mechanical starters alone make quite a study, and besides compressed-air distributors and air engines, include even small gasoline engines of about 4 hp. which weigh but 23 lb. with their own magnetos and carburetors. Then there is a special gun of large bore for aeroplane use, which fires out of both ends at the same time in order to eliminate the recoil. There are many special instruments to indicate the speed, angle of incidence, drift, altitude, and other factors necessary for the navigation of an aeroplane. Mechanical stabilizers also have developed into quite a study by themselves. In the Sperry system there are four small gyroscopes driven by three-phase current, which maintain a constant horizontal reference plane, and motion of the aeroplane about this plane closes electrical contacts which

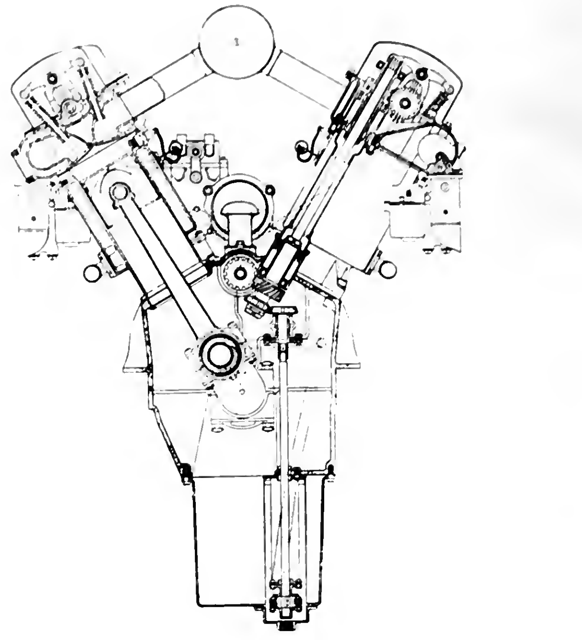

Fig. 6 12-Cylinder American Knox Engine. Cylinders 4¾ x 7 in. 300 hp.

operate clutches in the servo-motor. The windmill of the servo-motor, which is exposed to the relative motion of the air, is the source of power used in operating the controls. When the windmill reaches a predetermined speed, the blades fly outward, at the same time turning so as to reduce their

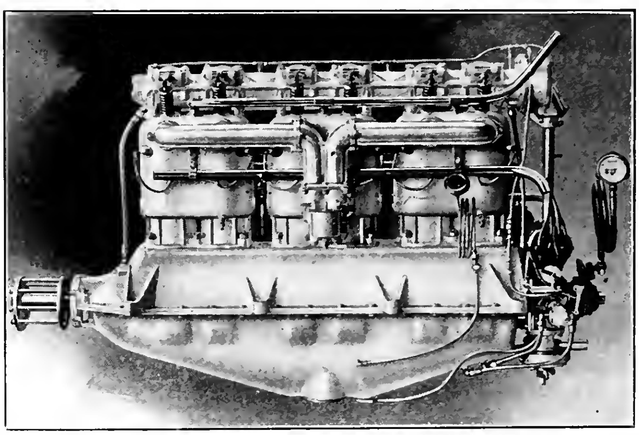

Fig. 7 Carburetor Side of the Wisconsin Engine. Cylinders, 5 x 6½ in.; Rating, 130 hp.

pitch, thus holding a constant speed. The magnetic clutches when energized connect the windmill to worm gearing, which drives the drums over which the control wires are wrapped. With this stabilizer it has been possible for the aviator to leave his controls and walk out on one of the wings while in full flight.

Descriptions of many mechanical parts of aeroplanes would not be expedient at this time because in many instances they would not be accurate even at the time they are read.

THE STEAM MOTOR CAR

By ABNER DOBLE,[1] DETROIT, MICH.

THE object of this paper is to recall the various objections to steam-driven motor vehicles which existed nine years ago when I first began my work on steam cars, and to tell of the steps to eliminate these objections.

The unsatisfactory points of the steam car were briefly, (1) low mileage on water, the average run on one supply of 35 gal. being 30 to 35 miles, although the Stanley is now securing about 200 miles; coincident with this necessity of frequently replenishing the water supply was (2) the formation of scale in the boiler, with a resultant drop in efficiency and added liability of burning the already extremely hot heating surface, which in turn necessitated the frequent cleaning of the boiler; (3) the toil and time involved in firing-up or lighting the main burner, which necessitated the use of matches and invariably required six or seven minutes or longer. The steam cars of eight or nine years ago also presented troubles of a less general nature; some had considerable difficulty with boiler leaks, some were too hot for comfort in summer, others carried their gasoline under high pressure and were altogether too easily ignited as a whole. Lastly, steam cars were very expensive to run, and their control and operation was a complex affair requiring intelligent and unfailing attention.

With the advent of the long-stroke, high-speed engine in Europe the internal-combustion motor came to be looked upon as the only practical power plant available, despite the admitted flexibility and smoothness of steam. I spent six years in building experimental steam-power plants and in experimenting. Late in 1913 we tried the combination of a fire-tube boiler with a honeycomb radiator to condense the exhaust steam. The results were truly startling. The car would run from 1000 to 1500 miles on one tank (24 gal.) of water. The effectiveness of the boiler was in no way lessened by the oil pumped into it.

The theory upon which we had worked was that in order to travel an adequate distance upon one supply of water, a honeycomb type of radiator must be employed to obtain the necessary cooling surface. The honeycomb radiator furnishes approximately six times the cooling surface of any other type of equal size. The reasons why this type had previously been deemed unavailable were the fact that the heavy molasses-like oil used in steam engines would clog up the extremely small radiator passages, and that the exhaust steam, particularly where a flash boiler was used, was liable to melt the soldered joints in the radiator. As far as I could find out, the use of a very heavy oil, especially where superheated steam was not employed, was a superstition. The presence of moisture in the steam goes a long way toward the proper lubrication of the cylinders and valves. In a steam-motor car little lubrication is required, as the piston speed is low at ordinary driving speeds, and the cylinder surface is cast iron, which is easy to lubricate.

In view of the foregoing it was determined to try ordinary gas-engine cylinder oil, and from the first it proved entirely satisfactory. To eliminate the possibility of melting solder in the radiator, we chose a fire-tube boiler. We realized that the presence of oil in the boiler would cause violent foaming, but believed that the high pressure used would eliminate trouble from this source. The normal steam pressure in the boiler was 600 lb., but as soon as the steam passed the throttle valve there was a large drop in pressure, sufficient to cause any water coming over from the boiler to pass into steam immediately.

Another reason why we did not use the customary heavy oil was because of the effect it would be certain to have upon the boiler. The action of the thin oil was all that could be desired. It immediately went into an intimate mixture with the water, due to the violent agitation and intimate contact. Agitation in the water tank was caused both by the motion of the car and by the fact that the return pipe from the base of the radiator entered the water tank very near the bottom. This also caused the water in the tank to act as a very effective supplementary condenser. The oil was accordingly regularly pumped into the boiler along with the water, and far from having a deleterious effect, really performed its most valuable functions in that part of the power plant. This oil is very thin at 420 deg. fahr., the approximate steam temperature at 600 lb. pressure, and the coating of oil, which forms over the entire inner surface of the boiler, is consequently so thin as to have a negligible effect upon the heat-transference conditions, and does not materially increase the liability of burning the heating surface.

As scale cannot adhere to a surface coated with oil, the interior of the boiler remains entirely free from incrustations of scale matter, and is likewise quite thoroughly protected from corrosion. The second function of the oil is to coat each particle of scale-forming material as it is thrown out of solution, thus preventing one particle from sticking to another in such a way as to form a body of sufficient size to clog some restricted passage. No large amount of scale-forming material is introduced into the system since but little make-up water is required, and all that remains in suspension until it reaches the water tank. The violent ebullition and constant flow of the medium toward the steam outlet causes the minute particles of scale to be carried along with the steam, so that the boiler and radiator are both kept free from deposits. The scale material finally reaches the water tank, where it either remains or continues to circulate through the system, without any apparent deleterious effect.

I have carefully examined the boiler and radiator of a car driven over forty thousand miles, and they were as clean or cleaner than when the car was built. I do not believe that there could be a more adequate proof of the entire effectiveness of the system. Lastly, the oil performs its normal function, being carried along with the steam in the form of minute globules, thus lubricating the throttle valve, cylinder walls and inlet valves.

DEVELOPMENT OF A STEAM GENERATOR

We next turned our attention to the development of a steam generator which would fill all our requirements. The fire-tube boiler, which had been successfully used in conjunction with our improved condensing system, possessed a number of the essential qualities we required; it held the temperature of the steam practically constant with no danger of sufficiently

[1] The General Engineering Co.

Presented at a meeting of the Cincinnati Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, February 15, 1917.

exhaust temperatures to melt soldered joints or effect an undesirable change in the lubricating oil. It always kept a large reserve of water heated to the steam temperature, which gave it steaming stability and admitted of great acceleration. The heat transference conditions caused it to be efficient, due to the extremely short distance, through which the gases of combustion radiated their heat to the tube walls.

On the other hand, it had its disadvantages: it was heavy and costly to manufacture, since it had to be wound with a mile of piano wire to minimize the potential danger present in a large diameter shell. It was liable to leaks, which might be caused either by overheating with low water or by oil working through the expanded joints where the tubes were fastened into the heads.

The flash type of boiler was out of the question, but it had certain good points which I intended to include in my steam generator. The direction of the water flow opposite to the flow of the gases of combustion was a great advantage, in that it allowed the water to extract, as far as possible, the last remaining thermal units. The all-steel construction, with its consequent freedom from leaks due to low water, was another very desirable feature. The water-tube boiler seemed to have little in its favor except safety due to the small diameter of the tubes, and the possibility of so constructing it as to have a good supply of water heated to approximately steam temperature. We had, however, already eliminated the possibility of scale settling in the boiler, so it seemed possible that we could use it as a basis upon which to combine the desirable characteristics of the other two types.

After much experimental work we finally worked out our present steam generator, similar in theory to the flash boiler, yet in appearance more like the water-tube boiler and having a water level in the evaporating zone. It consists of a number of identical sections of cold-drawn seamless steel tubing. Each section consists of an upper and lower header and sixteen vertical tubes. The vertical tubes are swaged at either end to half their diameter and are welded to the headers by the autogenous acetylene process, making each section in effect one piece of steel and actually stronger at the joints than the tubing itself. The generator is designed for a working pressure of 600 lb., and the safety valve is set for 1000 lb. Each section is tested to withstand 5000 lb., and ruptures only occur when the pressure is made to exceed 8000 lb. cold-water pressure. When this does occur, the rupture is invariably remote from the welds.

One third of these sections forms the economizer, the remaining sections being used for the actual generation of steam. They are placed very close together and completely encased by a $\frac{3}{4}$-in. wall of kieselguhr brick, which we have found excellent. This is held in place by a planished-iron jacket. Directly below the evaporating sections is the combustion chamber, and below the economizer is the exhaust for the gases of combustion. A bridge wall three fourths the height of the generator divides the two sets of sections. A manifold, through which water enters, connects the lower headers of the economizer sections. The water leaves by a similar manifold at the top and is led to a manifold connecting the lower headers of the evaporating sections. The steam leaves the upper headers and is conducted through a fourth manifold to the throttle valve.

Besides being absolutely free from any danger of explosion a boiler of this construction is cheap to manufacture, and any damaged section can either be easily and cheaply replaced, or isolated in a very few minutes by blanking it off until it can be replaced. The excellent heat-transference conditions due to the close and regular heating surfaces virtually duplicate those of a fire-tube boiler, while a large reserve of water close to steam temperature is always present. The progressive flow of the water counter to that of the gases, with no circulatory flow, and the all-steel construction show a distinct similarity to the flash type. Water is supplied to the boiler by a crank-driven pump, and the water level maintained about half way up the generator by an automatic regulator. If the water level falls below normal the regulator tube will fill with steam and its expansion closes a by-pass valve, thereby allowing water from the pump to enter the boiler. As soon as the level reaches normal, the regulator tube fills with water which has not been in circulation in the generator and is therefore comparatively cool. The regulator tube at once contracts, permitting the valve to open and all water to be by-passed back to the supply tank.

THE COMBUSTION SYSTEM

The most uncertain feature of the steam car, and one of its greatest disadvantages, was getting the burner properly ignited. Practically every steam car has used a bunsen burner of the vaporizing type. In order to insure sufficient mixture reaching the combustion space to ignite readily and continue burning, preheating was required to vaporize the fuel. Once the burner was going properly the vaporizer was heated by the fire, but when the car was not to be used for a time a supplementary burner was kept lighted to maintain the vaporizer heat and ignite the main burner when it was again necessary to generate steam.

On more modern steam cars acetylene gas has been used to heat the vaporizer. It considerably alleviated the difficulty, but meant an additional fuel tank to carry and replenish. After the vaporizer was hot the fuel valve was opened slightly, allowing the passage of only a very small amount of fuel until the burner itself had become thoroughly heated, and not until then could the fuel valve be left wide open without flooding the burner. When the fire was finally well started, steam was made quickly. With certain types of boiler sufficient pressure for starting could be generated in a minute and a half after the main burner was going. The chief problem of quick starting was therefore to eliminate the time required for lighting the main burner. The first real step we made in the right direction was to abandon entirely the former steam-car system and borrow a leaf from the book of gas-engine practice.

The idea was to use a spark plug for ignition, a carburetor for mixing the fuel and air, and an electrically driven blower to supply a forced draft. This worked fairly well as long as gasoline was used for starting, except for considerable precipitation of the fuel. We became more ambitious, however, and determined to make use of nothing but kerosene. The attainment of this more difficult goal required a large amount of experimental and laboratory work, but we finally determined that cold kerosene could invariably be ignited by an electric spark, if the following conditions were observed:

1 The kerosene had to be broken up mechanically into sufficiently small particles to insure a rise in temperature past the point of ignition during the time in which they absorbed heat from the spark

2 The spark had to occur close to the atomizing nozzle at a point where the resultant fog was sufficiently dense to insure one group of kerosene particles invariably igniting the rest

3 The velocity of the fuel particles had to be low enough to permit them to absorb sufficient heat from the spark to raise their temperature beyond the ignition point

4 It was essential that the mixture be much richer in the vicinity of the electric spark than that which would provide the most efficient combustion. In the latter connecnection we also found that in order to secure complete combustion of a large amount of fuel in a small space, it was necessary to utilize a combustion chamber made of a highly refractory material designed to attain a very high temperature.

To meet these conditions we developed the apparatus which we now use. The electric current is supplied primarily by a generator driven by the main driving gear. This charges a storage battery, which furnishes the ignition spark and drives the motor blower. As there is but comparatively little demand upon the ignition, we can afford to use a primary current of high amperage and accordingly secure an unusually hot spark. The kerosene is fed under low air pressure to a float chamber similar to that of a gasoline carburetor but of special design. A jet fed from the float chamber projects into a venturi tube perpendicular to the center line of the tube. The level, when the apparatus is not in operation, is somewhat below the mouth of the jet. A multivane blower driven by a small electric motor forces air through the venturi tube into the combustion chamber. The passage of the air creates a vacuum of several inches in the fuel jet, causing the kerosene to pass the spark plug as a fog of very finely atomized particles. The tube widens considerably before the point where the spark occurs, thereby appreciably diminishing the velocity of these particles.

As soon as ignition occurs, the heat of the fire causes a bi-metal switch to break the spark circuit, and the fresh fuel continues to be ignited by that which is already burning. When the steam pressure reaches 600 lb. it breaks the motor-blower circuit and fuel ceases to enter the combustion chamber. As soon as the pressure decreases to 550 lb. the circuit is remade and the spark once more ignites the fuel. This arrangement maintains the pressure in the generator virtually at normal without any attention on the part of the driver. Another motor-blower circuit breaker is used as a safeguard against the possibility of low water in the generator due to lack of water in the supply tank. In this case the breaking of the circuit depends upon the expansion and consequent elongation of the lower header of one of the generator sections when it becomes overheated.

This generator was rated at 75 hp., was 32 in. long, 22 in. wide and 28 in. high. The heating surface was slightly in excess of 150 sq. ft. When ignition took place the water in the generator was at 66 deg. fahr., but reached 212 deg. in forty seconds; in eighty seconds the pressure was 100 lb.; it reached normal, or 600 lb., two minutes and fifty seconds after the switch was turned, the increase from 500 to 600 lb. requiring just ten seconds. In order to maintain a full head of steam, 600 lb., it is only necessary for the combustion system to operate seven seconds in every twenty minutes. This applies when the car is standing where the surrounding temperature is about 60 deg. fahr.

THE ENGINE

In designing the engine my chief concern was to provide ample dimensions of the working parts in order to insure continued operation under maximum conditions of load. Although the compound engine may provide for high expansion, it is not desirable for use in motor cars, as the ratio of the cylinder volumes has to be carefully determined in relation to the probable loads, speeds and steam-chest pressures. In the steam car these conditions vary so widely that it was necessary to use the single-expansion engine.

I employed the uniflow principle, because I wished to secure high expansion with a simple, noiseless valve gear and one valve per cylinder. The inlet valves are placed on top of the cylinders. They are of the slide type, and are so constructed as to lift off their seats if the compression at any time exceeds the steam-chest pressure. Another reason for the uniflow was the fact that it makes unnecessary the use of superheated steam, as the thermal conditions in the uniflow cylinder approach the ideal. All troubles caused by superheated steam are therefore absent, and but little cylinder lubrication is necessary. The exhaust is through ports uncovered by the piston at the end of its stroke. With this arrangement it is possible to secure cut-off as early as 10 per cent of the stroke. The inlet valves are actuated by a simplified form of the Joy valve gear, thus dispensing with eccentrics and making possible a one-piece crankshaft. It differs from the Joy in that it dispenses with the connecting and anchor links, and has a straight instead of a curved rocker guide.

This gear operates the 1/4 cut-off, which is used for all ordinary running, with perfect accuracy, and the slight variation at 5/8 cut-off, which is used for starting or heavy pulling, and at 1/8, used for high speed or economy, is not noticeable in the running of the car. To provide against water in the cylinders or a leaky throttle valve, a small piston valve is placed on the lower side of the cylinders. This valve is normally held open by a spring. It is connected to the four clearance spaces of the cylinders, and any water or steam not under sufficient pressure to actuate this valve passes through it to the atmosphere. As soon, however, as any steam under an appreciable pressure reaches it, the pressure will force down the piston and close the valve. The engine is geared to the rear axle in the ratio 47:49, or virtually one to one; yet can produce sufficient torque to slip the driving wheels on dry pavement. On account of the low engine speed an elaborate system of lubrication for the engine mechanism is entirely unnecessary.

I will sum up the chief advantages of such a steam-power plant for motor-vehicle service.

1 Torque range of 100 per cent with a maximum torque available at zero speed; change-gear mechanisms and clutch therefore unnecessary

2 Mean effective pressure (and equivalent drawbar pull) always under control of the operator; variable by throttle and cut-off from zero to maximum, a maximum limited only by the tractive capacity of the rear wheels

3 Utmost mechanical simplicity with not over twenty-four moving parts in the entire car and only eleven in the engine

4 Smooth and quiet operation, due to low engine speed and to location of the engine

5 Low manufacturing cost, owing to simplicity of construction and lack of "fussy" work in production

6 Entire absence of lubrication troubles; no contamination of crankcase oil by kerosene, gasoline, water, road dust, or carbon

7 Low fuel cost per mile.

In connection with this last point, some very brief statistics may prove of interest. As a basis of comparison, we selected three well-known gas cars, the first being a six-cylinder car

weighs [illegible] 2400 lb. and developing a maximum of about [illegible] hp.; the second weighs 2700 lb., has six cylinders, and [illegible] develops [illegible] hp.; the third, a twelve, weighs 4400 lb., and develops 80 hp. Our steam car has a generator rated at [illegible] hp., and weighs 3400 lb.

The four cars may be known as A, B, C, and D, and the results at [illegible] on a level road were as follows: A delivered [illegible] hp. at the engine, 12.[illegible] hp. at the rear tires, and traveled [illegible] miles per gallon of gasoline. *B* showed 14.3 hp. at the engine, 10.6 hp. at the wheels, and ran 15.4 miles per gallon of gasoline. *C* developed 36.1 hp. at the motor, 29 hp. at the wheels, and obtained 9.5 miles to the gallon. *D*, the steam car, at 10 m.p.h. develops 13 hp. at the engine, 10 hp. at the rear tires, and secures 11.1 miles per gallon of kerosene.

With gasoline at twenty cents and kerosene only eight cents per gallon in Detroit, there appears to be a considerable balance in favor of the steam car, but it is at the more normal driving speed of twenty miles per hour that the best economy showing is made.

A, a light car well known for its fuel economy, at 20 miles per hour ran 31.5 miles on one gallon of gasoline; *B*, 22.7 miles; *C*, 11.8 miles; and *D*, 17.3 miles on a gallon of kerosene.

REDUCING FRICTION BY AUTOMATIC LUBRICATION

By J. Wm. PETERSON, MILWAUKEE, WIS.

Member of the Society

It is my vocation to make things run smoothly, and as has been so aptly said: "Blessed are they that remove friction, that make the courses of life smooth and the intercourse of men gentle." It is not work that kills off so many of our prominent business men before they have reached their allotted three score and ten, it is worry. Revolution does not destroy machinery, it is worn out by friction, which is the worry of work.

Friction is the resistance produced by two bodies coming in contact in a sliding or rolling motion. The product of this resistance or friction is a rise in temperature. You can warm your hands by briskly rubbing them together. Now, put some oil between your hands, and you can rub all day without producing enough heat to feel it. There is just this much difference between properly and poorly lubricated bearings.

It has always seemed to me that friction and its natural antidote, lubrication, have not received as much study from engineers as their importance would warrant. For instance, in a recent book by Archbutt and Deeley,[1] authorities on lubrication, one finds the remarkable statement that more than one half of the 10,000,000 hp. developed in Great Britain is expended in overcoming friction, and that a considerable portion of this wasted power is due to faulty lubrication; and again, in Professor Thurston's[2] classic treatise on Friction and Lost Work we find the statement: "It may probably be fairly estimated that one half the power expended in the average case, whether in mill or workshop, is wasted in lost work, being consumed in overcoming the friction of lubricated surfaces."

While the two statements quoted are general, they are based upon the experience of two well-known authorities. With these figures in mind, when we purchase new machinery let us not be so foolish as to quibble for that fraction of a per cent in efficiency guaranteed for our new engines or machines, and pass lightly over the question of lubrication or make no mention of it at all in our specifications. Let us not lose sight of the fact that the efficiency of an expensive machine may, after a few months of service, become lower than that of a less expensive machine, simply through lack of an efficient system of lubrication. A prominent dealer in second-hand machinery has remarked that in the purchase of any second-hand apparatus he always looks first at the bearings, for their condition largely determines the value of the machine in his eyes. In other words, if the machine has a good system of lubrication, the second-hand value is considerably higher.

Probably the reason friction losses are not so forcibly impressed upon us is because of their insidious nature. We can see leaks in the steam piping and repair them, our CO_2 recorder instantly shows improper methods of firing boilers, a thermometer tells us when our flue gases are too hot or our feedwater is too cold, and our voltmeters indicate the voltage of our electric generators, so that we can correct defects; but the losses caused by friction are not so obvious nor so easily measured. It is only when it becomes excessive—when the bearing becomes decidedly overheated or the babbitt starts to run out—that we become impressed as to the enormous power-consuming properties of friction.

The antidote for friction is scientific lubrication, or the application of a lubricant of the right kind at the right place and in the right quantities. It is the proper valuation of the last three items that gives us the most trouble and usually requires the services of a competent lubrication engineer. In order to give these points brief consideration, I will divide lubrication into two parts, first, interior or cylinder lubrication, which is delivering oil into cylinders and valves against the pressure of the steam, air or gas; and second, bearing lubrication.

CYLINDER LUBRICATION

This problem places us between the two horns of a dilemma. We know that the more oil we use, the smaller will be the amount of power consumed by friction, but we know also that most of the oil which is mixed with the steam going into the cylinder passes out with the exhaust and is forever lost. Up to the present time no good commercial system has been devised for separating oil from exhaust steam or the condensate and rendering it again suitable as a lubricant for cylinders. Of course a certain amount of oil can be removed by line separators, etc., but this is usually mixed with so much water and is so thoroughly emulsified that it is not suitable for further cylinder lubrication. The object in cylinder lubrication is to secure the highest degree of lubrication with the smallest amount of oil.

[1] Lubrication and Lubricants, 3d ed., p. 50.

[2] 7th ed., p. 12.

Presented at a meeting of the Milwaukee Section of The American Society of Mechanical Engineers, December 20, 1916.

Another reason for keeping the amount of oil as low as possible is that as it is impractical to remove it from the condensate, and a large proportion of the oil finds its way into the boilers and makes trouble, for oil is quite an efficient heat insulator. Wm. Parker, Engineer-in-Chief of Lloyd's Registry, found not long ago that by painting an open steel dish with three or four coats of greasy deposit taken from the bottom of a boiler and mixed with cylinder oil, it was possible to burn the dish before the water in it boiled. This might be called a side line of lubrication, but lubrication engineers have to take it into consideration.

Within the memory of the youngest engineer cylinder lubrication has gone through many changes. First, suet or tallow was injected through a small hole in the cylinder every time the engineer happened to think of it. Next, grease cups were used, grease being supposed to be reduced to a liquid and flow into the steam chest, lubricating the valves and cylinders; but as the grease was usually cooked out of the cups, it went everywhere except where needed. Next came the hydrostatic lubricator, in which two or three feet of water pressure is used to force the oil into the steam. The last and most important step was the general adoption of the mechanically driven force-feed lubricator, in which the oil is positively, and at regular intervals, forced into the cylinders by means of pumps.

Most plants have adopted the system of force-feed lubrication for the main power units, but there are many depending upon more or less antiquated methods for supplying cylinder oil to their auxiliaries, such as pumps. Many engineers do not consider the auxiliaries of enough importance to warrant the refinement of automatic lubrication, but as auxiliaries are usually located in the basement, boiler room, or other out-of-the-way places, where they do not receive as much attention as the main units, automatic lubrication of such machines is of at least as much importance as that of the main units. The amount of power consumed by the auxiliaries, compared with the main units, clearly shows that lubrication of the former must be carefully considered.

For illustration, take one of the largest railway houses in the country. The areas of the rubbing surfaces of the main units in this plant amount in all to about 1,507 sq. ft., while those of the steam and air ends of the auxiliaries, air compressors, vacuum pumps, etc., total about 530 sq. ft.; thus there is one-third as much rubbing surface in the auxiliaries as there is in the main units, and as some of the auxiliaries are automatically started and stopped without supervision, it is evident that they should not only be supplied with a good system of lubrication but also with one which will start and stop automatically with the machines to which it is attached.

The power consumption of auxiliaries is more striking in smaller plants than in large ones. For instance, in the Marbridge Building 34th Street and Broadway, only 50 per cent of the power produced is used by the main generating units, the remainder being consumed in elevator pumps, blower engines, vacuum boiler feed, house pumps, air compressors, etc. In the power plant of a modern apartment house in New York City, two-thirds of the total power is consumed in the main units, the other third being used for refrigerating machines, boiler feed and house pumps, vacuum cleaning systems, sewerage pumps, etc. These are only a few examples, but there are many plants where, even though the main units are properly lubricated, the cost of lubrication could be greatly reduced and the plant efficiency improved if the auxiliaries were equipped with an efficient system of lubrication.

Properly designed force-feed lubricators deliver a predetermined amount of oil and the delivery is not affected by changes in temperature or the viscosity of the oil. They are much cleaner and neater to handle than hydrostatic lubricators and can be filled while in operation or connected up to a central system of supply, and will effect a saving in oil of at least 50 per cent.

BEARING LUBRICATION

The problem of adequately lubricating bearings is entirely different. In the old days the engine had a few holes and the engineer had to treat it to a dose of oil on frequent visits; in some instances bearings were provided with grease cups, and instead of a dose of oil he would, on his regular rounds, give these cups an extra twist. Nothing similar to this is now seen in the modern power plant. Economical lubrication requires the installation of modern scientific apparatus which will automatically apply the oil in a manner that will do the most good. Poor lubrication increases wear and tear, reduces the life of machinery, and wastes a large amount of power by friction, resulting in increased fuel consumption.

The only economical method of lubricating bearings consists in supplying as much oil as the bearings will take and of collecting, filtering, and using it over and over again. In passing through the bearings the oil takes up small pieces of metal removed from the bearings by friction, dust, etc., also water from condensed steam, which has leaked past the stuffing boxes. If solid matter and water are properly removed from the oil, it is in a condition to be used over again; therefore the crux of a good automatic system of lubrication is the filter, wherein the oil is restored to its original pure and clean state. An engine or machine equipped with an efficient system of continuous lubrication feeding a stream of oil to all bearing surfaces will run much cooler, wear longer and render the necessity of keying up less frequent than is the case where lubrication is provided by oil cups feeding drop by drop.

In the power plant of a shoe factory the engine-room log shows that before the adoption of continuous stream lubrication it was necessary to key up the pins and [illegible] once every two weeks, whereas since the oiling system was installed, keying up is only necessary every six to eight weeks. One of the engines in this plant, a 200-hp. Corliss engine, is equipped with an individual oiling and filtering system, and the make-up oil only amounts to two gallons per month. A further illustration of what can be accomplished with a properly designed automatic system of bearing lubrication is furnished by one of the largest public-service plants in the country, where 30,000,000 kw. are generated each month. The total amount of oil consumed for all the main generating units and their auxiliaries amounts to only 300 gal. [illegible] and in another plant the actual cost of cylinder and bearing lubrication amounts to only two cents per 1000 [illegible]

PLANT EFFICIENCY

The work done by a steam engine is necessarily divided into three parts: that done against the outside load, which alone is the useful work; that done against the back pressure in the cylinders; and that done against other resistances, the most important of which is friction. Work is also done at the beginning of each stroke in overcoming the inertia of the moving parts, but in a properly designed engine most of this should be restored to the engine before the end of each

[illegible] In the modern type of engines the mechanical efficiency is very high. In tests of ten new engines of different makes—four simple, four compound, one triple expansion and one quadruple expansion—the mechanical efficiency ran from 9[illegible] per cent to 97 per cent.

In engines not so modern in design and which have been running for some time, the mechanical efficiency may be surprisingly low. In one of fifteen engines tested of this class, which have been operating from ten to twenty years, the mechanical efficiency averaged about 70 per cent. In one case it ran as low as 60 per cent. If the mechanical efficiency is 70 per cent, the recoverable loss would be at least 20 per cent. Take a plant of, say, 1000 hp. The cost of producing a horsepower per year is about \$30. A loss of 20 per cent would be 200 hp. at \$30 per year, or \$6,000.

The values for the mechanical efficiencies of steam engines are about as follows: 95 to 98 per cent, rare and unusually high; 90 to 95 per cent, usual good practice; below 80 per-cent, decidedly low. Experiments on distribution of friction show that the greatest loss, amounting to one-third or one-half of the total friction, occurs in the main bearings; the next important loss is that of the piston and piston rod, amounting to about 21 per cent of the total friction. Of this amount $6\frac{1}{2}$ per cent is chargeable to the friction of the piston and rings against the cylinder walls, and about 14 per cent to the stuffing box of the piston rod, leaving 1.7 per cent chargeable to unaccountable losses. The losses due to friction of the working parts of an engine include considerably more than the mere loss of power, namely, the depreciation resulting from wear of bearings, guides, and other rubbing surfaces, and the expense arising from accidents traceable to excessive friction.

DESIGNING LUBRICATION SYSTEMS

There has always been a great deal of guesswork, mystery, and secrecy on the part of manufacturers in regard to the general design and installation of automatic bearing-lubrication systems for power-plant machinery. The lack of general information on this subject has resulted in the installation of many unreliable oiling systems not really suited to conditions existing. The requirements of an efficient lubricating system are:

1 A stream of clean oil supplied continuously at just the points where needed.
2 A filter which will thoroughly remove all dirt, small particles of metal, and entrained water, and properly cool the oil.
3 The system should be automatic in its operation and absolutely reliable.

One sometimes hears the statement made that oil becomes worn out through use. This is not the case, as has been amply proved by extensive tests made by several eminent authorities. There may be some slight increase in its specific gravity after it has been used continually, owing to the fact that by increase of temperature some of the more volatile oils are driven off and small amounts of cylinder oil used for lubricating the piston rods, etc., become mixed with the bearing oil; however, the heavier oil is still as good as ever, if properly treated. In some cases the mixture of cylinder oil with the bearing oil, which gets into the system from the piston-rod lubrication, causes serious complications on account of the small percentage of animal fat necessary in the cylinder oil. This in time causes the oil to become emulsified and entirely unsuitable for circulating. To remedy this trouble, there are two alternatives; the first is to dam off the space below the piston-rod stuffing box between the cylinder and the guide barrel so that the cylinder oil dropping from the rod is carried off through the bonnet drips and does not become mixed with the bearing oil; the second is to install a wiping device on the piston rod and lubricate it with bearing oil. I know that a great many engineers believe that only cylinder oil is suitable for lubricating piston-rod stuffing boxes, but we have had very good success in several instances by applying regular bearing oil in this manner.

The lubrication engineer has three alternatives to work upon in the design of a scientific system: he may install a central oiling system in which the main supply of oil is stored at one point and conveyed to the bearings of the various power units and auxiliaries by means of main feed and branch pipes to each machine; or he may make each individual engine, pump, air compressor, etc., a unit by itself, and supply it with its own oiling and filtering system; or he may provide a combination of the two by providing one lubricating system to take care of a group of machines.

In the application of the first system it is necessary to install a large part of the apparatus in duplicate in order absolutely to insure continued operation of the plant. The amount of duplication depends a good deal upon the arrangement of the plant, the susceptibility of the various parts to injury, the value of continued operation and also the ideas of the designing engineer.

To insure absolutely reliable lubrication, many plants are now installing individual oiling and filtering systems, so that each unit, from the smallest auxiliaries to the largest power unit, is equipped entirely independently of all other units in the plant. Practically everything necessary for these individual oiling systems is above the engine-room floor and therefore always in sight and under the care of the engineer or attendant.

The so-called splash system used on several makes of high-speed engines has many disadvantages. Usually the engine frame forms an oil reservoir, and the crank dipping into the oil at every revolution throws it out on the rubbing surfaces. It soon becomes saturated with small particles of metal and is entirely unsuited for use over and over again between the rubbing surfaces; furthermore, the oil, being at the high temperature of the engine frame, has practically no ability to carry off heat which may be generated in the bearings, and finally on some engines the steam leaking past the piston-rod packing and condensing in the oil reservoir soon mixes with the oil to such an extent that an emulsion is formed, which has practically no lubricating value. The proper lubrication of engines equipped with the splash system can be easily accomplished by connecting an oil supply line into the reservoir of the splash system and a dirty-oil overflow arranged so that a predetermined level of oil is maintained in the reservoir; thus the dirty oil passes out through the overflow at the same rate at which clean oil is delivered into the reservoir. In this way continuous circulation of oil is maintained and good reliable lubrication is insured. Real bearing-lubrication economy is possible only when

1 Every bearing is continually supplied with a stream of clean oil so that the rubbing surfaces float past each other on a film of oil instead of coming into metallic contact, reducing cost of producing power.
2 When the oil is automatically collected, filtered, purified for use over and over again, reducing cost of attendance and oil.

PROBABLE REQUIREMENTS IN MACHINE TOOLS

A Discussion of Means for Their Fulfilment, and a Description of an Automatic Tool-Feeding Mechanism in Which the Feed is Governed by the Driving Torque

By A. M. SOSA,[1] CINCINNATI, O.

OUR observation of the progress made in the construction of machine tools in the last twenty years shows that the development of machine tools has been accomplished by the natural process of producing or designing mechanisms to meet the requirements that were brought forth in the course of the work, and which requirements may well be divided in two classes. To the first belong those that are due to new conditions created independently of the machine itself; and to the second, those that demonstrate the evolution of the machine in itself.

CLASSES OF REQUIREMENTS

The discovery of high-speed tools brought forth the necessity of designing new gear combinations for driving the machine that would permit of a greater power input. This is a requirement of the first class. But it was observation and suggestion that has developed the modern type of quick-change gearing; and this is an example of requirements of the second class.

We aim to be ready to meet these necessities as they arise, and are prepared with systematized knowledge to solve the new problems created; but the improvements or requirements brought about through our observation and suggestion are proportional to the amount of study that we are willing to invest during the course of our daily work.

Our standards for improvements are based on the general principle of simplification of manual operations consistent with the quality of the finished product and cost of production.

Our aim is, in fact, not only to make manual operations easier, but to eliminate manual operations as much as possible. The reason is that we can perfect a machine. We can time a machine and standardize its product much better than we can the operator. And we are now satisfied by daily evidence that, at least in a mechanical sense, machines can do what men can do.

We have in modern machine tools automatic stops, power quick traverse, belt shifters, tool lifters, sizing grinders, and other numerous attachments with which we are familiar. These attachments add in each case some parts, and in some cases complicated mechanisms, to the original machine, in order to increase its output by simplifying the manual operations. The increase and dependability of the output justify the additional expense.

Each of the examples here given is of the same nature, inasmuch as its object has been to eliminate the frequent repetition of some manual operation. They all require the setting of some additional gage to reproduce a given performance, and we may well associate the above with the general study of jigs and fixtures, as their development has been hand in hand.

These accessories do not affect the standard construction or the fundamental lines of the machine to which they are applied. Changes that affect the fundamental construction are of such blended character that it is difficult to point out the different steps of the transformation. The total advance may be appreciated by comparing the modern machine with its equivalent of twenty-five years ago, and the most influential details in this advance can be attributed to the perfecting of gear wheels and their combinations.

In those days it was not permissible to feed a tool with rack-and-pinion motion nor to drive a cutter with an all-gear combination; the tooth marks were clearly visible. And it was not all the fault of workmanship, as imperfect applications of gear trains were many times the cause of such poor results.

We can say, in general, that positive transmission of motion and quick-change-gear combinations are the prominent details that characterize the modern machine tool. These gear changes are quick and simple, with very few exceptions, but there are exceptions, and besides, these are, at their best, manual operations, two good reasons for attracting our attention.

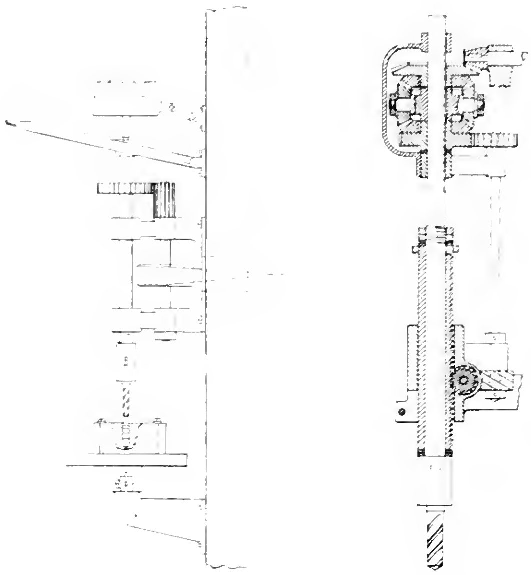

Fig. 1 Fig. 3

Fig. 1 Upright Drill for Testing Hardness
Fig. 3 Drill With Driving Force and Feeding Force Complementary

We may consequently say that the further perfecting of gear trains and their combinations, consistent with our continuous effort for saving manual labor, will bring about the modification of some of those gear changes that are now left to the will of the operator.

PROBLEM OF THE DRILLING MACHINE

As an illustration I will call your attention to one particular application, and I will select the drilling machine. Here

[1] Member Engineers' Club of Cincinnati.

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the changing of tools is ordinarily very frequent. The diameter of the tool is charted with its corresponding speed in revolutions per minute. A quick change of the position of one or two levers and the proper speed is given to the tool.

But to feed this tool properly is a consideration not quite so simple. In the first place, excessive speed will not break the tool, while excessive feed will break the tool. In the second place, if excessive speed burns out the tool, the feed again will break the tool or the machine. The feed is, in both cases, the more important change of the two.

On the other hand, a drilling machine, on account of its constructive capacity, admits of two or three times as many speeds as it does feeds, for the reason that all the feed-change gears must be comprised in the head of the machine. The result is that the same feed is charted for a considerable number of tool diameters.

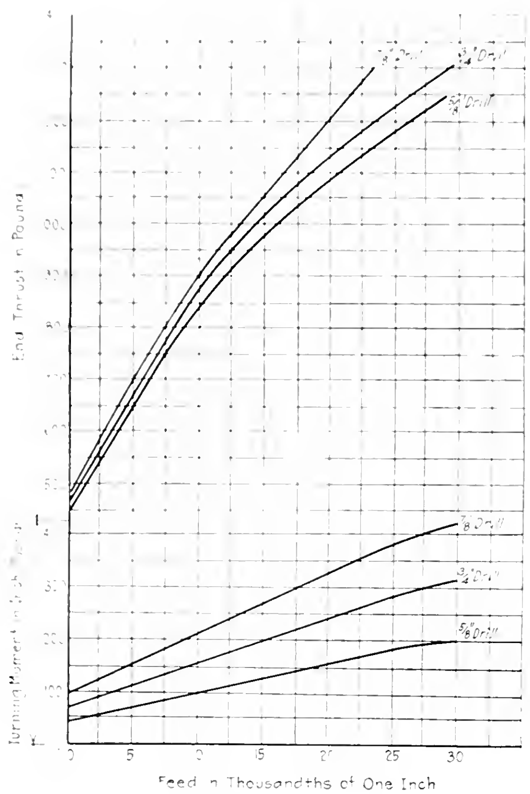

FIG. 2 RELATION OF END THRUST TO DRIVING FORCE

Another consideration is that the amount of feed given on the chart will feed the tool properly after the cut has been started and brought to full diameter without abnormal effort that would indicate that the tool is dull, and for this reason the operator will start feeding by hand previous to connecting with power feed, making certain that the tool is cutting freely, and also will finish feeding by hand in many instances to prevent a breakage as the tool comes through the metal. When using tools in connection with jigs, where said tools carry stop collars to gage depths, it is also necessary to feed by hand against such stops. Consequently, the operator, after making the necessary feed changes, will feed by hand the greater part of the time in many instances.

The conclusion is that the power feed in such a machine does not meet all of the requirements, being more a hand than a power-operated mechanism.

These limitations of the feed gearing are not characteristic of the drilling machines alone, for other machine tools will be found wanting in similar respects if carefully examined.

Now, if we are to continue perfecting gear transmissions, this most likely will be the nature of the requirements that we will have to meet in the near future.

That it is possible to accomplish the desired results there is no doubt in our minds. Nevertheless, as an example, I will suggest an analysis and a possible solution of a plain train of positive gearing to feed the tool in drilling machines that might be considered a step in the right direction in the development of feed gearing.

ANALYSIS OF DRILL-FEEDING PROBLEM

Fig. 1 represents the elements of an upright drill as it is used for testing the hardness of materials. The spindle is driven in a normal way. Provision is made for the application of a given weight to the spindle of the machine. Here, for a given weight and a given speed, the materials under test for hardness are graded by measuring the penetration of the tool in a given time. Tests of this kind have been published in the *American Machinist,* and are quoted here only to substantiate the fact that the tool can properly be fed by a constant pressure. The feeding of drills is at present accomplished by positive motion.

Fig. 2 gives in condensed form the results of numerous tests for determining the values of the end pressure needed to feed the tool,[1] and the torque required to drive the same tool.[2] The values of three tool diameters are given: 5/8 in., 3/4 in. and 7/8 in. There are two curves given for each side, one for the value of the end pressure or thrust, and one for the value of the turning moment or torque. The upper curves, for end pressure, read pounds on the vertical scale corresponding to feeds on the horizontal scale in thousandths of an inch. The lower curves, for the turning moment, read pounds at one inch radius on the vertical scale corresponding to feed in thousandths of an inch on the lower scale. For example, the end thrust required to feed a 5/8-in drill with an 0.011-in. feed is 875 lb., and the torque required to drive it is 100 in.-lb.

The driving force and the feeding force are so related in the actual action of cutting that the one cannot exist without the other; in other words, they are two component forces, and their values are functions of each other. These values, as given in Fig. 2, vary in the same direction, but not proportionally, as may be seen by the relative obliquity of each two curves for the same diameter of tool. It will be seen that as the feed increases the end pressure increases more rapidly than the turning moment.

Fig. 3 shows an elementary construction of a drilling machine where the driving force and the feeding force are complements of each other. This is a differential gearing such as is used on the rear axle of an automobile, and whose construction and efficiency are well known.

PROPOSED DIFFERENTIAL GEAR FEED, IN WHICH THE ADVANCE IS GOVERNED BY THE DRIVING TORQUE

A small bevel pinion is our source of power, this driving a double bevel gear running loose on the spindle. Meshing with the lower half of the double bevel gear are two bevel pinions running loose on trunnions that project from a sleeve; this sleeve driving the spindle by means of a sliding key. These bevel pinions are called planet pinions, and meshing with

[1] Thrust of Twist Drills, H. Hess, Am. Mach., 1907, p. 598.
[2] Power Required to Drive Twist Drills, Frary and Adams, Am. Mach., 1907, p. 210.

them is another bevel gear, called the supporting gear, around which the planet pinions will roll when driven by the first driving gear. The supporting gear also runs loose on the spindle, together with a spur gear, which is the first member of the feed train of gearing. A vertical shaft, two spiral gears, and a rack and pinion complete the feeding mechanism.

The said supporting gear is positively geared to the spindle for feeding. Its motion is proportional to the feeding movement of the tool, and if the tool does not advance this gear will not turn. The said driving sleeve is carried around by planet pinions at one-half the speed of the first driving gear as long as the supporting gear does not turn, but as the speed of the supporting gear, when the tool is feeding, is very low, it only affects the spindle speed on a very small percentage.

The planet pinions exert a tooth pressure on the supporting gear equal to one-half the pressure effective on their trunnions, measured on a radius equal to the pitch radius of the supporting gear. This pressure is transmitted through the feed train of gearing down to the end of the tool. The amount of tooth pressure on the supporting gear and the amount of end pressure on the tool, or, the ratio of these two pressures, depend on the gear ratio of the feed train of gears. The pitch radius of the supporting gear multiplied by its tooth pressure equals the turning moment given in Fig. 2. The tooth pressure of the supporting gear multiplied by the feed-gear ratio equals the end pressure given in Fig. 2.

This mechanism, fitted with the proper feed-gear ratio, will, in driving the spindle with a given torque, produce the necessary end pressure to feed the tool just enough to maintain the said torque. These two forces, the driving force and the feeding force, are functions of each other, and it is necessary that they come to be in equilibrium at the desired rate of feed in order to maintain the feed constant.

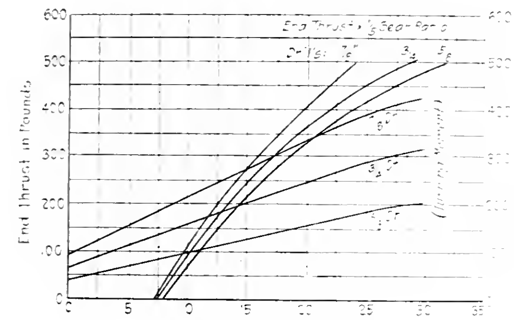

Fig. 4 Relation of End Thrust to Feed-Driving Force. End Thrust Reduced by Gear Ratio of 5:1

Fig. 4 is a modification of Fig. 2. The turning moments are the same as before, but by introducing a feed-gear ratio of about 5 to 1, the values corresponding to end thrust are reduced by a factor of 5. The curve for end thrust in this diagram represents the force inside the differential gear which, multiplied by the feed-gear ratio, will produce a force five times greater to feed the tool. A factor was selected high enough to permit the lines of the end thrust to intersect the lines of the turning moment. As the feed increases the two lines that correspond to the given diameter advance until they intersect. The point of intersection represents the amount of feed reached when the two forces come to be in equilibrium.

With the gear ratio assumed in the present example, a $\frac{7}{8}$-in. tool will reach 0.015 in. feed and maintain 0.015 in. feed thereon; a $\frac{3}{4}$-in. tool will reach 0.013 in., and a $\frac{5}{8}$-in. tool will reach 0.011 in. feed.

Fig. 5 represents the head of a radial drill mounted on the arm of the machine. Only the details that pertain to the present subject are shown, and these again in a very elementary form.

The horizontal shaft, inside the arm, through bevel gears, not shown, drives a second horizontal shaft at right angles. This second shaft carries another bevel gear which meshes with the two bevel gears shown near the bottom of the figure. A clutch between these two gears serves to drive the vertical shaft in either direction. From here on the gearing for driving and feeding the spindle is the same as in Fig. 3, except that the supporting gear is placed above the planet pinions and the driving gear below, for convenience only. The reversing clutch will change the direction of rotation of the whole train of driving and feeding gears.

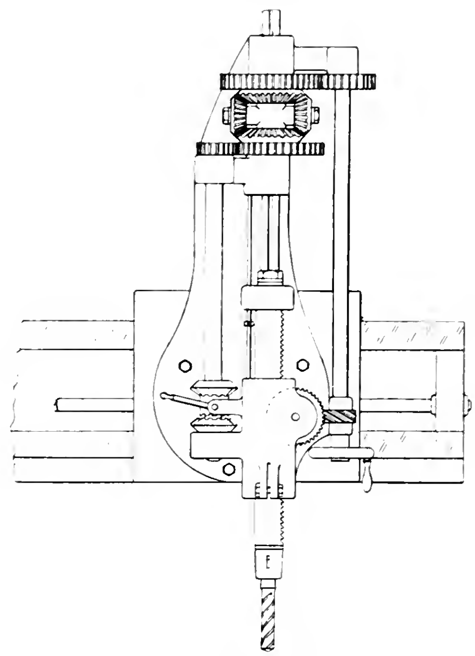

Fig. 5 Drill with Automatic Feed Governed by Driving Torque

The reversing-clutch lever has two positions that correspond to the upward and downward movement of the spindle. It is operated by hand or is tripped by a collar on the spindle, striking an adjustable dog on a vertical rod, shown in a parallel disposition to the spindle. Said vertical rod is arranged to throw the clutch into the reversing position automatically, so that, if the tool is at work and the reversing clutch is tripped, the tool will withdraw from the work, and will do so whether the tool is a drill or a tap. If, on the other hand, the clutch is thrown in, the tool will advance until striking the work.

It will be noticed that the idle movement of the spindle before the tool strikes the work or after reversing, will be a rapid movement. It will also be noticed that the hand wheel shown on the right-hand side is operative at any time and whether the tool is under cut or not, except in the case of a tap, when the reversing clutch must come into action. It will also be noticed that stop collars on drills will be effective when feeding by power. Could this mechanism be realized, the result would be a machine without feed consideration, as far as the operator is concerned.

METALLIC ALLOYS, WITH PARTICULAR REFERENCE TO BRASS AND BRONZE

By WILLIAM M. CORSE,[*] NIAGARA FALLS, N. Y.

LAW defines an alloy as "a coherent metallic mass produced by the intimate mixture, whether by fusion or otherwise, of two or more metals or metallic substances." Our world is composed of about one hundred elements, of which approximately fifty are metals. Of these metals about forty are in everyday use and less than fifteen to any great extent. As an alloy may consist of two or more metals, we can see what a large number of combinations are possible. There are many pairs of metals that have never been alloyed, so the possibilities for research are almost limitless.

Before taking up the better known metallic alloys such as brass and bronze, let us glance at some metals which are now passing from the rare into the common class.

Cobalt is a metal similar to nickel in many respects but has properties which it confers on its alloys that are distinctive.

Chromium is commonly known as an ingredient of some steels and in combination with cobalt forms stellite, an alloy which has quite recently helped out during the shortage of tungsten.

Tungsten is well known now both in high-speed steel and in the tungsten-filament electric lamp.

Calcium is a metal not produced as yet in large quantities, but as a hardener for lead has recently attracted attention. It will harden lead about ten times as much as antimony, which is commonly used for the purpose. The manufacture of shrapnel bullets stimulated this use.

Magnesium is now a commercial product finding its use principally in light alloys.

Vanadium is another metal used in alloy steels and in some bronzes.

Silicon in 1900 was a curiosity but is now produced at Niagara Falls in large quantities.

Titanium is, next to iron, the most abundant metal in the earth's crust. It principal use at present is as ferro-carbon-titanium, which is used as a cleansing agent in steel. It is also used in bronze alloys and its oxide as a white pigment.

Cadmium, thallium, molybdenum, and *boron* can be produced cheaply and are awaiting their extensive practical uses.

Copper, tin, lead, zinc, aluminum, and antimony are the most useful of the non-ferrous group. The metals alone have many uses, but the field is widened when metallic alloys are produced.

Copper and tin with copper above 80 per cent form the true bronzes. Other metals added confer special properties but the dominating feature of the alloy is the copper-tin base. Lead, for example, is added to aid in machining and zinc to promote soundness.

Copper and zinc with copper above 56 per cent form the true brasses. These also are modified by the addition of a third or fourth metal such as tin or lead, but still possess the properties of the basic copper-zinc combination in the particular proportion specified.

For some reason the term bronze is also applied to other combinations than copper-tin alloys; for example, manganese bronze. This is a copper-zinc alloy approximately 60 per cent copper and 40 per cent zinc, to which a hardener, consisting principally of iron, is added. Aluminum bronze is another example; it is an alloy approximating 90 to 95 per cent copper and 5 to 10 per cent aluminum.

Alloys consisting principally of tin or lead to which other metals such as antimony and copper have been added as hardeners, are known as babbitt metals.

Alloys have been known for hundreds of years but their scientific study has been undertaken only during the past twenty-five years. This period has been marked by several distinct phases of development:

1 The advent of the chemist and metallographist into the trade
2 The exchange of information through trade journals and scientific societies. The oldest trade journal was started in 1902 and the two scientific societies, viz., The American Institute of Metals and The Institute of Metals of Great Britain, were founded in 1907 and 1909, respectively
3 The application of knowledge gained to engineering problems and shop methods both from a manufacturing and consuming viewpoint.

These three phases enabled information pertaining to the industry to be widely disseminated, and the exchange of knowledge has led to many permanent advances and made possible many developments; for instance, aluminum is now a commercial article; magnesium, tungsten, titanium, and vanadium are well known and have important uses. The methods employed in studying alloys have been conveniently classified by Roberts-Austen and Stansfield[1] under

1 The chemical grouping of the metals in a solid alloy
2 The separation of the constituents during solidification.

The first of these includes the methods of investigating their specific gravity, electrical resistance, diffusion, electrolytic conduction, thermo-electric power, heat of combination, electromotive force of solution, also the isolation of constituents by chemical methods, and microscopic examination.

The second group deals with those methods involving a study of the separation of the constituents of an alloy on solidification, and includes measurement of fall of temperature during solidification by means of a pyrometer, mechanical separation of the constituents of an alloy by heating to definite temperatures and draining off or pressing out the liquid portion, and investigation of the changes in the magnetic character of certain alloys during heating and cooling.

The methods thus outlined have given valuable results, but according to Gulliver[2] the most fruitful results have been obtained by considering alloys as solutions of metals in each other and studying them by means of the thermometer or pyrometer, and the microscope. The record of temperature gives the melting point, freezing point, and critical temperatures of the alloy; the microscope shows its structures; and these two determinations taken in conjunction reveal very valuable data.

The microscopical study of metals and alloys is known as metallography. In this connection it may be mentioned that

[*] The Titanium Alloy Mfg. Co.

Abstract of paper presented at a meeting of the Buffalo Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, January 31, 1917.

[1] Law, Alloys, p. 39.

[2] Gulliver, Metallic Alloys, 2d ed., p. 1.

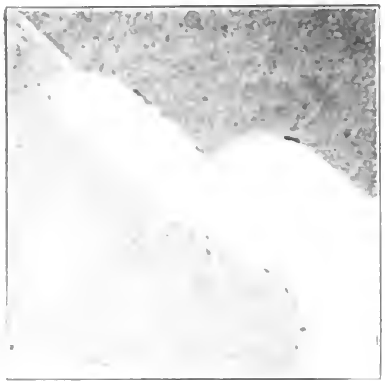

Fig. 1 Magnified 100 Diameters

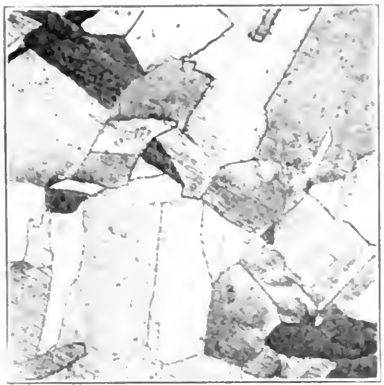

Fig. 2 Magnified 100 Diameters

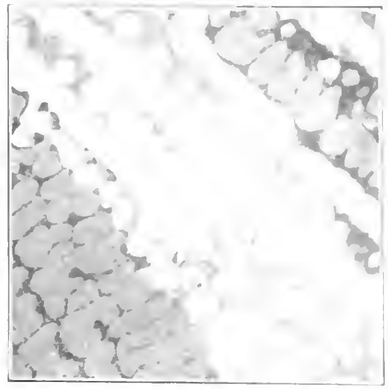

Fig. 3 Magnified 100 Diameters

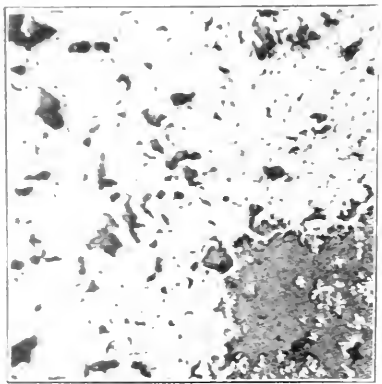

Fig. 4 Magnified 20 Diameters

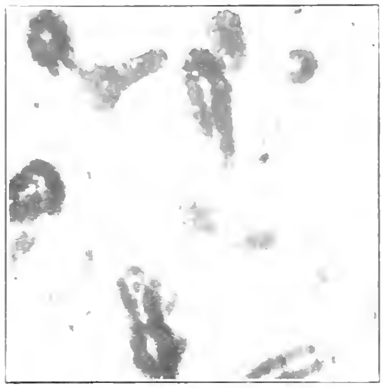

Fig. 5 Magnified 200 Diameters

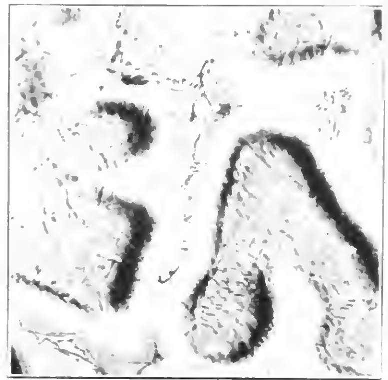

Fig. 6 Magnified 400 Diameters

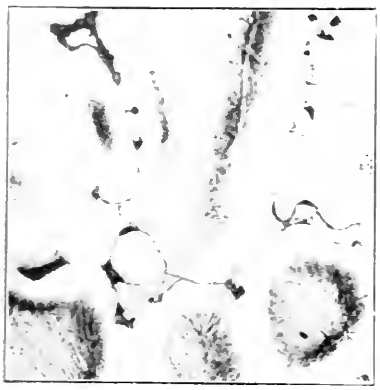

Fig. 7 Magnified 400 Diameters

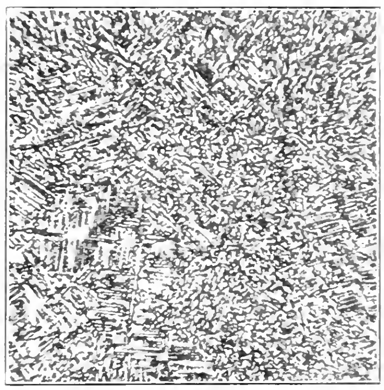

Fig. 8 Magnified 20 Diameters

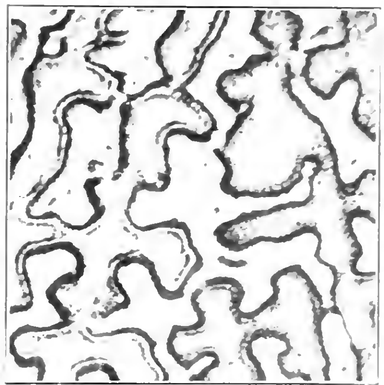

Fig. 9 Magnified 200 Diameters

Fig. 10 Magnified 200 Diameters

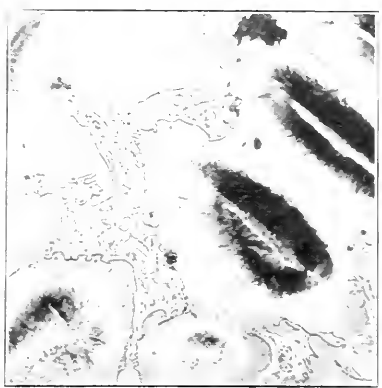

Fig. 11 Magnified 200 Diameters

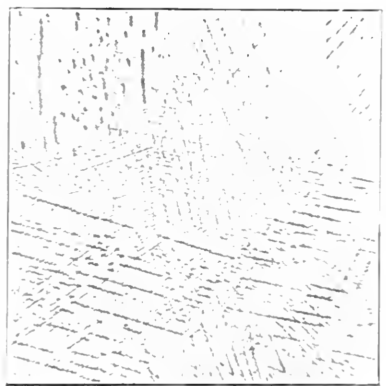

Fig. 12 Magnified 20 Diameters

Figs. 1 to 12 Photomicrographs of Typical Bronze Structures

the reports of the Alloys Research Committee to the Institute of Mechanical Engineers of Great Britain are splendid examples of this kind of work and stand as enduring monuments to their authors.

The tensile strength, yield point, elongation, and reduction of area are determined on a machine of the Olsen or Riehlé type, and the hardness determined wherever possible by the Brinell method. The latter consists of forcing a 10 mm. steel ball into the surface of the metal under constant pressure and measuring the diameter of the depression. By referring to a table the corresponding hardness number is found. The scleroscope is also used, but the results are not as dependable as those found by the Brinell method.

Fatigue testing machines such as the White Souther give valuable results in special cases. For example, the resistance to fatigue or vibration of titanium aluminum bronze was found to be about ten times that of manganese bronze, both bronzes being of equal strength. Machines to determine wear have been devised but not as yet widely adopted. A good machine of this kind would be very valuable.

One of the questions frequently asked in engineering circles is, how the ancients tempered copper. Various attempts have been made from time to time to claim the discovery of this lost art but without much success. The facts are that the tempered copper of the ancients was an alloy and not a pure metal. The chemist has shown us that it contained iron and tin in sufficient quantities to harden the metal. The main difference between ancient and modern metallurgy lies in the purity of the metals produced. The ancients really made alloys instead of pure metals, and secured the corresponding properties of alloys while assuming that what they handled was pure metal. While this fact has been known for a long time, the slow dissemination of metallurgical information gives ample opportunity for the country drug store to produce several discoveries of this lost art annually.

While it is generally known that small amounts of certain elements such as carbon, phosphorus, and sulphur exert a profound influence on the properties of steel, it is not as generally known that small amounts of certain elements such as oxygen, sulphur, vanadium, titanium, and phosphorus also exert profound influence on the properties of certain non-ferrous alloys.

The study of the metals in the bronze foundry is a larger proportion of the scientific work to be done than the same study in the iron or steel foundry. The iron foundry has but a few grades of metal to make, while the brass foundry or casting shop may have a hundred standard formulæ for alloys and several times as many for special cases. Each alloy requires the thought and attention of the man in charge. The importance of the study of metallic alloys, I am quite sure, will furnish sufficient work for years to come.

I should also like to mention the need of coöperation between the metallurgist and the engineer. Instances of lack of knowledge on alloys come up every day. For example, a large railway recently specified an alloy of copper 58 per cent, tin 40 per cent, zinc 2 per cent. We inquired the need for such an alloy and received the reply that the service of the part in question demanded a hard metal, and in an effort to find one a consulting engineer was asked to suggest a formula. The suggested alloy is certainly hard, but it is so brittle that if the casting were allowed to drop on the floor it would break into a hundred pieces. Twenty per cent tin in that alloy would have been about the limit.

Another point to be emphasized is the difference which exists between results of test bars and the properties of the casting itself. Design, relation of thick and thin sections, and weight all have a very direct bearing on the result. Many engineers do not possess data on the relation between the strength of the test bar and the strength of the casting. Although the matter has been the subject of a few articles, it will bear repeating, as many misunderstandings arise through a lack of knowledge of this relation. I know there is a wide discrepancy between the two, but do not have sufficient information as yet to warrant the formulation of a rule. I want to mention the fact so that engineers will recognize that the condition exists, and they will be willing to coöperate in getting more data on the subject.

The illustrations are given to bring out the need of coöperative advice and show the sort of problems that arise. These can only be solved by the application of scientific methods and the appreciation by both manufacturer and consumer of the necessity for coöperative work and study. That the field of alloys research is of interest is not questioned by those who have worked in it, and it will only be necessary to present the matter in the proper light to convince engineers of its practical value.[1]

ILLUSTRATIONS

Fig. 1 shows the structure of pure cast copper of high electrical conductivity magnified 100 diameters. Parts of large uniform crystals are shown, the different crystals being of different shade because this metal has been etched with ammonia and peroxide, which attack some crystals more than others, depending on the way the polished section happened to cut the various crystallographic axes. This structure is typical of all pure metals; the only impurities seen here are the few small black spots, which are probably traces of oxide.

Fig. 2. shows this same material at the same magnification after forging. The crystals are very much smaller, and many of them show more or less parallel bands, evidence of the phenomenon known as *twinning*. Although this is a view of forged pure copper, the structure is perfectly typical of all hot-worked pure metals or solid solutions, such as rolled brass, for instance.

Fig. 3. at the same magnification shows the structure of copper cast carelessly, without deoxidation. Melted copper dissolves oxygen from the air very readily in quite large amounts, but when this oxidized copper solidifies on cooling, the cuprous oxide is thrown out of solution, forming a mixture with the metal called an eutectic. This eutectic is shown clearly in this figure as a dark substance filling the spaces between the rounded grains of copper. It is a weak, brittle substance, and spoils the ductility of the metal. The copper crystals are shown here of different shade as in the previous figures, on account of the action of the etching reagent, as explained before, but in both the light-etching and dark-etching copper crystals the oxide eutectic is etched darker than the copper.

Fig. 4. in which the structure is magnified 20 diameters, shows copper containing lead instead of oxygen, and this metal was not etched, so that the copper crystals are not shown. Lead is so much softer than copper that it wears away to a lower level in polishing and does not take as good a polish as copper, so that it always looks dark in a polished section through the microscope. The dark spots here are lead and the bright background is copper. Metal like this is used for soft bearings that must give good service at very high speeds, and not become hot even if lubrication is not always effective. Since copper and lead do not dissolve in each other even when melted, it is hard to cast a uniform mixture of the two, and it takes care and skill to avoid the occurrence of large globules of lead, one of which is shown in part in this figure, and which might so weaken the casting as to cause it to break. An interesting feature of this figure is the presence of very small star-shaped crystals of copper, somewhat like snow crystals, in the large globule.

Fig. 5 is a view of a leaded bronze, or an alloy of copper, tin and lead. This metal has been etched, and the structure is shown

[1] I wish to thank Mr. George F. Comstock for his able coöperation and for the photomicrographs which accompany this paper.

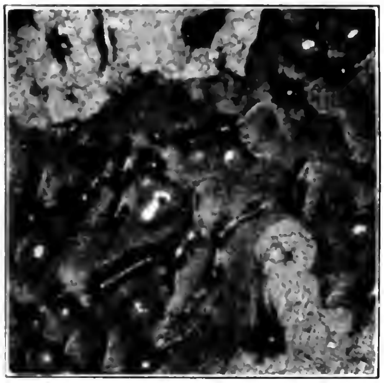

Fig. 13 Magnified 200 Diameters

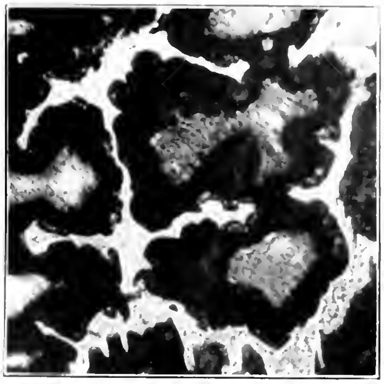

Fig. 14 Magnified 200 Diameters

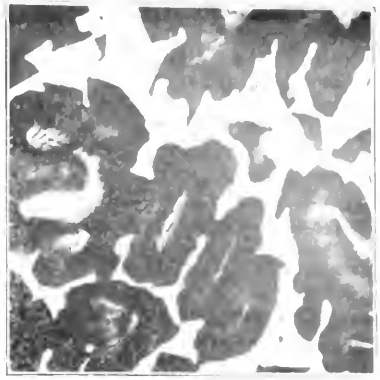

Fig. 15 Magnified 200 Diameters

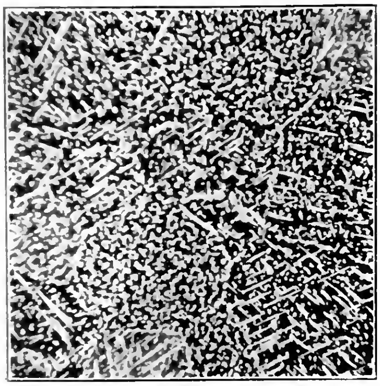

Fig. 16 Magnified 20 Diameters

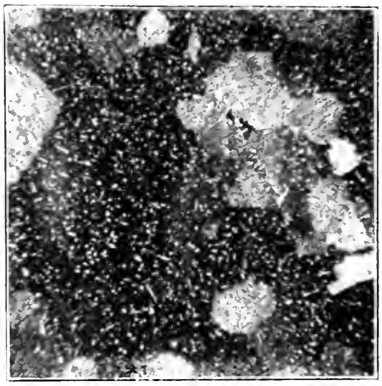

Fig. 17 Magnified 20 Diameters

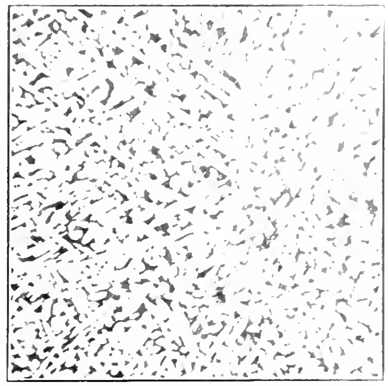

Fig. 18 Magnified 20 Diameters

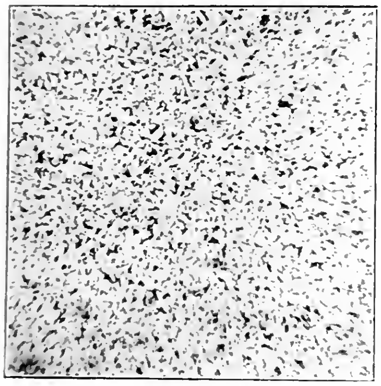

Fig. 19 Magnified 20 Diameters

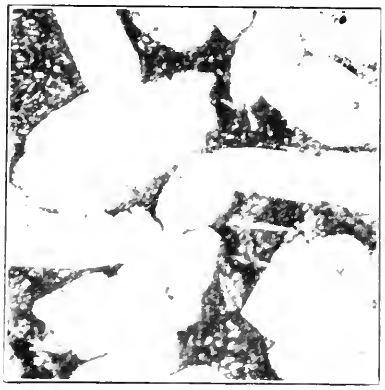

Fig. 20 Magnified 400 Diameters

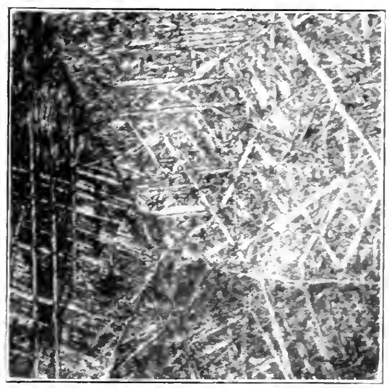

Fig. 21 Magnified 200 Diameters

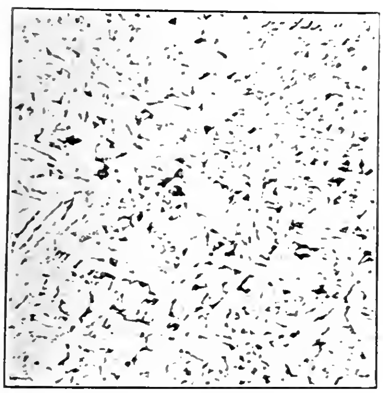

Fig. 22 Magnified 200 Diameters

Fig. 23 Magnified 200 Diameters

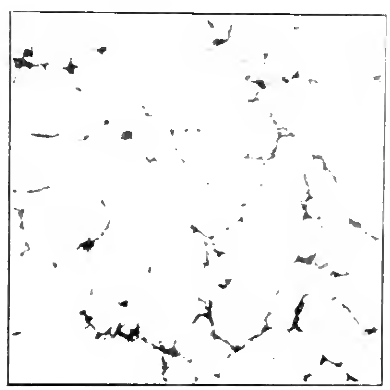

Fig. 24 Magnified 50 Diameters

Figs. 12 to 24 Photomicrographs of Typical Bronze Structures

magnified 200 diameters or ten times as much as in Fig. 4. Here two other features are shown on account of the presence of tin in the alloy. The rough-looking black spots with bright centers are not lead, but the soft cores of the bronze crystals, which, being lower in tin than the rest of the metal, were eaten away by the etching reagent, while the parts higher in tin were left bright. The soft cores, low in tin, are found in all cast bronzes, because when bronze first solidifies in cooling from the melted condition the first metal to freeze is nearly pure copper, the tin remaining as long as possible in the liquid part. When cooled so far that the last bit of the alloy must freeze, there is so much tin left in the metal that remained liquid longest that a new constituent, high in tin, is formed. This constituent is shown in this figure as bright irregularly spotted areas, sharply outlined. These areas are bluish gray in color, contrasting quite strongly with the yellow color of the other bright parts of the alloy. The gray constituent is known as the copper-tin eutectoid and is hard and brittle. The lead in this alloy appears as dark gray rounded spots. It makes the metal more easy to machine and gives better bearing properties.

Fig. 6 shows at a magnification of 400 diameters a bronze containing 10 per cent tin and 2 per cent zinc, with little lead. The eutectoid is clearly seen here, and the cores are very distinct. The parts that seem to be at a lower level are the soft, low-tin parts of the crystals which were attacked by the etching reagent and dissolved away from the originally smooth polished surface. The parts standing up in relief are higher in tin and resisted the attack of the etching solution.

Fig. 7, also magnified 400 diameters, shows an alloy of the same general composition as the last one, but of poor quality. There is hardly any eutectoid shown here but instead there are numerous black lines and spots. These are films of tin oxide, which destroy the strength and ductility of the alloy. They show that the metal was not completely deoxidized when cast: in good bronze these films should not be found.

Fig. 8 shows the appearance of a polished and etched section of a soft bearing bronze, with only about 6½ per cent tin, and a little lead and zinc magnified only 20 diameters. Here the only thing shown is the arrangement of the soft cores of the crystals, and this dendritic or pine-tree structure is typical of nearly all cast bronzes.

Fig. 9 shows the alloy of Fig. 8 magnified 200 diameters. The harder bright portions stand out clearly above the softer cores, and contain a few traces of the eutectoid and a few spots of lead. The good bearing qualities of this metal are probably due in large measure to the irregular alternation of hard and soft streaks on any given surface. On a bearing the hard streaks would carry the load, and the soft streaks in wearing away would form microscopic channels facilitating the distribution of oil.

Fig. 10 shows the same alloy, magnified the same amount as in Fig. 9, but in this case the sample was chilled quickly in casting instead of being cast in sand and slowly cooled. The finer grain caused by chilling is apparent, and also the soft cores are more extensive, at the expense of the hard bright portions, but otherwise the structure is the same.

Fig. 11 is an extremely coarse-grained gear bronze, of English manufacture, with about 10 per cent tin and a little lead and zinc. This section is magnified 200 diameters like the last two, and also etched in the same way. The soft cores appear as large black streaks, and the spotted structure of the eutectoid is clearly seen. This bronze would be hard to machine, on account of the learge spots of hard material in it, which would dull the point of the tool.

Fig. 12 shows a similar bronze with 11 per cent of tin, etched in the same way and magnified 20 diameters, but cast in a chill. The very fine grain as shown here can be easily and certainly produced by chilling this alloy, and is far superior to a coarse structure from all points of view.

Fig. 13 shows a sample cut from the chilled face of a bronze gear containing 11 per cent of tin, magnified 200 diameters, or ten times as much as Fig. 12, and etched differently, so that all the surface is darkened except the hard high-tin eutectoid. The soft cores of the crystals are shown here as black streaks with bright centers, but the main part of the alloy was darkened by ferric chloride to give a greater contrast between it and the bright eutectoid. The interesting point about this structure is the very small amount of eutectoid present in spite of the high tin content, and the result is that this metal is easy to machine and still hard enough to make a good gear. Such a structure is produced merely by chilling the metal as soon as it is cast.

Fig. 14 shows the same metal, etched and magnified in the same way, but slowly cooled in casting. The large amount of eutectoid here makes the metal brittle and hard to machine. The soft cores in this alloy are so coarse that their centers form rather large light areas, but the eutectoid is much brighter and of more irregular shape.

Fig. 15 shows the structure of a harder gear bronze, with 13 per cent tin and 2 per cent zinc, sand-cast, and etched and magnified 200 diameters. There is still more eutectoid here, and its spotted structure is clearly brought out. Bell metal has only a little more eutectoid than this.

Fig. 16 shows the structure of a rather coase-grained and soft manganese bronze, magnified 20 diameters. The metal when just solid in cooling from the liquid state consisted entirely of the dark constituent; on further cooling the bright needles separated out along the cleavage planes of the original crystals. The different original crystals may thus be distinguished, not only by the color assumed in etching, but also by the directions of the bright needles in them.

Fig. 17 shows a fine-grained, harder and stronger manganese bronze, etched and magnified in the same way. This metal was cooled faster in casting, and the bright needles did not have much chance to develop before the temperature dropped too low for any further growth.

Fig. 18. Another non-ferrous alloy which has strength and ductility comparable with manganese bronze and steel is aluminum bronze, a name applied to alloys of copper with up to 10 or 12 per cent aluminum. The structure of a typical 10 per cent aluminum bronze, cast in sand, and magnified and etched in the same way as the previous views of manganese bronze is shown here. This alloy is seen to be normally coarser grained than manganese bronze, and to have more of the light constituent, which is softer, and less of the dark constituent, which is harder. Consequently its yield point is lower than that of manganese bronze, but its ultimate strength and ductility are just as good, and in endurance or resistance to fatigue, and in bearing qualities, it is far superior. It also resists corrosion very well.

Fig. 19. We have found that the addition of iron to aluminum bronze refines the grain very decidedly, and gives a higher yield point and slight improvements in other properties except the resistance to corrosion. Here is shown the typical structure of an alloy of copper with 10 per cent aluminum and 4 per cent iron, magnified and etched as in Fig. 18, the distinctive characteristics being the fine grain and absence of the long parallel needles always seen in ordinary aluminum-bronze castings.

Fig. 20 shows the structure of a good sand-cast sample of 10 per cent aluminum bronze etched as before but magnified 400 diameters. The dark constituent is here seen to be of duplex composition, containing light and dark particles. This in fact is a eutectoid similar to the one seen in the tin bronzes, but it etches dark instead of light.

Fig. 21. Aluminum bronze shares with steel the property of hardening in quenching, with the formation of a peculiar martensitic structure, as shown here. This structure was produced by heating a small piece of 10 per cent aluminum bronze to 900 deg. cent. and quenching it rapidly from this temperature in cold water. This is magnified 200 diameters. Such metal as this is strong, often taking over 100,000 lb. per sq. in. to break it, but has no ductility. It has a hardness of about 200 Brinell. As in the case of steel, a double heat-treatment consisting of quenching followed by tempering gives superior qualities.

Fig. 22 shows a structure obtained by reheating a quenched 10 per cent aluminum bronze to a dull red heat and cooling slowly. The structure is shown magnified 200 diameters and is much finer than is ever obtained in an untreated casting. This metal has a high yield point and a high ultimate strength, with over 10 per cent elongation and very great resistance to fatigue.

Fig. 23. The casting of aluminum bronze is especially difficult because of the easy formation of oxide of aluminum in the metal and the great difficulty of removing it afterward. This figure shows some inclusions of aluminum in aluminum bronze, magnified 200 diameters and not etched. It takes special care and the use of special fluxes to prevent the occurrence of such inclusions in all alloys containing notable quantities of aluminum.

Fig. 24 shows the typical structure of the light alloys, composed largely of aluminum, magnified 50 diameters. This particular alloy contained 8 per cent of copper, and its polished surface was etched to darken the copper-aluminum eutectic, leaving the nearly pure aluminum crystals bright. The eutectic is very brittle, but much harder than aluminum, so that although this alloy has hardly any ductility, it is harder and stiffer and a little stronger than the purer metal would be.

GRAPHICAL CONTROL ON THE EXCEPTION PRINCIPLE FOR EXECUTIVES

By FRANK B. GILBRETH, PROVIDENCE, R. I.

Member of the Society

We have stated many times that the greatest waste in the world today is from unnecessary, inefficient and ill-directed motions. Many people think that this statement refers only to such activities as those of the bricklayer, the shopworker and other kinds of mechanics and manual workers. It does refer to them, but by no means to them only. It refers to the activity of every one and, by no means least, to that of managers and all other executives.

To one trained in the sciences of management and motion study, nothing is more ridiculous and pitiful than the average executive when he tries to enforce new motion methods on those farthest below him in the industrial scale, while he at the same time commits nearly all the motion wastes in his own personal work. The personal work of the executive should consist as much as possible of making decisions and as little as possible of making motions. General recognition of this fact has resulted in the common practice of assigning to the executive one or more secretaries, or clerks, to relieve him of certain parts of his work which involve mere motions and less important decisions than that part of the work retained by the executive.

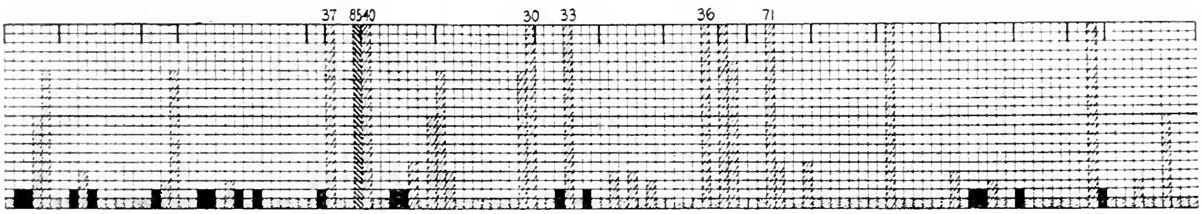

Fig. 1 Simple Illustration of a Chart Used on the Exception Principle

Such a chart may, for example, show the promptness of performance of an information bureau of a factory in charge, say, of trade publications, estimates of work under consideration, and records of design sketches. Each horizontal space may represent a specific request for information and each vertical space the time required to supply it. Colors may be used to indicate notable time differences. The point of the exception principle is that the chart shows at a glance when it took too long for a definite inquiry. Then it may be the duty of one individual to ascertain why, for instance, as long as 10 min. was necessary and another when the time is, say, over 20 min. In the so-called three-position plan of management (in which the occupant of any particular job gets supervision from the one promoted from it and serves as a tutor to one in line to fill it), the result is an effort to keep the time intervals within the safety zone, so to speak, so that No. 1 of the three-position plan is not likely to be demoted to improve the service.

INFORMATION A SATISFACTORY CHART SYSTEM SHOULD AFFORD

Some executives are furnished with charts which show by means of comparable curves the increase or diminution in outputs, costs, overhead expenses and, in comparatively rare instances, even in results as compared with budgets. As compared with an organization which has no cost system, such a recapitulation even in the form of an "expenditure system" and such cost statements and graphical charts are a great step forward. No cost system nor chart system, however, can be considered really satisfactory unless it fulfills the following requirements; i.e., it must determine and show —

1 What the quantities of individual outputs should be (prophecies of outputs)
2 Prompt records of individual outputs
3 What the costs should be (prophecies of costs)
4 Prompt records of costs
5 Causes of fluctuations and deviations of outputs and costs from prophesied outputs and costs.

The executive may have much to do with originally determining items 1 and 3; but after the computations of 1 and 3 have been completed, he can best attack the problem of enforcing items 2 and 4 and, also, of determining 5 by the use of graphical charts. He should be provided with charts which will tell him how promptly such records of output and cost have been made; or, in other words, how much time has elapsed between the completion of the output and the recording of it and its attending costs.

A long experience has shown us that the by-products of a properly operated chart system are even more valuable than its direct product. We find that the psychological effect of the variable "promptness" itself makes the curves representing outputs and costs fall more nearly in the proximity of the established norms and locations prophesied on the charts. Such charts give the executive and his colleagues accurate measured information of deviations from class in all departments. The motions that an executive would expend in getting information by such old methods as, for example, walking through the works to see with his unreliable eyes conditions which are not typical, partly owing to his presence, bring results of little value compared with the results that can be obtained by the same amount of time and motions concentrated on those facts and conditions which cause the great fluctuations from the desired output.

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It is obvious that the foreman, or other functionary, should see promptly all the records of output in his particular department after they are achieved. In most cases he will be able to handle his duties still more satisfactorily if he, also, sees the costs of the output of his department. The time of the over-foreman, however, who may have several foremen and departments under him, is too valuable to have him, also, examine with care all the records of all the men under him. Consequently, he should be furnished with information in concise form, in order that as little as possible of his time may be taken. This has often been furnished him in the form of "averages."

USE AND VALUE OF PROGRESSIVE AVERAGES

Ordinary averages have their use. Progressive averages are, however, more valuable, because they show the trend of progress and of efficiency. It sometimes pays to make ordinary averages, but the value of examining such ordinary averages is slight compared with the benefits which result from concentrating the same amount of motions and attention on those individual cases that brought the average away from the ideal. A case of "bad average" may be the excuse for "putting the foreman on the carpet," but the results of this do not compare with the good results that are derived from having the over-foreman investigate promptly the case or cases that spoiled the average.

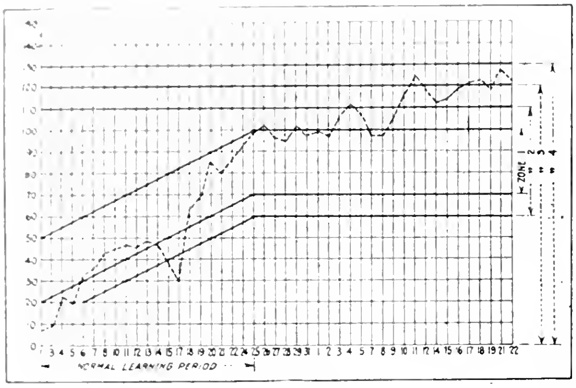


Fig. 2 Example of Exception Principle Chart Covering Output of an Individual, Including Learning Period

In this chart zones are established so that points of performance falling below or above certain limits come automatically by that fact to the attention of certain individuals. The lower the record or the higher the record the higher in the industrial-management scale will be the individual who must inquire into the conditions. The results may indicate poor instruction or incompetency in foremanship or they may bring the executive into personal contact with the worker in the matter of commendation for unusually high performance.

Moreover, the decisions of the over-foreman can be made more quickly, for he has the information which comes from locating the trouble accurately. Instead of "tearing out" the foreman or the workmen, he will find, from the causes marked on the chart, that the worker's low output is due to lack of the proper tools; to his not having been furnished with tools in standard conditions; to the routing system having failed to give him proper materials in the right quantities, in the right sequence, at the right time; to something which has gone wrong with the equipment or surrounding conditions; to the man's not having been properly instructed; to there having been an unwise selection of the man or the machine, or both, for the particular job.

The worker, also, is more careful not to do anything which is not expected of him, because he knows that the exception will surely be noticed by the executives higher up and will interfere with his chances for promotion or transfer to work of a more desirable kind. Knowing that they will be investigated properly will create a tendency on the part of the foreman and the workers to coöperate with others whose work affects theirs, or who in turn may be investigated. This coöperation becomes general, and sooner or later becomes a habit.

OPERATION OF THE EXCEPTION PRINCIPLE

Now the time of the executive next above the over-foreman is still more valuable than that of the over-foreman, and so on up to and including the managing director or president. No executive should make a routine motion of handling, turning over or examining charts containing data, either normal or with considerable deviation from class, where the causes of the deviation can be handled properly by those in lower executive positions. The exclusion of such cases can be obtained by having the executives determine *zones* on the charts, it being understood that as long as the points fall within the zone he is not to see the charts unless he specially requests to see them. He is, however, to have sent to him, for initialing, any chart having a point that falls outside his excluded zone.

An executive of any class will find it beneficial to see exceptionally large cases of deviation on the desired side of the line so that he can recognize and appreciate and take a personal interest in cases of unusual efficiency. It is through such cases that he gets in touch with unusually good methods. This is a check on the exception principle of the time-study-man's work. It also gives the executive valuable opportunities on the exception principle for proper managerial decisions in cases of the selection of candidates for promotion under the "three-position plan" of promotion and organization building. The curves showing progressive averages of departments may be examined at times farther and farther apart, these intervals to be determined in each particular case by the favorable or unfavorable comparison of records of such averages showing outputs and costs, with the prophesied outputs and costs. The executive is thus relieved later of work which is necessary at first, but which is not necessary when the particular case is running satisfactorily.

It is impossible to prophesy with accuracy what the amounts of outputs and costs should be without motion study and time study. But once these have been made and the actual outputs and actual costs approximate those prophesied, the high executives should devote very little time indeed to inspecting this class of charts. Instead, they should spend their time on other work, other departments, and more important things where their supervision will bring more valuable results.

It will be seen that these "Output, Cost and Causes Charts," with the "exclusion zones," enable the executive to eliminate the motions required for general oversight and inspection until a place on a chart is brought automatically to his attention where he can actually help those below him and furnish them with better instructions for handling their work more efficiently; or for making such changes as will naturally result in promotion, or the selection or shifting of individuals better fitted to do work elsewhere. The possibilities of relieving the executive of unnecessary motions and of enabling him to be more efficient in his own work are not exceeded in the case of any manual worker.

THE PENCIL ELECTRODE METHOD OF WELDING FOR BOILER JOINTS

By E. A. WILDT, SCRANTON, PA.[1]

THIS paper has special reference to the welding of joints of drums and to boiler shells as the latter term is commonly understood. The trend of the times is towards that type of boiler in which all the tubes are bent, particularly in the large units such as those at the Commonwealth Edison Station in Chicago, the Delray Station in Detroit, the Ford Automobile Factory and the Solvay Process Company. Since the dimensions of the boiler rooms are growing out of all proportion to the size of the engine rooms, and every item making for a decrease in the size of parts so as to reduce the room for the boilers is in demand, much higher pressures will be resorted to—an item for making the reductions required. Drums are to be used up to 60 in. in diameter, and in order to bear a pressure of 300 lb. or 500 lb. the thickness of the plate will be very close to $2\frac{1}{2}$ inches.

With regard to making the joints in such a drum, is it not more feasible to weld them instead of employing the usual butt strap? There are several methods of making this joint by spot welding, and that which seems to have forged its way to the front is the pencil form of electric welding, which is now fairly generally used in steam-boiler work, although as yet recognized only for low pressures. The weld made by this process is not so hard as others of the autogenous kind.

In a weld, two pieces of metal heated to the proper temperature are united into one solid piece. Success of the process depends on bringing the pieces of metal to the proper heat. For this purpose we have the oxy-acetylene torch, the thermit process and the electric arc, the last of which is the form of modern welding particularly referred to here.

Electricity is used only to supply the heat, and in the pencil method only just enough heat is obtained to accomplish the joining of the two metals. No reference is here made to any particular design or set of apparatus: some are built to use a uniform voltage, others to use uniform amperage or uniform wattage. All autogenous welding is accomplished by adding new metal to the joint to be made, and it is only in the pencil electric arc method that positive incorporation of the added metal with the metal to be joined is secured. The opposite was the case in some recent failures in other forms of electric and gaseous welding wherein fluidity of both the added metal and the pieces to be joined is a necessary condition. By the electric pencil method fluidity is avoided and only just enough heat is used to make the plate and the electrode plastic, and there appears also to be an action in it which in the direction of the current tends to pull the metal from the electrode to and into the plate when just at the proper heat. This is so much in evidence that welding can be carried on overhead without the metal dropping upon the operator.

The temperature in the added metal in the gaseous and electric carbon type wherein fluidity is a condition approaches 2800 to 3000 deg. fahr., while in the electric pencil method the temperature in the metal being added is not more than 1500 deg. fahr. As a result the added and the adjacent metal in the weld is not rendered so hard as would otherwise be the result. This is also proved by the fact that, while cutting can be done with other methods, no cutting can be done with the metal electrode.

This point that the temperature of the arc is so high, so hot, that there is danger of the metal becoming vaporized, is answered by the fact that the conditions surrounding this particular form of spot welding are analogous to and the same as for "forge welding" as carried on by the everyday blacksmith at his anvil: there he has a fire very much hotter than the pieces to be welded are required to be heated to; in fact, it must be so: there must be a considerable surplus of heat for quick action; the blacksmith watches and if through carelessness the pieces are overheated, he says they are burned and spoiled and has to begin over again.

No other form of welding has the characteristic this one has, wherein there is an automatic action which prevents overheating, actually showing that in this regard it is equal if not superior to "forge welding."

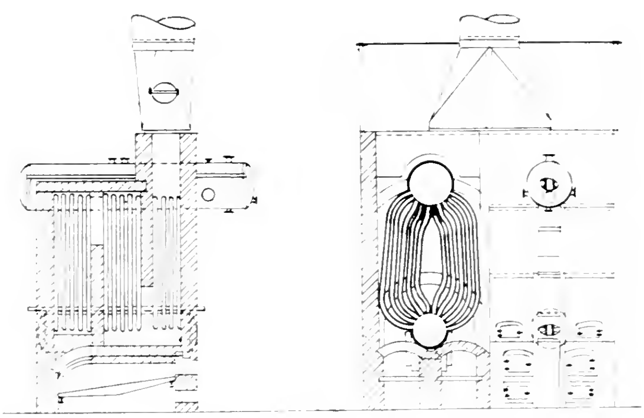


FIG. 1 BATTERY OF TWO 100-HP. WATER-TUBE STEAM BOILERS. THE WELDED HEAD JOINTS ARE VISIBLE OUTSIDE THE BRICK SETTING

The form of welding approved in the A.S.M.E. Boiler Code, known as Forge Welding, entails in its operation the production of big expansion strains, because the whole seam and the seam only is made at a welding temperature, producing an upsetting of the plastic metal by the unexpanded portion of the adjacent metal, so that when the forged welded seam has cooled off, the adjacent unexpanded metal produces tensile strains of very considerable strength, tending to pull the welded portions apart as it contracts, to the extent of close to $\frac{1}{8}$ in. per ft. of the seam. In comparison with this, the metal electrode pencil method is a great improvement, because due to the very small area of metal heated the expansion strains are but fractional and may be considered negligible. Both the approved forged welding and this method of welding which is hereby submitted to the Boiler Code Committee for approval are exactly alike in the particular that the metal is not heated in either beyond the point just necessary to produce welding: when it comes to expansion strains they are less in the latter, and in both methods the weld improves with age.

[1] Lackawanna Boiler and Grate Company.

Abstract of paper presented at the Steam Boiler Session of the Annual Meeting, December 1916, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Although the electric heat reaches an estimated temperature of 6500 to 7000 deg. fahr., in this process the metal wire does not have time to reach this temperature before it is added to the plate or in the usual groove which is to be filled with the welding metal. As fast as the metal wire becomes just plastic, the pencil must be advanced towards the work, or the arc gap will become too long for the electric arc to maintain its circuit. The distance needed for the arc does not amount to much more than 1/16 in., because the voltages used are low, rarely exceeding 60 or 70, and failure on the part of the attendant to maintain this distance by constantly advancing the pencil is met at once by the extinguishing of the arc, because the gap becomes too long for it to maintain itself.

Only in this process, carelessness is practically eliminated, both as to overheating and heating any considerable area, and the heated area is confined to the smallest dimensions

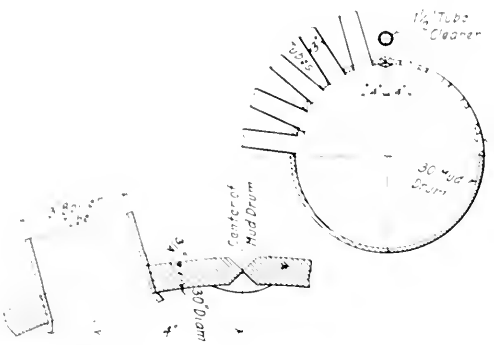


Fig. 2 Cross-Section of Mud Drum, Showing Electric Weld Which is Not in Contact With Fire

of any; therefore the expansion and contraction strains are smallest. The wire forming the electrode only gets red hot at the point, showing the very localized character of the heat, the balance of the wire remaining black; while in the carbon form of electric welding, the carbon gets very hot from the point up to the holder.

Tests have shown that for pressures of 500 lb. per sq. in., and with plates of 2½ in. or similar thicknesses, this method of welding makes a better joint than straps and rivets. The maker of such joints can always know by the hydraulic test whether his work is done perfectly or not. Test after test shows there are no leaks; all you have to do to insure a perfect job is to secure an operator willing to do a good job, pay him well, and it is fair to say that it is then practically impossible to do a defective weld by this method.

In electric carbon arc welding of rolled stock, the metal in the weld cannot have the same properties as that in the original piece; it may have the same tensile strength but it will not have the same elasticity. This is a limitation in *any* welding process, but in this particular process the metal in the weld is changed the least of any, and in fact shows a tendency towards a fibrous condition. The metal of the weld can be controlled by the kind of metal that is added; low carbon steel will make the weld more ductile, high carbon steel will make it higher in tensile strength. A test piece made up entirely of the welding wire showed an elongation of 16 per cent.

In order to be sure that a joint so made will be stronger than the plate, and last indefinitely, it is only necessary to keep on adding new metal until the cross-section on both sides amounts to more than the plate itself. This can be carried to extremes, and may as well be, just filling the groove, usually V-shaped, the extra metal to lap over on each side ⅜ or ½ in., and made in bulged form, both inside and outside of the drum, taking on the form somewhat of a butt strap joint.

There has just recently been put into service, with a view of trying it out in actual practice, a small water tube steam boiler (Figs. 1 and 2) of the vertical 2-drum type, with all the tubes bent tubes, the drums in which have not a rivet in them. Heavy tests have been applied, and there is not the slightest doubt that the men who have to do with the erection of this boiler do not anticipate any danger to anyone from it. Of course, it is realized that the construction has not been approved, but it is necessary for someone to take a stand and bring it to a head. Without something to show and to test, there will be no basis on which to ask for an approval. The situation is somewhat analogous to the man who wants to obtain a job as a stationary engineer,—not having a license he cannot obtain the job and not having the job he cannot obtain the license.

DISCUSSION

John C. McCabe. I would like to ask Mr. Wildt as to the temperature of 1500 deg. fahr., which seems to me rather low. I would like to ask also how he eliminates the possible stresses set up internally in the weld. As I understand the problem, if he has a differential for each degree difference in temperature between the different plates, there is an internal stress of about 195 lb. The other point is, you can determine the safety of a vessel by the electrostatic test. It is well known that electrostatic pressures are seldom allowed anywhere near the elastic limits of the metal, and in the tests and investigations of failures made, I have found the welding material varied, the per cent of elongation running from a fraction of one up to 11, and in view of the bendings or flexures that occurred in the best-formed cylinders, I fail to see how an autogenous vessel, as we understand the problem now, can be considered a safe one.

Christopher H. Bierbaum. Is not the great difficulty with all autogenous welding for boiler plates the fact that so much of the plate adjacent to the weld is heated, the elastic limit of the plate reduced, and its elongation increased? The test pieces which have been exhibited here show that very fact. There is no break in the weld. We know that autogenous welds can be made as strong and stronger than the original metal, and especially in the case where the weld is left a little thicker than the body of the metal itself. But do not the internal strains set up and the heating of the plate adjacent to the weld decrease the elastic limit of the metal in the neighborhood of the weld, and induce conditions which should be very carefully determined before any theoretical conclusion can be drawn?

P. A. E. Armstrong.[1] I do not think the forge process of welding is the only process valuable for boiler work; it is not as reliable as could be desired because of the difficulties of thermal disturbance in the metal in the vicinity of the weld. Thermal disturbance is brought about by two things, time and heat. In the vicinity of the weld the grain of the steel is enlarged and the tensile strength of the metal has fallen about one-third. I have conducted over a thousand tests on welds

[1] North American Company, 30 Broad St., New York.

in Sheffield, England, in working up a high-class steel suitable for welding, and found that with ordinary 0.30 to 0.40 carbon steel it was impossible to get more than about 60 per cent of the original strength, yet the breaks did not occur in the weld but some two or three inches away from the hammered area. In every instance the break occurred because of an enlarged grain.

The crystal grain of the metal, providing the thermal disturbance has not reached the point of incipient fusion, can be recovered by subsequent heat treatment, but this is hardly applicable for boiler work; I think it is absurd to talk of annealing the shell of a boiler 30 ft. in length. When annealed, this shell would expand and buckle in all directions. If this boiler had riveted joints, the expansion and contraction would be so great that a movement would be set up at the riveted joint, and no amount of calking would give a tight joint; in all probability it would augment the looseness of the rivets.

The oxy-acetylene or gas process generally is a very good one, but the thermal disturbance in the metal outside the weld is very similar to that present during forge welding. The electric carbon arc welding is worse. The electric bare wire welding, known as the metallic pencil welding, overcomes thermal disturbance to a greater degree, but the deposited metal in the weld is distinctly cold-short. This cold-shortness could be improved by annealing, but this is quite impossible under boiler conditions. By duplicating steel bath conditions, however, we obtain a fusion process, where the fused metal has a structure which is practically as good as the original steel.

If you take a bare wire electrode and coat it with a large quantity of slag, it is possible to melt this electrode so that the fusion takes place under the slag and the deposited metal would have all the characteristics of ingot steel of a given carbon content. Such an electrode has been developed and is extremely suitable for the welding of boilers and pressure tanks generally. The exterior slag coating of this electrode has the effect of localizing the heat. The metallic core is fused so rapidly that there is practically no thermal disturbance in the vicinity of the weld and complete fusion takes place.

Fig. 3 shows a bare wire electrode. A globule of metal is just leaving the end of the electrode, to be passed across the arc and deposited upon the metal to be welded. The flame or highly incandescent gases immediately underneath the electrode are very nearly neutral; at the outside of the arc flame the burning gases are extremely oxidizing. It is here that the damage takes place. A very interesting experiment can be conducted to prove it. If a bare wire electrode is fused, a crater is formed immediately beneath the fusing end of the electrode. If the circuit is broken and the arc extinguished, then at the bottom of the crater there is a complete absence of oxide of iron, whereas on the top edge of the crater and right over the deposit a layer of about 0.01 in. of oxide of iron is present, which proves that in the center of the metallic arc there is a neutral place. If the flame is examined spectroscopically, its oxidizing nature can be very quickly traced, and the neutral zone can be discerned in the center of the flame when the outside of the arc flame is slightly disturbed.

The slag electrode in operation is shown in Fig. 4. The end of the electrode is in actual contact; in the bare wire case there is a space of about 1/8 in. between the fusing end of the electrode and the work. There is a complete absence of the arc flame effect, and the incandescent slag is passing off from the end of the electrode on to the work. The atmosphere of the slag electrode is practically neutral as the vapor is composed of vaporized slag and not of highly incandescent gases. The voltage across the arc is higher than that of the bare wire system, because the vapor offers a greater resistance to the path of the current, although the arc is shorter and should take only about half the volts to get across, if both arcs were atmospheric.

Fig. 5, 90 magnifications, shows manganese steel of 12 per cent deposited upon manganese steel of a like content. There is no thermal disturbance. The diffusion between the original and the added metal is very complete, showing an entire absence of oxide. The cementite occurring in the globule formation and very evenly distributed over the mass shows absence in the deposited metal of austenic needles.

Fig. 3 Bare Wire Electrode

Fig. 4 Slag Electrode

Fig. 6, 90 magnifications, shows 0.125 carbon deposited upon 0.65 carbon. There is complete diffusion, and the carbon of the original steel is saturating into the lower carbon of the added metal. There is a complete absence of thermal disturbance immediately adjacent to the weld; the grains of pearlite and ferrite are the same size at the area of diffusion as they are half an inch under the weld, the time factor playing a very important part. I have seen a piece of low-carbon steel which has been for about six months at 600 deg. cent., the ferrite grain of which when etched was 1/2 in. across. This metal was absolutely cold-short, had practically no ductility and was extremely low in tensile strength. After submitting to two heat treatments the grain of the metal was practically normalized.

As it is impossible, in a general way, to anneal welds in boiler construction and so normalize the grain, it is essential that the time factor be reduced as much as possible. This illustration proves it. The heat was at least 6000 degrees, the time something less than a second; hence the grains did not have the time to change and assume the size and formation of the superheated temperature. The metal in the vicinity of the weld is quite as strong as it was before welding, and the added metal will have all the characteristics of ingot steel, in this instance 0.125 carbon. The structure of the added metal is given in Fig. 7, 250 magnifications. It is taken about half an inch above the line of diffusion. The grain is of small size and excellent structure, the pearlite and ferrite grains being very consistently arranged, and there is a complete absence of enlarged grains due to subsequent thermal disturbance.

Table 1 is taken from a Report of the Department of Commerce and Labor, Steamboat Inspection Service, dated January 27, 1916, on the tensile strength of four samples of slag welding for marine boilers submitted.

TABLE 1 TENSILE TESTS ON SLAG WELDED PLATES

Numbers on plates	1	2	3	4
Thickness of samples, decimals in.	0.491	0.494	0.743	0.521
Widths of samples, decimals in.	1.00	0.991	1.00	1.023
Strain at which each sample parted	28000	27500	42120	31890
Strain per sq. in. of section, lb.	56689	56530	56680	59840
Reduced thickness of sample	0.685	0.660	0.948	0.852
Reduced width of sample	0.282	0.300	0.725	0.419
Reduction of area, per cent	60%	59%	7%	23%
Length of straight part in center of test piece, in.	8	8	8	8
Elongation, percentage of	29%	25%	7%	14%

Sample No. 1 is the original steel of about 56,000 lb.; it broke at 56,680 lb. Sample No. 2 is a plate cut in half, welded and machine flush; this broke at 56,530 lb., $2\frac{1}{2}$ in. outside the weld, proving that the weld was stronger than the original metal and that there was no thermal disturbance in the vicinity of the weld. The elongation is 25 per cent, but this shows absolutely nothing, because the sample started to neck $2\frac{1}{2}$ in. away from the weld, and the reduced area resulting from this necking caused the fracture. Sample No. 3 is a plate cut in two, welded and reinforced $\frac{1}{4}$ in. down the entire length of one side. This sample broke in the weld and the tensile strength was 56,680 lb., identical with sample No. 1, which proves that the weld was of about 56,680 lb. tensile strength. The elongation was 7 per cent, and as the sample broke in the weld the necking occurred there, and it is quite reasonable to suppose that the elongation in the weld was somewhere near 7 per cent. Sample No. 4 was a plate reinforced on one side and then the welded metal entirely machined off, leaving the original plate at its original thickness. This plate was prepared so as to find out what effect the thermal disturbance had upon the metal adjacent to the weld.

As will be seen, the tensile strength of the metal has been increased and the ductility reduced. This is to be expected from the slight thermal disturbance taking place, as the added metal was as thick as the original steel. The results according to the test sheet show at least the great tensile strength of the welds made by this slag electrode.

Corrosion and welding are closely associated. It has been proved that corrosion is electrolytic in character, the positive pole of the small galvanic couples being highly corroded and the negative pole being practically free. When testing a piece of boiler steel for polarity, it is shown that there are numerous places where corrosion can be set up, due to electrolysis; all mechanical work on iron and steel will immediately start corrosion due to electrolysis, the electrolyte being supplied by the atmospheric moisture. A simple experiment will prove this. If a small portion of a piece of steel, neutral

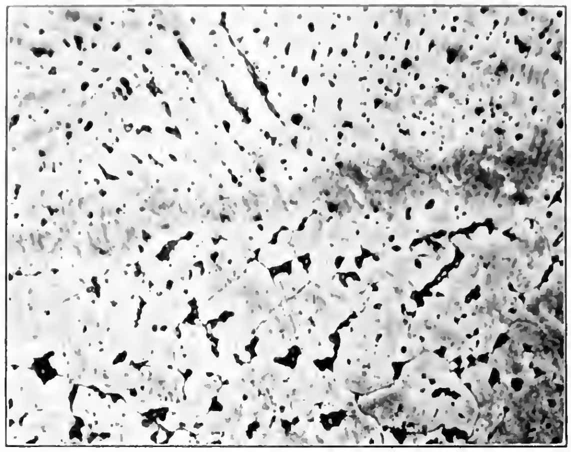


FIG. 5 12 PER CENT MANGANESE STEEL ON 12 PER CENT MANGANESE STEEL, MAGNIFICATION 90

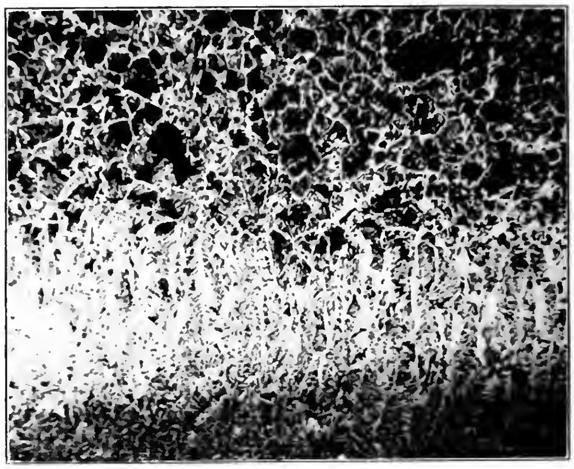


FIG. 6 0.125 CARBON STEEL ON 0.65 CARBON STEEL, MAGNIFICATION 90

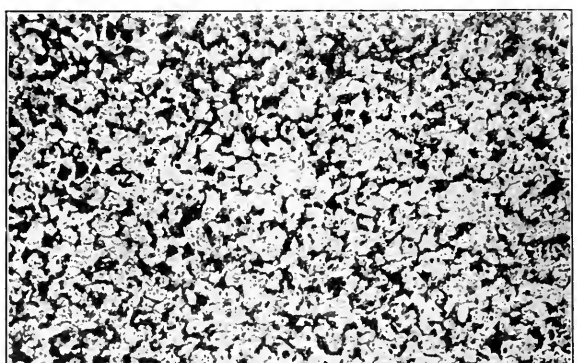


FIG. 7 STRUCTURE OF ADDED METAL, MAGNIFICATION 250

across its entire area, is hammered and tested for polarity, a voltaic circuit is present, the stress from the hammered portion being electro-positive and the original steel being

electro-negative; therefore it follows that every rivet head, calked edge or hammered portion of the boiler is electro-positive to its shell generally. Thermal disturbance and small mechanical work will set up polarity, and such a weld will be distinctly electro-positive to the surrounding metal. This is particularly noticeable in machine welded flue tubes in locomotives; 90 per cent of the corrosion taking place will always be present when the added length of tube has been made to recover short tubes. Autogenous welding is distinctly electro-positive to the surrounding metal, because the added metal is less pure, containing magnetic oxide of iron and other impurities. An oxy-acetylene or gas weld made on a pressure tank or boiler may be badly pitted by corrosion. A weld by carbon arc corrodes to a greater extent, and welds by the bare wire pencil method are certainly no better. Tests can be easily made by means of a millivoltmeter.

The deposit by the slag electrode is so pure that the added metal by this process is quite electro-negative to the surrounding metal and to a very large degree obviates corrosion at the weld. If the subject of corrosion is borne in mind, I am tempted to say that forged welding will not be permitted; some fusion process will be adopted wherein the corrosive influence of an electrolytic circuit is to a very large degree restricted.

Victor Mauck. In all processes of welding it is necessary to raise the temperature of the metal to be welded to the point of fusion. Given a neutral flame free from non-combustible impurities, such as sulphur, nitrogen, etc., the arrest of the heating process at the exact point of fusion, and a uniform contact of the parts, a perfect weld of practically equivalent strength, section for section, to the adjacent metal would result. However, there are so many factors involved over which we have but indifferent control that this result is rarely attained. It is therefore necessary first, to rate the efficiency of the weld based on average manufacturing practice; second, to provide an ample factor of safety. A sufficiently high hydrostatic test pressure should be specified to insure ample minimum strength; and I lay particular stress on high test pressure.

In a riveted joint the fundamental operations are uniform and of a mechanical nature, affected but slightly by the human equation. The weld on the other hand has a much higher theoretical strength, but is *all* human equation, hence the importance of the high test pressure. A weld will vary widely in strength throughout its length, but this variation is less than in a riveted seam. Welds cannot be made commercially (except one form of electric weld) without more crystallization of the metal, and will lead to eventual failure under vibratory action if provision is not made for a sufficient factor of safety. It is possible to surround the processes with all reasonable precautions, in the public interest, and at the same time allow them that latitude for development they deserve, and which is conceded them abroad.

The process of electric welding by induction probably attains the nearest to the theoretical possibilities of any weld we have. The operation, being entirely mechanical, is uniform and under perfect control. There is no crystallization of the metals and the human equation is practically eliminated. The heat in this process is generated within the stock itself, radiating from the surface as opposed to the application of a very intense external heat, as in the oxy-acetylene flame or electric arc. In the latter case the surface is overheated before the body of the metal reaches welding temperature, with resultant burning and crystallization. In this process 100 per cent welds are the rule rather than the exception.

The production of pig iron in the United States last year amounted to 39,150,000 tons, according to *The Iron Age*, which is about 30 per cent in excess of the output for 1915. The production of steel in 1916 was probably in excess of 42,000,000 tons.

The Council of The Institution of Civil Engineers of Great Britain have extended an invitation to any members of The American Society of Mechanical Engineers who may be visitors in London to use The Institution Library and Reading Rooms, as well as to attend the meetings of The Institution, and have authorized the necessary steps to give effect to this on the presentation of an introduction from our Society. The Council trust that their American professional colleagues may often visit and make use of the new home of the Institution.

In the cooling of electrical machinery, with the high-speed units of large output, the designer is seriously handicapped. In a 15,000 kva. turbo-alternator, say, which is a medium size nowadays, the total loss is about 545 kw., and an enormous volume of cooling air is required for carrying away the heat due to this loss. According to Mr. B. G. Lamme, an expenditure of 1 kw. in 1 min. will raise the temperature of 100 cu. ft. of air 18 deg. cent. Therefore, for a temperature rise of the outgoing air of 20 deg. cent. above that of the incoming air a loss of 545 kw. will necessitate a supply of ventilating air of approximately 50,000 cu. ft. per min.—*The Electrician* (London), Feb. 2, 1917.

The endothermic energy of acetylene makes its ignition temperature low, thus preventing high compression in an engine cylinder. This in turn detracts from the efficiency of the engine and bars the economical use of this gas for power purposes. As compared with all other industrial substances acetylene occupies a position at the top of the list for light and heat. To get a substance which would compete with acetylene in its present field it would be necessary to get one with a higher endothermic energy content. Through well-known laws of chemistry it is recognized as impossible to obtain such a substance by any combination of carbon and hydrogen.—*The Engineer* (London), Feb. 23, 1917.

Mr. Max Toltz, member of the Council of the Am.Soc.M.E., recently introduced into the House of Representatives of the State of Minnesota a "bill for an act to provide for the safety of life and property in this state in the construction and use of steam boilers; creating a board of boiler rules to prescribe regulations for boilers used in this state, which will be uniform with other state rules now in existence, in order to provide for the free interchange of boilers between states; to define the power of the board of boiler rules; to provide penalties for the violation of this act and rules and regulations of the boiler rules."

The bill provides for the appointment of a board consisting of preferably a professor of mechanical engineering of the University of Minnesota, a manufacturer of boilers, a user of boilers, and a consulting engineer. The board is to formulate rules for the construction of steam boilers, as nearly as practicable in conformity with the A.S.M.E. Boiler Code.

JUNIOR AND STUDENT PRIZE PAPERS

ON the recommendation of the Am.Soc.M.E. Prize Committees, the Junior Prize for 1916 was awarded to L. B. McMillan for his paper entitled the Heat Insulating Properties of Commercial Steam Pipe Coverings. Honorable mention was awarded to Victor J. Azbe for his paper on Power Plant Efficiency, and Herbert B. Reynolds for his paper on the Flow of Air and Steam through Orifices.

Student Prizes for 1916 were awarded to: Boynton M. Green, Leland Stanford University, for his paper on Bearing Lubrication; Howard E. Stevens, Rensselaer Polytechnic Institute, for his paper on An Investigation of the Dynamic Pressure on Submerged Flat Plates, and M. Adam, Louisiana State University, for his paper on The Adaptability of the Internal-Combustion Engine to Sugar Factories and Estates.

Honorable Mention in the Student Prize Competition was awarded to: M. Boyd Gordon, University of Cincinnati, for his paper on A New Type of Uniflow Engine; S. C. Williams, Stevens Institute of Technology, for his paper on Photostatic Reproduction, and Charles P. Miller, Pennsylvania State College, for his paper on Investigation of Properties of Low- and Medium-Carbon Steels.

Abstracts of the papers awarded Junior Prizes have already appeared in The Journal and abstracts of the papers awarded Student Prizes are published below.

DYNAMIC PRESSURE OF SUBMERGED FLAT PLATES

By HOWARD E. STEVENS,[1] AUBURN, N. Y.

THE object of this investigation was to find an equation expressing the relation between the velocity of a stream and the resulting pressure on a submerged flat plate held perpendicular and at right angles to the direction of flow. Experiments were conducted with the plate at different depths below the surface in order to establish whether this affects the equation. The effect of varying the area and shape of the plate was determined, and one plate was used only partially submerged to ascertain whether the same equation would hold.

In all these experiments the plate was moved through still water. Now, there might be some question as to whether such results would apply to moving water impinging on a stationary plate. In the early part of the nineteenth century Duchemin found that results obtained by one method apply to the other. Such authorities as Lanchester, Zahm and See all agree that the cases are identical. However, De Villamil says they would be the same only when surrounding conditions are identical. Thus, results obtained by moving a body in still water would only apply to a stationary plate if the moving water were in a static condition; that is, if tank and water were moved as a whole. In refutation of this statement, it is very evident that the water impinges on the plate just the same whether the tank moves or not, and is in no more static condition with reference to the plate than if it were an open stream.

The plate was fastened to a vertical piece of sheet steel, *F*, Fig. 1, which was bolted to a wooden block *A*. *F* was placed in such a position that, as the apparatus was moved, the thin edge cut the water. The upper end of *A* was forked, one arm going on either side of a framework *G*. At point *H* in each arm was a horizontal pivot, thus allowing *A* to swing to a vertical plane. Fastened to *A* was a horizontal arm of steel *J*. A link *K* with a horizontal knife edge across the bottom moved along *J*, and the knife edge rested in *V*-shaped grooves cut in the under side of *J*. To *K* was fastened a vertical wire *C*, the upper end of which was attached to the platform of a pair of scales. A small wire *D* fastened to the arm of the scales moved over a scale *E* as the arm moved up and down. This was to determine when the scales were balanced, as it was so arranged that then *D* was opposite the middle line of *E*. The frame *G* was clamped on a four-wheeled car which could be pushed along a track over a flume about 100 ft. long and 5 ft. wide. The axis of the frame was made parallel to the track, and the plate was made vertical with a spirit level (when the scales were in the balanced position), so that the plate was perpendicular to the direction of motion.

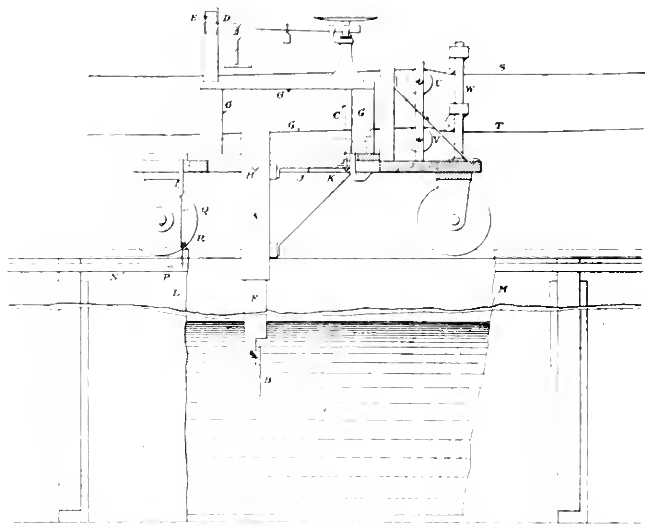


Fig. 1 Apparatus for Determination of Dynamic Pressure on Submerged Flat Plates

Fig. 1 shows a cross-section through the car and flume between points *L* and *M*, and an outside view to the left of *L* and to the right of *M*.

To determine the velocity a chronograph made by Wm. Gaertner and Co., of Chicago, was used. This had a revolving drum driven by clockwork to which a sheet of paper could be attached. Three pens which had a small lateral motion controlled by electromagnets made records on the paper as it moved. One pen recorded seconds. The electromagnet for this pen was connected in the circuit with a seconds pendulum on a clock. Every time the pendulum swung through its lowest point (once a second) a small needle on it passed through a bubble of mercury, closing the circuit. This excitation of the magnet pulled the pen sideways, giving little spines on the curve. A thin iron strip which ran along the side of the tank had little metal pins *P* every 8 ft., called "stations" in the following discussion. Attached to the car was an iron support *Q*, to which was fastened a flexible contact brush, *R*, which would rub on these pins. This would close the circuit through a second magnet and cause its pen to jump laterally. The third magnet was controlled by the experimenter, who

[1] Rensselaer Polytechnic Institute.

pushed the car. A horizontal handle was attached to the car with which to push it and on this handle was a push button. When the scales were balanced the experimenter closed the circuit through the third magnet by means of this push button, thus drawing the third pen sideways. In order to get a circuit while the car was moving, two trolley wires were used, S and T. Over these ran trolley wheels U and V, and other wheels on the standard W kept the wires pressed tightly against U and V, insuring a good contact. A wire connected U and V, and thus one circuit was made through W, P, R, Q, V, and T for the second magnet. The push button was connected by two wires to U and V, which thus gave a circuit for the third magnet.

Before making runs a plate was attached to F and the scales balanced to give the dead weight of the apparatus. Then weights were placed on the scales, the chronograph was started, and the car was pushed along at such a speed as to keep the scales balanced. Two runs were made with each weight. The weights used varied from 1 lb. to 40 lb., a sufficient range to give a good curve. One set of runs with various scale loads comprised a test. At the end of each test the plate was removed, a new dead weight found, and a series of runs made

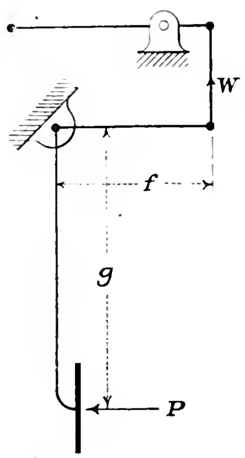


Fig. 2 Frame Diagram of Apparatus

in the same way with just the support of F to take the resistance of the water. These tests were called zero tests and gave the amount of pressure on the support. From these were plotted curves, scale readings vs. velocity. Log paper was used so that the curves would be straight lines and thus give a check.

First a 7-in. plate was used. The depth was varied by raising or lowering the level of the water in the flume. Then a round plate of one-half the area was used at three different depths. A rectangular plate 8 in. by 4 in. was tried with the long axis horizontal and then with it vertical, one test each way at a constant depth. A square plate 6 in. by 6 in. was next used at one depth only, and lastly the rectangular plate was used with the long axis vertical but only half submerged, giving virtually a square 4 in. by 4 in. below the surface. All the plates were painted. They were ⅛ in. thick.

Following is the method of computations. Three curves were obtained from the chronograph records: a, the seconds curve, the distance between two spines representing one second; b, the stations curve, each space between spines representing 8 ft. moved over by the car; c, the curve made by the pen controlled by the push button on the car. Where this is to the left, the scales were balanced, and only that part of the run (d to e) is of value for computations. The number of spaces on a between the spines nearest d and e was counted and the distance in inches measured. Dividing one by the other gave the seconds per inch of the curve. This was repeated with b, giving the stations per inch of the curve. Since each station represents 8 ft., multiplying the last result by 8 gave the feet per inch of curve b. Dividing this by the seconds per inch gave feet per second, or velocity. The weight on the scales was of course known and the dead weight was subtracted from it. Then the amount of pressure on the support at the known velocity was found. The difference between them gave the net weight on the scales corresponding to the pressure on the plate only. By knowing the lever arms f and g, P, Fig. 2, was computed; $Pg=fW$.

De Villamil says the desired equation is parabolic in form, therefore one was assumed:

$$P = KAV^n \dots\dots\dots\dots\dots\dots [1]$$

where P=total pressure on the plate in lb.
K=a coefficient
A=the area of the plate in square feet
V=the velocity in feet per second
n=a constant.

Dividing [1] by A, $P/A=KV^n$; passing to logs, $\log P/A = \log K + n \log V$, which is a straight-line formula.

P/A was computed for each run and $\log P/A$ was plotted as a function of $\log V$. Naturally these are straight lines; n is the tangent of the angle between a curve and the horizontal axis, while $\log K$ is the intercept on the vertical axis; n was found to be 2, while K had various values.

Then K was assumed to depend on the depth and the relation was taken as

$$K=b\,D^m \dots\dots\dots\dots\dots\dots [2]$$

where b = a coefficient
D = depth of center of plate below surface in feet
m = a constant.

Then $\log K = \log b + m \log D$, which is a straight line.

Log K was plotted vs. log D for each series (a series was composed of all the tests on one plate); m is the tangent of the angle between a curve and the horizontal axis and log b is the intercept on the vertical axis; m was found = —0.1, while b had various values. This in [2] gave $K = b/D^{0.1}$.

Then b was assumed to vary with the area. Two equations were assumed, $b = cA + g$, and $b = dA^f$. Several runs throughout the experiments were computed each way and the majority lay nearer the former curve than the latter, hence this was chosen: c was found to be 0.6, while g varied from 1.20 to 1.29, according to the shape of the piece. Since these are so nearly alike, it may be said that the shape of the plate is immaterial, and the average value of g = 1.25 will be taken.

$$\text{Now [1] is } P = KAV^2 \dots\dots\dots\dots [3]$$

Substituting for K its value,

$$P = AV^2 b\, D^{-0.1} \dots\dots\dots\dots [4]$$

Substituting for b its value,

$$P = AV^2/D^{0.1}(0.6A + 1.25) \dots\dots\dots [5]$$

which is the desired equation between the pressure and the velocity.

The investigation was carried a little further. Since P/A is the pressure in lb. per sq. ft., $1/W \times P/A$ (where W = weight of 1 cu. ft. of water) will be the pressure head h_p.

Since V is the velocity, $V^2/2g$ = the velocity head h_v. Now, from [1]

$$\frac{P}{A} = k_1$$

$$\text{then}\quad \frac{P}{A}\cdot\frac{1}{W} = \frac{k_1}{w}\cdot\frac{2g}{2g} = \frac{k_1 2g}{w}\times\frac{1}{2g}$$

$$h = \frac{k_1 2g}{w} = k_1 \frac{64.3}{62.4} = h_v\,.$$

$$\frac{h}{h_v} = 1.03\,k_1\,.$$

Substituting the values of k_1 found, this ratio varies from 1.31 to 1.67, with the average value of 1.47. Merriman says in his "Hydraulics" that it varies from 1.25 to 1.75, with best values from 1.4 to 1.5.

BEARING LUBRICATION

INFLUENCE OF SURFACE VELOCITY ON MEAN FILM THICKNESS

By BOYNTON M. GREEN, PITTSBURGH, PA.

Assuming that a machine will do the work for which it is designed, its economic value depends on the degree of efficiency with which it will do that work. The energy supplied to it is consumed in three ways: in overcoming the external load, or in doing the actual work required of the machine; in deforming the various parts of the machine, and in overcoming friction. The energy consumed in doing the actual work required is a legitimate expenditure for which there is value received. If the machine is properly designed, the energy lost in deforming its parts is returned somewhere during the work cycle, because the parts will never have been stressed beyond their elastic limit and hence, on returning to their original shape, will liberate the energy spent in deforming them, while that spent in accelerating masses will be given back upon their return to their original velocities. This leaves the energy lost in friction, which is a direct waste. Some friction is inevitable, so the question is: how may this loss be reduced to a minimum?

HISTORICAL DEVELOPMENT

It is interesting to note that this important problem of design was the last one to be attacked from a scientific standpoint. For years after the designer was able to calculate with a fair degree of accuracy the stresses in frames, shafts, levers and gears, he was content to design his bearings by guess and precedent. This tendency to slight bearing design was fostered by low machine speeds and lack of efficiency data. But with the introduction of electricity as a motive power and the resulting higher speeds and ever-increasing demand for greater efficiency, the necessity for better bearing design became urgent.

The first important attempt to investigate the conditions obtaining in a bearing was made in 1883 by Beauchamp Tower, an Englishman, at the request of the Institution of Mechanical Engineers. He used a journal 4 in. in diameter by 6 in. long, the bearing only covering the upper half of the journal. He was able first to explain the difference between partial or greasy lubrication and complete or flooded lubrication. Tower's results were qualitative rather than quantitative, but they brought out the facts that there was probably a complete film of oil separating journal and bearing in the case of flooded lubrication, and that the conditions of bearing friction in the case of flooded lubrication approximate fluid friction more nearly than solid friction.

The next step was made in 1885 by Prof. Osborne Reynolds, who used Tower's numerical data as the basis of a mathematical discussion of the subject. Reynolds applied a hydrodynamic theory to Tower's data and obtained an equation between the variation of pressure over the surface and journal velocity, which explained the existence of the oil film at a high pressure. He showed the presence of a wedging action of the lubricant, and this in turn brought out the importance of the bearing allowance, or difference in diameters of journal and bearing. From this followed the discovery of the general law for pressure distribution throughout the oil film, and the fact that the point of nearest approach of journal and bearing changes position with change of load. Reynolds realized that viscosity changes with temperature, so he made a determination of the relation between viscosity and temperature for olive oil, and deduced an empirical formula from which he obtained expressions for the approximate variation of viscosity with speed and load, since both these affect the bearing temperature. These expressions brought Tower's results into very close agreement with Reynolds' hydrodynamic theory. The hydrodynamic theory of fluid friction was also developed independently in 1884 by Petroff, a Russian, (data published in German in 1887).

This theory is undoubtedly the correct one to apply to the case of flooded lubrication. However, it cannot be applied directly, as the equations contain several constants which can only be determined by experiment, and it is to this work that later investigators have turned their attention rather than to the development of new theories. In 1903 some important investigations were carried on by O. Lasche for the Allgemeine Electricitäts-Gesellschaft of Berlin. Up to that time investigations had only been made with loads under 500 lb. per sq. in. and velocities under 500 r.p.m. (among the most important were those by Stribeck, Z.d.V.d.I. 1902), and the A.E.G. found it necessary to obtain data for velocities up to 3000 r.p.m. and correspondingly high loads. Lasche's work was quite exhaustive and incidentally threw considerable light on the transmission of heat away from the oil film.

FLUID FRICTION

The general equation for fluid friction is

$$\mu = \eta\, V/py$$

where μ = coefficient of friction
η = coefficient of viscosity
V = journal surface speed
p = pressure per unit of projected area of bearing
y = mean film thickness.

Usually p and V can be determined from the conditions of the problem and values of η can be taken from known data on oils. Concerning values of y, nothing definite is known, but some general deductions can be made. According to Smith and Marx's Machine Design, 1915, it is a function of the running-fit allowance, of p, of V, and of the temperature t of the bearing, which may be summed up in the following expression

$$y = \frac{k_a V^x}{p^w t^z}$$

From a consideration of this expression and its application in the general equation for friction it would seem that the

[1] Leland Stanford University.

next step would be an investigation of the mean thickness of oil film. Some work was done on this subject in 1897 by Professor Kingsbury (Jour. Am. Soc. Nav. Eng.), but as he used air as a lubricant, his results can only be taken as an indication of what to expect when using oil. As the mean film thickness y is influenced by four variables, it would be necessary to make the investigation in four steps. In Kingsbury's experiment the velocity only was changed. The pressure and allowance were kept constant while the apparatus was allowed to run until the temperature became constant before any test readings were taken.

EXPERIMENTAL PART

In the present experiment it was thought best to follow Kingsbury's lead and investigate the influence of velocity on mean film thickness, and the apparatus was designed with this point in view. The bearing is shown in section in Fig. 1; it is non-adjustable and consists of a plain phosphor-bronze sleeve about 3¼ in. in diameter by 7 in. long, pressed into a cast-iron housing which was bolted to a lathe bed. Lubrication was effected by two steel oil rings of rectangular section. Two sets of oil grooves were cut in the upper half of the bronze as shown in the figure. On assembling the bronze sleeve and housing, it was found that the bronze was elliptical in section, with the major axis vertical, the average difference in diameters being 0.001 in. To obtain the best results from the apparatus, the sleeve should have been reamed after pressing it into the housing. Although this was not done, the inaccuracy did not seem to affect the results appreciably.

The journal was a piece of mild steel, ground carefully to a diameter of 3.244 in., giving a running-fit allowance of 0.0035 in., or about 0.001 in. per inch of diameter. On each end of the journal was fitted a cast-iron flywheel weighing about 67 lb., secured by a nut. The total weight of the assembled journal, flywheels and nuts was 165.5 lb., making a nominal load on the bearing of 7.275 lb. per sq. in. of projected area. The whole apparatus was mounted on two parallel lathe beds, and three lathe heads with four-step pulleys were utilized for the drive. The usual overhead countershaft drove the first lathe head, which drove the second head by a short piece of shaft and dogs. The second head drove the third by a short belt and tightener pulley. It was found necessary after several preliminary trials to introduce the tightener, so that the second belt could be used for gradual acceleration of the heavy rotating mass. The third head drove the test journal by a piece of ¼-in. steel shaft about 2 ft. long. As this flexible drive rod was loosely connected by a dog to the lathe head and by a cotter pin to the journal, it is fairly certain that no external deflecting load was applied to the latter. With the drive arranged in this way, sixteen speeds were possible, but as all the cone pulleys were of the same design, some of the speeds were duplicated, so that only six speeds could be used.

With this apparatus it would be possible to vary the bore allowance by starting with a very small allowance and then grinding down the journal to give larger allowances. This procedure was contemplated when the apparatus was designed, but lack of time prevented tests with more than one allowance. To locate the position of the journal with relation to the bearing, three micrometers of a design similar to Kingsbury's were used. The micrometers and journal were placed in the primary circuit of an induction coil with a battery, and a telephone receiver was connected to the secondary of the coil. With Kingsbury's apparatus it was only necessary to mount one micrometer in the bearing, because his bearing was a simple cast iron cylinder, so supported that it could be rotated about its own axis, thus bringing the micrometer into any position desired. His method was to locate the point of nearest approach and read the micrometer, calling this the zero reading. Then the bearing was rotated 180 deg. and another reading was taken. Half the difference between the zero reading and the second reading gave the radial distance between the axis of the bearing and the axis of the journal, and the angular displacement was read from graduations on the end of the bearing cylinder.

In the present experiment the bearing could not be rotated, so it was necessary to use three micrometers spaced 120 deg.

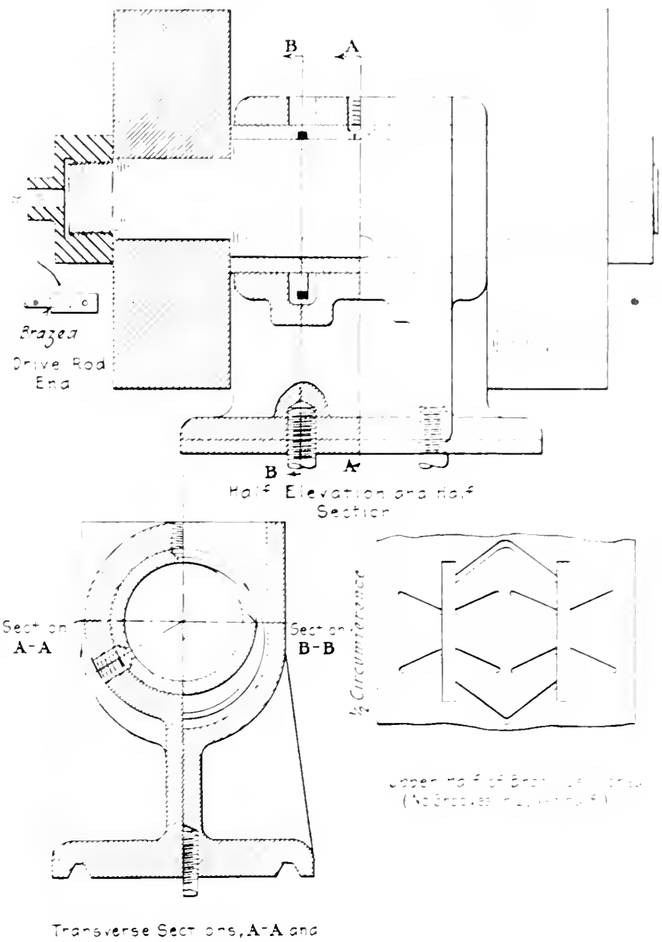


Fig. 1 Test Bearing

apart around the bearing in a plane through its center and perpendicular to its axis. The moving part of the micrometer consisted of a ¼-in. steel rod hardened at the contact end and threaded 40 threads per in. at the other end. To the threaded end was clamped a pointer 3¼ in. long which served both to turn the rod and to indicate the reading. The rod was carried in a brass sleeve threaded to receive it and electrically insulated from the bearing by a fiber bushing pressed on to the sleeve. The graduated scale was carried on an arm clamped to the top of the brass sleeve. This arm also carried a binding post for the electrical connection. The whole micrometer was held in place in the bearing by means of a brass collar which screwed down over the tapered fiber bushing.

[illegible] meters were calibrated by screwing them into [illegible] then screwing down the micrometer point to touch [illegible] inside micrometer. The experimental micrometers [illegible] graduated in this way to thousandths and the ten-thousandth divisions were laid off from these major divisions. Micrometers 1 and 3 were graduated for a total of [illegible] thousandths, and micrometer 2 was graduated over a range of six thousandths. Before any test readings could be taken, it was necessary to set the micrometers to zero, i. e., bring the micrometer points flush with the inside surface of the bearing brass by placing inside the bearing a sector cut from a polished iron ring which had been ground to the exact diameter of the bearing. The zero readings of all the micrometers were checked after every three or four test readings.

The runs were made short purposely, usually under two minutes, to eliminate the temperature factor as far as possible. A long run was made at a constant speed to obtain some information concerning the influence of temperature on the position of the journal relative to the bearing, but the micrometer readings showed that the bearing itself was expanding very rapidly due to its thin section, so this investigation had to be abandoned. From ten to fifteen readings of each of the micrometers were taken at each speed and the most consistent of the readings at each speed were averaged to obtain the final experimental data which are given in Table 1.

In determining the mean thickness of oil film from the results the following approximations were made: (*a*) that the loaded portion of the film was that below a horizontal plane through the center of the bearing, (*b*) that the thickness of the film at this plane and on each side of the journal was equal to the radial bearing allowance, (*c*) that the mean thickness of film was the average of the thickness at this plane and the minimum thickness of the film. The minimum thickness of film is the radial allowance minus the distance between the axes of the journal and bearing. Making use of these approximations the resulting values of mean thickness of film are given in Table 2.

The general equation of the curve plotted is

$$y = b + c^a \sqrt{V} \ldots\ldots\ldots\ldots\ldots\ldots [1]$$

where y = mean thickness of film in in.

b = one half the radial allowance

c = constant dependent on allowance and possibly on viscosity

a = constant dependent on viscosity and possibly on allowance

V = surface velocity of journal in ft. per min.

By translating the horizontal axis of the curve the constant b is eliminated and the equation becomes

$$y = c^a \sqrt{V} \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

From the experimental curve the values of c and a were found to be

$$c = 0.0000049, \quad a = 1.8$$

and the resulting empirical equation is

$$y = 0.0000049^{1.8} \sqrt{V} \ldots\ldots\ldots\ldots\ldots [3]$$

As to the application of the empirical equation in the general equation for bearing lubrication, it may be said that it may be used directly for conditions of the same allowance and a lubricant having the same viscosity. For other allowances and lubricants the change of c and a cannot be stated definitely. It can be said in general that c will change with some function of the allowance and a with some function of the viscosity. It is also possible that c may be affected by the viscosity and a by the allowance.

The oil used during the experiment was an ordinary mineral oil, known as Vacoline, manufactured by the Standard Oil Company. Its viscosity as given by the Engler viscosimeter was 11.0 at 20 deg. cent. and 2.95 at 50 deg. cent. compared with water at 20 deg. cent., which gave a specific viscosity of 38.9 at 20 deg. cent. and 8.7 at 50 deg. cent.

TABLE 1 DISTANCE BETWEEN AXES

Average Experimental Data					Results	
V Ft per Min.	Temp deg. fahr.	Micrometer Readings, In. 1	2	3	Axial Dist. In.	Angle
0	..	0.0002	0.0035	0.0002	0.00175	90°00′
196	58	0.0001	0.0026	0.0006	0.00158	80°45′
306	66	0.0003	0.0025	0.0004	0.00153	88°10′
511	66	0.0003	0.0025	0.00065	0.00142	82°00′
817	78	0.0002	0.0023	0.0005	0.00134	83°00′
1224	70	0.00025	0.0021	0.0004	0.00125	86°05′
2042	80	0.0002	0.0020	0.0006	0.00113	77°40′

TABLE 2 MEAN THICKNESS OF OIL FILM

V	Distance between Axes	Min. Thickness Film	Mean Thickness Film
0	0.00175	0	0.000875
196	0.00158	0.00017	0.000960
306	0.00153	0.00022	0.000985
511	0.00142	0.00033	0.001040
817	0.00134	0.00041	0.001080
1224	0.00125	0.00050	0.001125
2042	0.00113	0.00062	0.001185

INTERNAL-COMBUSTION ENGINES FOR SUGAR FACTORIES AND ESTATES

BY M. ADAM,[1] PINA, CAMAGUEY, CUBA

THE internal-combustion engine is making such rapid progress that it will be of interest to consider its possibilities in the cane-sugar industry. Naturally, with steam engines the exhaust steam can be utilized for the various heating and evaporating operations. At times, however, there is absolutely no use for exhaust steam, and, as generally no bagasse fuel is then available, oil, wood, or coal would have to be used for the steam plant, depending on the locality. The use of an oil engine here would at first sight seem possible, but calculation shows that the saving realized would not justify the expense of a new installation. Another point of importance in Louisiana sugar factories is that when the temperature is low, the heavy oil will not flow by gravity, and several devices which have been tried are either costly or inefficient. The best solution would be to use a pump run by an internal-combustion engine.

But the greatest field for liquid-fuel engines is on the agricultural side of the industry. The labor problem on the average sugar plantation is a source of anxiety and trouble; the problem of feeding and caring for the draught cattle is also a serious one, though the use of mules and horses is imperative. The amount of animal power required is only 30 per cent at present in the production of the cane, including harvesting. Machines are, however, being developed to do the

[1] Louisiana State University.

harvesting, and it can be safely predicted that in a few years the horse will only be required to do about 8 to 10 per cent of the total.

The agricultural motor tractor, although it has many advantages, has not come in as fast as was expected. The first motor tractors were of very heavy construction, with the consequence that the soil was packed and the crop injured. Of late years, however, the light tractor has made its appearance, and is now no longer an experiment. Some of the best types are the Mogul, Wyles, Martin, Ivel-Bauche, and the Sanderson. The type to be used depends largely on the nature of the soil. In the caterpillar type of tractor the area of contact between the ground and the engine is very much increased, thus securing a greater drawbar efficiency and lower pressure per sq. in. on the ground. A caterpillar 24 in. wide and with 6-ft. length of contact gives the same pressure as a road wheel with a 120-ft. diameter and a width of 24 in. The pressure per sq. in. of a caterpillar is only about 4 to 5 lb., which is very much less than the pressure exerted by the hoof of a horse. A caterpillar will also travel easily on almost any kind of soil, a point of importance. The Martin's cultivator, with its light and simple construction, is of this type; it is made to use benzol or gasoline, as most of the tractors of English make. The Mogul type, however, can burn kerosene, which is so much cheaper than gasoline. Another possible application of heavy-oil engines in sugar plantations is for irrigation, and in some countries for drainage.

The heavy-oil engine has a decided advantage over other types also in fuel cost. The cost per b. hp-hr., excluding rent, administrative costs and electrical apparatus, works out from careful calculations, as follows:

Steam plant	1.605 cents
Gas-producer plant	1.222 cents
Heavy-oil-engine plant	0.511 cent

Gasoline plant was not included, as the cost would undoubtedly come even higher than that for steam plant, and it is safe to assume that an alcohol engine could not compete with the heavy-oil engine or the gas-producer plant. When we speak of heavy-oil engines, we have in mind the Diesel engine. This engine differs from all other internal-combustion engines in that a full charge of air is compressed to a point above the igniting point of the fuel and the fuel injected into it, when it burns under a pressure and temperature which can be perfectly controlled. There are no explosions, but a steady combustion at a predetermined lower temperature and without any increase in pressure, the combustion line being practically an isothermal. A small pump supplies the fuel to the chamber. A special compressor serves to compress the air to inject the fuel and to store a surplus in an air tank for starting the engine when cold. A very sensitive governor controls the quantity of fuel injected, regulating the heat, and hence also the expansive power of the air medium. Apart from high efficiency, a great advantage with this type of engine is that there is practically no limitations as to the kind of fuel to be used, so long as it is liquid.

In installing an irrigation plant for a large sugar plantation, the best arrangement would be to have a central plant near the sugar factory, delivering current at say 440 volts. This can be stepped up to 12,000 volts at the plant and distributed over the plantation, being stepped down again to 440 volts to each separate motor directly connected to its pump. It would be well to divide the power required between a steam plant and a Diesel plant. During grinding, most of the load would be taken by the steam generator, thus permitting the utilization of the exhaust steam. By partially electrifying, say, the centrifugals and machine shop for manufacture of sugars and repair work could be done most efficiently, the load being then taken by the Diesel engines, as there will then be no use for exhaust.

To my knowledge there are no such plants in existence, though there are several using producer gas. The great Buzi Illovo estates in Portuguese East Africa are irrigated in this manner. Most of the property consists of flat alluvial soil, the water being pumped from the Buzi River by means of seven centrifugal pumps, three of which are operated by a suction plant. There is also another producer-gas irrigation plant in the tropics which is giving perfect satisfaction. It consists of three gas producers and three gas engines directly connected to electric generators. There is also one water-tube boiler and a 800-hp. poppet-valve engine directly connected to a 600-kw. generator. Eleven pumps geared and belted to 50-cycle, 310-volt motors, furnishing water for the irrigation of the sugar cane, are located on the different haciendas. The gas plant consists of three double-acting, two-cylinder, four cycle, 18 x 24-in. Allis-Chalmers gas engines running at 200 r.p.m. The engines are supplied with gas by three R. D. Wood dry-bottom, updraft producers, which may be worked as suction or pressure, burning anthracite coal.

All the electric generators, directly connected to engines, are of 200 kw. capacity, and deliver 50-cycle current at 310 volts, which is stepped up to 15,000 volts at the power house. At the pumps the current is stepped down to 310 volts. The irrigating pumps are at a distance of ½ mile to 4 miles, respectively, from the power house; the main plant is located near the factory. The gas plant is operated all the year for irrigation and takes off the factory load on clean-up days and days when there is no demand for exhaust steam. Tests run on the gas-producer plant gave 1.742 lb. of coal per kw-hr. and 1.387 lb. of coal per b. hp-hr., which shows very high efficiency.

With a plant of this size, however, the Diesel engine would give more economical service, and the day will probably come when this type of engine will be universally used for such work as irrigation and drainage.

Since its use was brought to the notice of the world in 1830, the export of nitrate of soda from Chile has exceeded a total of 53,000,000 long tons, and the present output is in the neighborhood of 2,500,000 to 3,000,000 long tons per annum. It is safe to estimate that the known areas can provide nitrate of soda for another 200 years at the present rate of production.—*Metallurgical and Chemical Engineering*, Mar. 1, 1917.

"It has often been said that the fixation of atmospheric nitrogen is not practicable in the United States because of the high cost of power. Now nitrate of soda costs $[illegible] per ton in New York, which is equivalent to $95 per ton for pure nitric acid. In Norway and elsewhere it requires about [illegible] kw.-year to produce a ton of nitric acid. The Mississippi River Power Co. supplies power to St. Louis at $[illegible] per kw.-year at 60 per cent load factor. At this rate the power necessary to produce a ton of acid would cost about $[illegible], and the margin between this and $95 is sufficient to warrant a very careful inquiry before accepting the statement that it cannot be done."—Charles W. Comstock, in Proc. A.I.E.E., January, 1917.

I am indebted to Prof. Kerr for this information.

WORK OF THE BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in The Journal, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee as approved by the Council on March 16, 1917, in Cases No. 140 and 143. In this report, as previously, the names of inquirers have been omitted.

Case No. 140

Inquiry: Do small vertical tubular boilers built for operation in connection with laundry or clothes pressing machinery and which are less than 24 in. in diameter, necessarily come under the requirements of Par. 266?

Reply: The Committee has decided that all boilers 24 in. or less in diameter shall have at least one opening for inspection and one opening in addition to the blow-off for washing out the boiler, these openings to be fitted with brass plugs.

Case No. 143

Inquiry: Has any action been taken as yet by the Boiler Code Committee in the matter of eliminating the copper content requirement for firebox boiler plate steel in Par. 25? Great difficulty is now experienced in securing plate to meet the present requirements of this paragraph.

Reply: The copper content requirement has been eliminated.

The National Research Council has organized an investigation on the subject of Food Poisoning, to be undertaken by the Harvard Medical School in its department of preventive medicine and hygiene.

The American Association for the Advancement of Science and many national scientific societies affiliated with it will hold its 70th meeting in Pittsburgh from December 28, 1917 to January 2, 1918, under the auspices of the University of Pittsburgh, the Carnegie Institute, Carnegie Technical Schools and other scientific and educational institutions of the city.

As already published in The Journal, Congress appropriated last fall \$35,000 to a monument in memory of John Ericsson, the eminent engineer, who was also a member of The American Society of Mechanical Engineers. This monument is to be erected in a prominent place in Washington. A special Commission was appointed by the Government, known as the John Ericsson Monument Commission, to take care of the details in connection with the erection of the monument. As mentioned in The Journal for March, 1917, six of the members of The Society are members of this Commission, which met at Chicago, March 10. It was the unanimous opinion that the sum appropriated by Congress would not be sufficient to erect a fitting memorial to a great engineer which would compare favorably with the memorials erected to men of other professions, and it was decided that at least \$25,000 ought to be added to the appropriation made by the Government, in order that a fitting memorial might be erected. It is proposed to raise this amount by private subscription, and all American engineers, organizations, and societies are invited to aid in commemorating the memory of John Ericsson, who gave signal service to the country at a time when its very existence hung in the balance. It is the first time that the United States Government has made an appropriation for the erection of a monument to an engineer, and as this engineer was also a member of The American Society of Mechanical Engineers, it is hoped that the members of the Society will be proud in aiding the efforts of the John Ericsson Monument Commission. Subscriptions toward the monument will be received by Erik Oberg, Associate Editor of *Machinery*, 148 Lafayette St., New York, a member of The American Society of Mechanical Engineers, who is also a member of the Commission. Subscriptions thus received will be acknowledged by publication as directed by the Commission.

The Engineers' Society of Western Pennsylvania took steps at a recent meeting to create a suitable memorial to the late George Westinghouse, Past President and Hon.Mem.Am.Soc. M.E. The meeting bore testimony that he was a persistent and indefatigable worker upon problems involving the safety and comfort of mankind, and that as an inventor and engineer he was the most widely and favorably known man of his time.

The following resolution was passed unanimously: "Resolved, that this Society, through its President, appoint a committee of five members, to be known as the Westinghouse Memorial Committee, who shall investigate a plan for the purchase of the former home of Mr. Westinghouse, known as Solitude, consisting of ten acres of land, converting same into a public park, to be forever known as 'Westinghouse Park,' erecting thereon a suitable memorial, and turning the whole over to the city of Pittsburgh, under its guarantee that the gift shall receive the same care and protection as other parks owned by the city."

The committee appointed consists of George S. Davison, Julian Kennedy, Vice-Pres.Am.Soc.M.E., William L. Scaife, Charles F. Scott, Mem.Am.Soc.M.E., and E. B. Taylor.

Members of the Society will wish to associate themselves with their colleagues of the Pittsburgh fraternity in doing honor to a distinguished citizen and engineer, and an honorary member of the Society, and hope that their efforts will be rewarded by an early realization of the memorial proposed.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

PRESIDENT HOLLIS is now on his second tour, covering this month the cities of Philadelphia, Pa., Schenectady, N. Y., Troy, N. Y., Buffalo, N. Y., Minneapolis, Minn., Indianapolis, Ind., Columbus, O., and Pittsburgh, Pa.

The message which Dr. Hollis is delivering to enthusiastic audiences was never more timely than now. The purport of it is that:

> We engineers can only take one attitude, that every citizen is permitted, even expected, to develop himself to the highest degree of service for his nation and mankind. There is only one way to do this, and it is for us to unite in the kind of good-will and good-fellowship that will enable us to work together towards the glory of our country—in peace, we hope, but in war if it is absolutely necessary.

The movement for this started throughout the world even before the present war, but of course the war has accentuated it both in this country and abroad.

The membership of the Society has recently received two circulars from the Engineering Societies' Joint Committee on Reserve Corps of Engineers; as a result about 1500 applications for commissions in the Engineer Officers' Reserve have been filed with the War Department. Perhaps one-third of these have been issued by the Secretary of War and signed by the President of the United States.

At the request of President Hollis, the presidents of the engineering societies have had two conferences with representatives of the National Council of Defense and of the Army and the Navy, with the result that there is in preparation a letter telling about the several departments of the service in which an engineer may enroll in the Officers' Reserve. In some of these departments the full complement has already been obtained, but in some others there is still a great need of reserve officers, particularly for members of this Society, experienced as they are in manufacture and in handling men.

Elsewhere in this issue is a resumé of the account of the opening and the dedication of the Science Building given by Past-President Swasey to Nankin University.

Letters have been received from both Dr. Brashear and Mr. Swasey telling of their wonderful trip to the Orient with Mr. Freeman and his two sons. The party is due to sail from Honolulu on the Tenyo Maru on March 27, reaching San Francisco April 2. Dr. Brashear states that when he boarded the boat at Vancouver 225 letters were awaiting him, and that in order to answer them all he has written ten articles for the Pittsburgh newspapers!

While on tour, Dr. Brashear gave two lectures in Peking, two at Shanghai, two at Canton, one at Manila and two on the ships on which he has been traveling. He has also promised our Committee on Meetings an address at the next annual meeting of the Society.

In one audience of his in Canton there were 1200 Chinamen and women, besides foreigners. In many cases his lectures had to be interpreted, interpreters being often Yale graduates to whom he kindly enough gave credit for delivering his lectures better than he himself did.

The party has met President Li Yuan-heng, the Vice-President, the President of the Senate and others of China's most brilliant men, both in politics, business and education. Mr. Freeman, in a conversation with the President of the Chinese Republic, emphasized the necessity for conservation in China particularly with respect to waterways.

Mr. Swasey is held in the highest esteem in China, where he has done wonderfully good work, both in the educational institutions and in the Y. M. C. A. During the trip, Mr. Swasey's seventieth anniversary was celebrated by a dinner given by Mr. Freeman.

The alumni of the Massachusetts Institute of Technology in Shanghai gave a dinner to Mr. Freeman and his sons also; in fact, the social entertainments were most complete wherever our friends visited.

This trip of our distinguished past-presidents calls to mind that we engineers, in our professional work and in our vacation trips, go all over the world. We thus have excellent opportunities for extending the greetings of the Society and developing the professional spirit universally. Please, therefore, invite engineers and officers of professional societies to call and send their friends to the Society headquarters, and we will do our best to assist them in whatever errand they may have.

Calvin W. Rice,
Secretary.

Council Notes[1]

AT the meeting of the Council on February 16, the following members were present: Ira N. Hollis, *President*, presiding; John H. Barr, C. H. Benjamin, R. H. Fernald, W. B. Gregory, W. B. Jackson, D. S. Jacobus, Charles T. Main, Spencer Miller; Wm. H. Wiley, *Treasurer;* R. M. Dixon, *Chairman Finance Committee*, and Calvin W. Rice, *Secretary*.

Representation at Council Meetings. It was voted to add the chairman of the Sections Committee to those committee chairmen now receiving invitations to attend Council meetings and take part in the discussion of matters relating to their work. The chairmen of the Finance, Meetings and Publication Committees already receive such invitations.

Increase of Membership Committees. A. G. Kessler was appointed chairman of an Increase of Membership Committee for Erie and vicinity, and Charles T. Hutchinson of a similar Committee for San Francisco and vicinity.

A.S.M.E. Boiler Code. Interpretations Nos. 76, and 116 to 135 inclusive, of the Boiler Code Committee were approved as presented, with one exception, No. 125, which was slightly amended, and ordered published. They appear in the March issue of The Journal.

A request from the Compressed Air Society that the Boiler Code Committee consider the formulation of rules to cover pressure vessels other than steam was referred back with the

[1] The March Journal went to press before the February meeting

request that the Society submit a brief covering the modifications of the Boiler Code it would recommend to meet the case.

Sections. Ernest Lee Jahncke was appointed on the executive committee of the New Orleans Section, in place of A. L. Black, resigned.

Student Branches were approved at Johns Hopkins University, University of Washington and University of Pittsburgh. The total number of Branches is now forty-three.

Engineering Standards Committee. In response to an invitation from the American Institute of Electrical Engineers for appointment of three representatives on a proposed joint conference committee of the national engineering societies, on a committee to bring about coöperation in American Engineering Standards, our Standing Committee on Standardization was authorized to appoint three of its members as the representatives of our Society on the joint committee.

Naval Consulting Board. Mr. Spencer Miller, one of the Society's two representatives on the Naval Consulting Board, reported the appointment of a Sub-committee on Special Problems, and that the Board is now holding frequent meetings, the proceedings of which are being kept confidential for obvious reasons.

Society Representation. Mr. Spencer Miller was appointed to represent the Society at the annual meeting of the American Institute of Mining Engineers.

Prof. H. E. Satterfield was appointed to represent the Society at the inauguration of Professor Ruddick as President of the North Carolina College of Agriculture and Mechanical Arts, on February 22.

Exchanges of Courtesies. It was voted to accept with appreciation and to most cordially reciprocate the exchange of courtesies to members in the use of the Library and rooms with the Institution of Civil Engineers, of England, and the Engineers Society of Northeastern Pennsylvania.

Calvin W. Rice,
Secretary.

United Engineering Society

Extracts from President's Annual Report

The important fact of the year 1916 in the United Engineering Society is that on July 25 contracts were executed by which the American Society of Civil Engineers became an additional Founder Society and arranged to make its permanent home in the Engineering Societies Building. The contracts provide for the construction of three additional stories to the building, the American Society of Civil Engineers to contribute a sum considered equivalent to what each other Founder Society had contributed and to participate in the original Carnegie gift and have an equal share in the property with each other Founder Society.

The construction of the addition to the building is under way, \$62,525.04 having been expended thereon in 1916. This work is in charge of a Building Committee consisting of H. H. Barnes, Jr., Chairman, E. G. Spilsbury, Charles Warren Hunt and Charles F. Rand.

At the request of the Founder Societies, important alterations were made to the lecture halls on the fifth floor of the building to make them suitable for social functions of the societies.

The Library of the American Society of Civil Engineers is being merged with the Library of the United Engineering Society and the Founder Societies.

At the present time the membership of the four Founder Societies is 29,000, and of associate societies 23,000, so that a total of 52,000 engineers now have their headquarters in our building.

The building is at present fully occupied.

The value of the real estate now owned by the United Engineering Society is \$1,617,171.16. This sum will be increased at the end of 1917 by the amount of the cost of the addition to the building.

The income of the Society during 1916 was..	\$53,062.03
The expenditure was....................	44,316.20
Gain for the year........................	\$8,745.83

Funds for the benefit of the Library were obtained during the year from contributions by the societies of Civil, Mining, Mechanical and Electrical Engineers and the United Engineering Society to the amount of................. \$15,542.33

From miscellaneous sources................	1,751.03
The gross income from searches was.........	5,382.98
Total............................	\$22,676.34

The Library expenses have been as follows:

Library Books purchased..................	\$2,340.88
Library Binding Expense..................	1,442.55
Library Supplies and Miscellaneous Expense.	1,379.38
Library Salaries..........................	10,923.81
Library Photostat.........................	1,091.02
Library New Lighting Fixtures.............	132.47
Library Searches Expense..................	5,366.23
Total............................	\$22,676.34

Dr. James Douglas, who started our Library Endowment Fund with a gift of \$5,000, has added \$95,000 thereto. The total of the fund is now \$102,559.70. An effort is being made to materially increase this fund, as the Library requires the income of a million dollars for its proposed development.

The securities in the Engineering Foundation Fund were sold and the proceeds reinvested to produce a higher income, as shown in detail in the Treasurer's report. The Fund now amounts to \$203,374.80.

The General Reserve Fund remains unchanged at..................................	\$10,000.00
The Depreciation and Renewal Fund is now..	71,456.12
The Surplus Account December 31, 1916, is..	6,053.25

Charles F. Rand,
President, United Engineering Society.

Professor Carpenter to Retire

Prof. R. C. Carpenter, Past Vice-President Am.Soc.M.E., reaches the retiring age at the end of the present college year and will sever his active connection with Cornell University at that time.

Respecting his retirement, the Committee on General Administration of the Board of Trustees adopted the following resolution:

> Resolved, that the Trustees in accepting the resignation of Professor Carpenter express their high appreciation of his services to the University for nearly thirty years. As a pioneer in the field of experimental engineering he is held in the highest esteem by all mechanical engineers, and by his writings in this field he has made an assured place for himself in the annals of his profession. As a teacher and investigator he is affectionately remembered by many generations of students, and his retirement from the Faculty of Sibley College will be viewed with great regret by all his colleagues.

THE SPRING MEETING AT CINCINNATI

THE fundamental principles which the engineers of this country have found to be essential for the successful production of munitions will form the subject of an important sion of the Spring Meeting of The American Society of Mechanical Engineers, to be held in Cincinnati, Ohio, May 21 to 24. A year ago, when the country began to take up the question of Industrial Preparedness, the Society devoted a session of its Spring Meeting in New Orleans to a discussion of this subject. This discussion was the means of bringing out many valuable ideas—one of them that of an industrial inventory, which was later put into effect by the Committee on Industrial Preparedness of the Naval Consulting Board. As the result of this inventory, the Government now has on file important data regarding the capabilities of nearly 30,000 industrial concerns in this country to manufacture munitions in case of necessity. It is expected that the Munitions Session at the coming Spring Meeting in Cincinnati will bring out a large amount of first-hand experience in munitions manufacture from firms which have specialized in this business during the last two years. Such information will afford a valuable supplement to that contained in the Industrial Census.

The meeting is in charge of the Committee on Meetings and the Cincinnati Section Committee, and other professional features will be a Session on High-Speed Gasoline Engines, at which recent developments in connection with internal-combustion engines for automobile and aviation service will be presented; a Session on Machine Shop Practice, devoted to questions relating to design and construction of machine tools, and a Joint Session with the National Machine Tool Builders' Association, which as attested by the following letter from John T. Faig, chairman of the Cincinnati Section, will be an important event for both societies. Incidentally, Mr. Faig's letter discloses some of the good things in store for those who attend the meeting.

THE SECRETARY, THE AMERICAN SOCIETY
OF MECHANICAL ENGINEERS:

The outstanding feature of the Spring Meeting for 1917 is the fact that it will occur at the same time and place as the meeting of the National Machine Tool Builders' Association, and that one of the professional sessions and several of the entertainment features will be joint sessions. This will bring our own Society in closer touch with machine-tool building. The building of all forms of heat motors, or water wheels, of railway apparatus, of heating and ventilating devices, and of transmission machinery, seems to be recognized as belonging more clearly to the field of the mechanical engineer than does machine-tool building. This is probably due to the fact that early machine tools were largely empirical, that very little was known regarding the laws underlying the cutting of metals and the power required to remove material by means of cutting tools. Improvements in various cutting steels and more rigid demands made upon machine tools by the general introduction of interchangeable parts, have caused an extremely rapid development in the machine-tool industry, which is fast raising machine-tool building to a science.

It is natural that special emphasis should be placed on machine-tool building at the Cincinnati meeting, for the reason that an amazing development of the machine-tool industry has occurred there during the past thirty years—a development apparently out of all proportion to that which has occurred in other lines in mechanical engineering.

It seems particularly fitting, therefore, that the American Society of Mechanical Engineers and the National Machine Tool Builders' Association should meet together at Cincinnati, and that these two organizations, already closely related, should come into more intimate contact. The local session, which is to be devoted to industrial education and to welfare work, will be a joint session of these two societies and of equal interest to both. Inspection trips to the various shops will be of interest to both societies.

A word about the entertainment features will not be out of place. The Entertainment Committee is making strong efforts to provide some novel and very attractive features that will maintain the reputation made when the British Institute of Mechanical Engineers visited Cincinnati in 1904. May is usually a lovely month in Cincinnati, and the topographical features of the Queen City make it attractive to those who enjoy being out of doors in the early Spring. A number of very beautiful spots are to be visited on the automobile ride, which is scheduled for Thursday afternoon. Arrangements have been made to afford visiting members, who desire to relax, an opportunity to play golf at one of the country clubs. For those who have the latter part of the week to spend, delightful trips may be made to the famous mound

SKY LINE, CINCINNATI, OHIO

Art Museum and Art Academy, Cincinnati

known as Fort Ancient, at Morrow, Ohio, about forty miles away; to the famous Blue Grass Region of which Lexington, Kentucky, is the center, which is a veritable garden in May, and to the world-famous Mammoth Cave in Kentucky.

Beside visits to the well-known machine-tool and steam-engineering firms, a number of invitations from large concerns making steel, soap, pianos, and other commodities have been received, so that a visiting member will have a wide choice in his selection of places to visit.

In general, the practice of the Society of holding professional sessions in the mornings and devoting the afternoons to entertainment and visits will be followed, except that on Tuesday afternoon there will occur a special professional session, which will be the joint session already mentioned.

Cincinnati is well supplied with hotels of every class. As May is a busy month, however, and as Cincinnati is rather popular as a convention city, members who expect to attend the meeting are urged to make reservations at once.

John T. Faig,
Secretary, Cincinnati Section.

Information regarding transportation to Cincinnati, hotels, the program of the meeting, features of interest to be inspected, entertainment, etc., is given below, and will be followed in the next issue by the complete program giving titles of the papers to be presented and discussed at the professional sessions. In the next issue, also, will be published comprehensive abstracts of these papers, and as heretofore the papers will in addition be published in pamphlet form in advance of the meeting and may be obtained by members upon application, for the purpose of contributing discussion.

TRANSPORTATION AND FARES

The Committee on Meetings, in order to secure as large a benefit as might be derived from selecting a particular train for those of our party attending this meeting from the East, have designated the train leaving New York City by the Pennsylvania Railroad at 5.30 p.m. on Sunday evening, May 20, as the official train. The schedule of this train follows:

New York to Cincinnati

	Train No. 7.
Lv. New York City, Pennsylvania Station	5:30 P. M.
Manhattan Transfer	5:48 P. M.
Newark, Market Street	5:52 P. M.
Trenton	7:00 P. M.
Philadelphia, North	7:38 P. M.
Philadelphia, West	8:07 P. M
Philadelphia, Broad Street	8:03 P. M.
Atlantic City	4:45 P. M.
Baltimore	8:05 P. M.
Washington	7:00 P. M.
Harrisburg	10:45 P. M.
Altoona	1:38 A. M.
Ar. Pittsburgh, Eastern time	4:30 P. M.
Lv. Pittsburgh, Central Time	3:55 A. M.
Ar. Columbus	8:45 A. M.
Ar. Cincinnati, Central time	12:20 P. M.

The individual rate, New York to Cincinnati, is $18.68; the party fare, ten or more traveling together on one date and train, is $16.42. The same rates apply in the reverse direction.

There is an extra fare on the train above mentioned, between New York and Cincinnati, of $1.00.

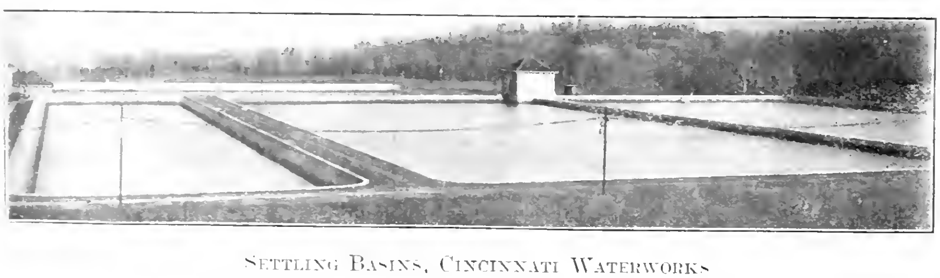
The lower berth rate, New York to Cincinnati, is $4; upper,

Ohio River from Eden Park

$3.20; compartment, $11.50; drawing room, $14. The same rates apply in the reverse direction. A minimum of one and a half tickets are required for compartment space and two full tickets for drawing room.

All reservations for this train should be made with William V. Kibbe, District Passenger Solicitor, Pennsylvania Railroad, 487 Fifth Avenue, New York City.

Members residing in the New England States who do not wish to come by way of New York and join the party on this train, may find it convenient to take the New York Central train which leaves Boston at 2:00 p.m. Sunday, May 20, arriving in Albany at 7:45 p.m. This train leaves New York



Settling Basins, Cincinnati Waterworks

at 4:50 p. m. on Sunday and arrives in Cincinnati at 11:15 on Monday morning.

HOTELS

The Cincinnati Section Committee has selected the Hotel Sinton as headquarters for the Spring Meeting. The rates of this hotel are as given below, and members are requested to *write direct to the hotel for reservations*. Some members

Bird Cages at Zoo

may prefer to stay at the Hotel Gibson, diagonally across the street from the Sinton, or elsewhere, in which case the following table of rates will be of service to them. The rates are on the European plan.

Hotel Sinton

Room without bath, one person	\$1.50 per day and up
Room with bath, one person	2.00 per day and up
Room without bath, two persons	2.50 per day and up
Room with bath, two persons	3.00 per day and up

Hotel Gibson

Room with bath, one person	\$2.00 per day and up
Room with bath, two persons	4.00 per day and up

Grand Hotel

Room without bath, one person	\$1.00 per day and up
Room with bath, one person	2.00 per day and up
Room without bath, two persons	2.00 per day and up
Room with bath, two persons	3.50 per day and up

Rookwood Pottery, Cincinnati

TENTATIVE PROGRAM

With the meeting still six weeks off, the Meetings Committee and the Cincinnati Section Committee have practically completed the details of the program. There remain but one or two special sessions to be inserted. A slight change in the arrangements for excursions has been made over those given in the last issue of the Journal.

Monday, May 21

Morning........Registration.
Afternoon.......Registration.
Trip to hospital.
Visits to shops in Cincinnati.
Evening........Informal gathering.
Address of welcome.
Dancing.

Tuesday, May 22

Morning.........Business Meeting.
Machine Shop Session.
Visit by ladies to Rookwood Pottery and Art Museum.
Afternoon.......Joint Session with National Machine Tool Builders' Association.
Visits to shops in Cincinnati.
Trolley ride by ladies to Fort Thomas.

Municipal Hospital, Cincinnati

Evening	Smoker for gentlemen
	Reception for ladies

Wednesday, May 23

Morning	Munitions Session, as the [illegible] day or else adjourning to Thursday morning
	Trip for ladies through leading stores and skyscraper
Afternoon	Boat ride for all to Fernbank Dam or Water works
Evening	Informal dance

Thursday, May 24

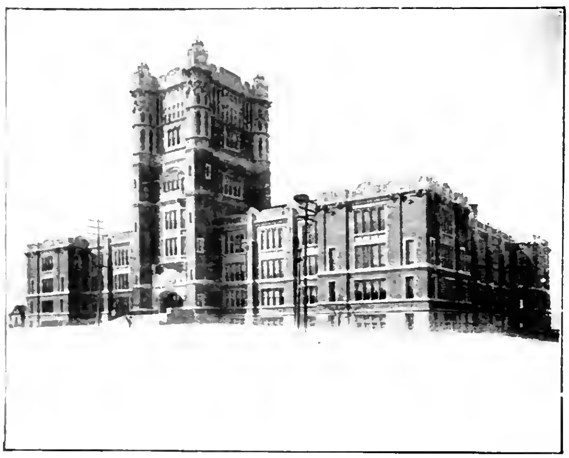
Morning.......	Miscellaneous Session.
	Gasoline Engine Session.
	Trolley ride for ladies to the Zoo.
Afternoon......	Visits to machine plants.
	Motor-car ride to Mt. Storm, University of Cincinnati, Observatory and Ault Park.

Friday, May 25

Morning........	Trip to Fort Ancient (Extra).
	Trip to Mammoth Cave, Ky. (Extra).
	Trip to Lexington, Ky. (Extra).

TECHNICAL EXCURSIONS

Among the technical features of the entertainment at the Spring Meeting will be a visit to the large new station of the Union Gas and Electric Co., which is really of metropolitan dimensions; a visit to the Waterworks System, and a visit to the Fernbank Dam. The dam in the Ohio River, at the western city limits, is said to be the largest movable dam in the world. It is one of a series of 54 locks and dams being built by the Government in this river to make it navigable from Pittsburgh to Cairo.



Hughes High School, Cincinnati

Visits will also be made to some of the great machine tool factories in and near Cincinnati, and also to such great industrial concerns as the Procter and Gamble Soap Company.

PLACES OF INTEREST

Besides the engineering features of Cincinnati, those attending at the Spring Meeting will find many places of particular interest to visit.

The famous Rookwood Pottery is located on the brow of Mt. Adams, overlooking the downtown section of the city. Here the beautiful Rookwood ware is produced.

The Cincinnati University, in Burnet Woods, comprises McMicken, Cunningham, and Hanna Halls, the Van Wormer Library, Engineering Hall, Chemistry Building, Gymnasium, Power Plant and Observatory, which latter is on Mount Lookout, six miles from the center of the city. It is the only municipal university in the United States.

The Ohio Mechanics' Institute is another great educational institution. It is now housed in a magnificent new structure at Walnut, Canal and Clay Streets, which accommodates 4,000 students, and is a big factor among scientific and industrial training schools.

Cincinnati has a city hall which cost $2,000,000, and three new high schools which in architecture and appointments are not excelled in any city in the United States. The government building and custom house on Fifth Avenue cost over $6,000,000. A new municipal hospital cost $4,000,000.

Cincinnati has a system of public parks and boulevards which covers about 2,500 acres, and is now undergoing extensions and improvements. The oldest is Eden Park, located on the crest of Mt. Adams; it was once the vineyard of Nicholas Longworth, great-grandfather of Congressman Longworth.

Among points easily reached from Cincinnati are Chattanooga, Tenn., with the battlefields of Lookout Mountain, Signal Mountain and Missionary Ridge; Boonesborough, Ky., the oldest settlement established by English-speaking people in the Mississippi Valley; Lincoln's birthplace, near Hodgenville, Ky.; Mammoth Cave and Colossal Cavern; the tomb of President Harrison at North Bend; Point Pleasant, the home and birthplace of Ulysses S. Grant, and Georgetown, where the great General spent his boyhood.

Junior and Student Prizes

In the Technical Section of this issue are included papers by Howard E. Stevens, Boynton M. Green and M. Adam, which were awarded Student prizes at the Annual Meeting of the Society, December 1916.

It is hoped that these examples may stimulate those of our Junior Members and members of Student Branches who intend to enter for this year's competition, which closes on June 30, 1917, and particulars of which were published on page 153 of the February issue of The Journal and are also given in the 1917 Year Book on pages 508-9.

Any further information regarding this competition will be furnished on application to the Secretary, who will also be glad to give any suggestions to those entering this year.

Colonel Walter Katte

Col. Walter Katte, who was for fifty years active in railroad and bridge construction in this country, died in New York City on March 5. He was the first chief engineer of the Second and Ninth Avenue Elevated Railroads of the metropolis, and was identified prominently with the construction of the West Shore Railroad. His railroad experience included ten years in the service of the Pennsylvania System and twelve years as chief engineer of the New York Central Railroad. He was one of the early members of the American Society of Civil Engineers, and served twice as a director of the Institution of Civil Engineers, of London.

Mr. Katte's son, E. B. Katte, is a past Vice-President of our Society.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER MAY 10, 1917

THE American Society of Mechanical Engineers is an organization for mutual service of over 7800 engineers and associates coöperating with engineers. The membership of the Society comprises Honorary Members, Members, Associates, Associate-Members and Juniors, all elected by ballot of the Council. Application for membership is made on a regular form furnished by the Secretary which provides for a statement of the standing and professional experience of the applicant and requires references from voting members personally acquainted with the applicant. The requirements for admission to the various grades will be furnished upon request.

Below is the list of candidates who have filed applications for membership since the date of the last issue of The Journal. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate Member, those in the next class under Associate-Member or Junior, and those in the third under Junior grade only. Applications for change of grading are also posted.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by May 10, 1917, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about June 15, 1917.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

California

ABBEY, ALFRED R., Construction Engineer, Standard Oil Co. of Cal., Whittier

COX, SPENCER F., Mechanic, A. T. & S. F. R. R., San Bernardino

OTTERSON, N. E., Sales Manager, Senn Concentrator Co., San Francisco

Connecticut

BRYANT, RAYMOND F., Assistant to Vice-Pres., and Gen. Supt., Yale & Towne Mfg. Co., Stamford

HUBBARD, FRANKLIN G., Vice-President, The H. E. Harris Engrg. Co., Bridgeport

METZGER, ELMER E., General Superintendent, Geometric Tool Co., New Haven

STARR, ADOLPH, Chief Gage Inspector, Winchester Repeating Arms Co., New Haven

UNGAR, G. A., Technical Manager and Chief Engineer, S.K.F. Ball Bearing Co., Hartford

Delaware

HOMEWOOD, WILLIAM T., Designing Engineer, E. I. du Pont de Nemours & Co., Wilmington

PIERCE, H. M., Chief Engineer, E. I. du Pont de Nemours & Co., Wilmington

Illinois

BLAINE, JOSEPH R., Mechanical Engineer and Designer, Miehle Printing Press & Mfg. Co., Chicago

CALAME, ARMAND, Assistant Foreman Machine Shop, Elgin National Watch Co., Elgin

MILLER, KAY C., Chief Tool Designer, Chief Inspector, The Root & Van Dervoort Engrg. Co., E. Moline

WEBSTER, TOWNER K. JR., Vice-President, Webster Engineering Co., Chicago

WEST, OSCAR J., Sales and Consulting Engineer, Chicago

Indiana

CROW, MARTIN E., with Crow-Elkhart Motor Co., Elkhart

HETZEL, FREDERIC V., Chief Engineer, Link Belt Co., Indianapolis

Louisiana

BARELLI, JOHN S., Manager New Orleans Office, Heine Safety Boiler Co., New Orleans

Massachusetts

ALFORD, FRANK R., Superintendent, Chelsea Clock Co., Chelsea

BROOKS, JOHN C., Assistant to Vice-President, Goodell-Pratt Co., Greenfield

GUNNING, WILLIAM A., Chief Draftsman, American Optical Co., Southbridge

HALE, RICHARD A., Principal Assistant Engineer, Essex Co., Lawrence

McKITTRICK, PERCY A., Office Manager, Saco-Lowell Shops, Lowell

MILLIKEN, JAMES L., Resident Representative, Everett Mills, Lawrence

SMITH, CLAYTON O., Sales Manager, Norton Grinding Co., Worcester

Michigan

HARTMAN, DONALD E., Instruction Department, Consumers Power Co., Jackson

HEAVENRICH, OSMOND D., Chief Engineer, Detroit Pressed Steel Co., Detroit

OLSON, CHARLES W., Chief Tool Designer, Continental Motors Corp., Detroit

PLANCHE, ETIENNE, Chief Engineer, Dort Motor Car Co., Flint

SCHECKENBACH, JOHN A. V., Improvement Engineer, American Car & Fdy. Co., Detroit

Minnesota

GERRISH, HARRY E., Pres., Morgan-Gerrish Co., Minneapolis

JOHNSTON, WAYBURN E., Valuation Inspector, Northern Pacific Rwy., St. Paul

KOBEL, WILSON C., Assistant Chief Engineer, Minnesota Steel Co., Power Sta., Duluth

MORGAN, GLENN C., Vice-President, Morgan-Gerrish Co., Minneapolis

New Jersey

BROHPO, BENJAMIN N., Mechanical Engineer, Roessler & Hasslacher Chemical Co., Perth Amboy

FREDERICK, KARL L., Vice-President, Passaic Metal Ware Co., Passaic

PAUL, J. S., Factory Manager, Metal Process Co., Trenton

New York

CAUTLEY, JOHN R., Engineer Expert Dept., P. A. Frasse & Co., Inc., New York

GREEN, WILLIAM A., Manufacturer and Representative, American Engineering Concerns in Europe, New York

HUNTER, CHARLES F., Superintendent Repair Shop and Chief Engr. Power Plants, Witherbee, Sherman Co., Inc., Mineville

LEONARD, ALBERT P., Assistant Chief Engineer, Honolulu Iron Works Co., New York

McALLISTER, JOHN E., Assistant to President, Liberty Fuse & Arms Corp., Long Island City

MacFARLAND, EDWARD H., Steam Turbine Inspector, General Electric Co., Schenectady

MAIS, ALBERT F., Chief Engineer, Fulton Motor Truck Co., Farmingdale, L. I.

MARTIN, JOHN F., Superintendent, Neptune Meter Co., Long Island City

MORROW, JAMES E., Secretary and Manager of Production, Morrow Mfg. Co., Elmira

DE NEMETH, ZOLTAN, Engineer Power Plant Designs, James Stewart & Co., New York

SHIRADY, CHARLES D., Engineer, Van Siclen & Co., New York

SHAW, HUBERT A., Metallurgist, American Can Co., Geneva

WAGNER, JAMES J., Engineer, New York Central R. R. Co., New York

Ohio

[illegible]ANSON, JAMES F., Assistant to J. D. Lyon, [illegible] Engr., Cincinnati

[illegible]ARSON, JAMES R., [illegible], [illegible] Mach. Tool Co., Cincinnati

[illegible]ELL, M[illegible], Mechanical Draftsman, The A[illegible] Machine Co., Alliance

STEVENS, WILLIAM N., Machine Tool Design, Cincinnati Milling Mch. Co., Cincinnati

WALMSLEY, HAROLD M., Resident Engineer, S[illegible] & [illegible]endy, Cincinnati

Pennsylvania

HENRY, [illegible], Construction Engineer, American Sheet & Tin Plate Co., Pittsburgh

LELAND, EDWARD D., Superintendent Compressing Stations, Philadelphia Co., Pittsburgh

LIVERSIDGE, HORACE P., Operating Engineer, The Philadelphia Electric Co., Philadelphia

SCHULTZ, WALTER F., Chief Engineer, Driggs Seabury Ordnance Co., Sharon

WEBSTER, HARRY D., Mechanical Engineer, Bessemer & Lake Erie R. R. Co., Greenville

WHITCRAFT, ARTHUR, Sales Engineer, American Manganese Steel Co., Pittsburgh

Tennessee

BADGER, HARRY S., Superintendent Power Sta. and Sub Sta., Nashville Rwy. & Light Co., Nashville

Texas

MOELLER, WILLIAM, Suprintendent, Texas Portland Cement Co., Houston

Vermont

FULLAM, EBEN J., Secretary, The Fellows Gear Shaper Co., Springfield

Virginia

LEE, CAZENOVE G., JR., with E. I. du Pont de Nemours & Co., City Point

Wisconsin

BROWN, ARTHUR J., Chief Draftsman Electrical Dept., Allis-Chalmers Mfg. Co., Milwaukee

Canada

CAMERON, N. C., Chief Engineer, Imperial Tobacco Co. of Canada, Ltd., Montreal

France

SCHUTZ, HARRY M., Engineer, Niles-Bement-Pond Co. of U. S. A., Paris

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

Delaware

BANKER, WALTER B., Resident Engineer, E. I. du Pont de Nemours & Co., Wilmington

Illinois

MARLOW, FRANK W., Chief Engineer, Armour & Co., Chicago

MILLER, JOSEPH S., Mechanical Engineer, Kewanee Boiler Co., Kewanee

Massachusetts

HAMILTON, DON A., Mechanical Engineer, John Bath & Co., Inc., Worcester

Michigan

GILLOOLY, JOHN H., Draftsman, Steere Engineering Co., Detroit

KAMMERER, NELSON C., Chief Draftsman, Metalwood Mfg. Co., Detroit

Nebraska

SLOMAN, HUBERT E., Assistant Superintendent of Buildings and Construction, J. L. Brandeis & Sons, Omaha

New York

CONLEY, MURRAY C., Mechanical Engineer, Henry L. Doherty & Co., New York

HUNICKE, CLARENCE C., Patent Attorney and Attorney at Law, New York

LOGAN, ORWELL, Chief Engineer, Jensen Creamery Machinery Co., Long Island City

McHOLLAN, JAMES A., Assistant Engineer, The R. P. Bolton Co., New York

MEAD, FRANK R., Assistant to Chief of Department of Gauges, L. R. Kenyon, Munitions of the British Government, New York

MORLEY, MARCUS D., Assistant to Engineer of Tests, Edison Electric Ill. Co., Brooklyn

SERRELL, JOHN J., Vice-President, Smith-Serrell Co., Inc., New York

SMITH, ALBERT T., Manager, The R. U. V. Co., New York

TERWILLIGER, DAVID M., Engineer of Tests, Operating Department, Edison Elec. Ill. Co., Brooklyn

WHEELER, WILLIAM H., Purchasing Engineer, Austin Baldwin & Co., New York

Pennsylvania

KIRK, DONALD, Draftsman, Carnegie Steel Co., Homestead Works, Munhall

WARD, ROY J., with Shephard Electric Crane & Hoist Co., Pittsburgh

Virginia

DUFFEY, PAUL R., 1st Assistant Master Mechanic, Mathieson Alkali Works, Saltville

Wisconsin

HENSZEY, ROY O., Engineer and Architect, Carnation Milk Products Co., Oconomowoc

MOYER, WILL D., Public Utility Inspector, Wisconsin R. R. Comm., Madison

FOR CONSIDERATION AS JUNIOR

Alabama

HALLER, LOUIS G., Manager Birmingham Office, The Walsh & Weidner Boiler Co., Chattanooga

Connecticut

BACON, DAVID L., Plant Engineer, The Greist Manufacturing Co., New Haven

Florida

TILLIS, H. RHETT, Chief Engineer, American Agricultural Chemical Co., Pierce

Illinois

ARMACOST, WILBUR H., Engineer, Armour & Co., Chicago

BYANSKAS, JOHN M., Testing Engineer, Mech. Dept., Armour & Co., Chicago

PARRIGIN, HOMER, Steam Expert, Illinois Steel Co., Joliet

Indiana

KNOWLTON, CHASE H., Special Engr., Motive Power Dept., C. C. C. & St. L. Rwy., Indianapolis

Massachusetts

LINDBLOM, HERBERT R., Assistant to Foundry Supt., Saco-Lowell Shops, Newton Upper Falls

New York

BAACK, HENRY J., Laboratorian, Navy Department, Navy Yard, Brooklyn

BEARD, THEODORE H., Instructor Mech. Engrg., New York University School of Applied Science, New York

BENEDICT, BYRON W., Construction Engr., American District Steam Co., North Tonawanda

CARLSON, CLARENCE A., Designing Engineer, Canady-Blaisdell Corp., New York

DE LEMOS, FREDERICK P., Assistant to Chief Engineer, Automatic Sprinkler Co. of America, New York

HORTON, FRANK W., Designing Draftsman, National District Telegraph Co., New York

LEA, ROBERT B., Manager Stabilizer Dept., Sperry Gyroscope Co., Brooklyn

SQUIRE, MILFORD B., with General Electric Co., Schenectady

Ohio

ATWELL, NORBERT S., Inspector of Meters, Ohio Fuel Supply Co., Columbus

TAYLOR, ROBERT M., Works Engineer, The American Tool Works Co., Cincinnati

TOMLINSON, C. SPRAGUE, Assistant to Power Plant Engineer, The Firestone Tire & Rubber Co., Akron

WINBIGLER, HOWARD D., Assistant Mechanical Engineer, Faultless Rubber Co., Ashland

Pennsylvania

FURBUSH, GRANT E., Instructor, Dept. of Indus. Engrg., Penn. State College, State College

GOLDSMITH, LESTER M., Engineer of Tests, Atlantic Refining Co., Philadelphia

MOODY, WILLIAM M., Engineer, I. P. Morris Co., Philadelphia

REYNOLDS, LLOYD C., Assistant Steam Engineer, Worth Bros. Co., Coatesville

SWEETEN, ALLEN W., Designing Engineer, Simplex Valve & Meter Co., Philadelphia

Tennessee

WEIGEL, ROTHE, Mechanical Engineer, La Follette Coal & Iron Co., La Follette

Wyoming

CHRISTIAN, BEN, Mechanical Draftsman, Great Western Sugar Co., Denver

Canada

JENTZ, CARL D., Engineer, St. Maurice Paper Co., Cape Madeleine, P. Que.

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE-MEMBER

Minnesota
BUFFINGTON, HARRY C., Motor Engineer, Minneapolis Steel & Mchy. Co., Minneapolis

PROMOTION FROM JUNIOR

Connecticut
MACEWAN, Thomas S., Manager Sales of Mchy. Dept., S.K.F. Ball Bearing Co., Hartford

New Jersey
CHEETHAM, JOSEPH H., Chief Mechanical Engineer, McNab & Harlin Mfg. Co., Paterson

New York
GILLETT, LOWRY, Power Engineer, General Chemical Co., New York

Massachusetts
ADAMS, KILBURN E., with Edison Elec. Ill. Co., Boston

Missouri
DOWNES, NATE W., Mechanical Engineer, Kansas City School District, Kansas City

SUMMARY

New applications	118
Applications for change of grading:	
Promotion from Associate-Member	1
Promotion from Junior	5
Total	124

NECROLOGY

CHARLES ALEXANDER CANDA

Charles Alexander Canda was born in Summit, N. J., on June 18, 1869. He received his education in the public schools and Stevens Institute, graduating from the latter in 1893. He soon after became associated with the Brush Electric Light Co., New York, where he remained until 1899. During this time he designed a direct-current arc lamp whereby the top and bottom carbons were controlled in the head of the lamp.

In the latter part of 1899 he affiliated with the Canda Manufacturing Co., manufacturers of automobiles, serving in the capacity of assistant to the superintendent, acting superintendent from 1900 and superintendent in 1901. Early in 1902 he assumed the duties of secretary and became part owner of the Chrome Steel Works, Chrome, N. J., holding this office at the time of his death.

Mr. Canda was granted a number of patents, among them being a clamping device for tappets, wheels or shaft couplings, and an improvement on a machine for making tubes and tires.

Mr. Canda became a member of the Society in 1916. He died at his residence in Elizabeth, N. J., February 8, 1917.

FRANK EUGENE HOLT

Frank Eugene Holt was born at Holyoke, Mass., in 1856. He served his apprenticeship with Eddy and Stone, of Worcester, Mass., and between 1876 and 1893 was associated with The Washburn & Moen Manufacturing Co., during which time he was in charge of their Union Street shop, and did work in connection with the erection of rolling mills for that company. In 1893 he accepted the position of master mechanic with the Spaulding & Jennings Co., and when this plant was absorbed by the Crucible Steel Company of America, he went to the Singer Manufacturing Co. to design and erect a rolling mill to produce small steel shapes, and thereupon was put in charge of the power houses of the company, at the Elizabethport factory, and performed advisory duties in connection with the power operation of their plant at St. Johns, Canada.

At the time of his death, Mr. Holt was President of the Singer Club, and a member of the Singer Engineering Society. He joined the Society in 1900. He died on February 4, 1917.

CAPTAIN WILLIAM HENRY JAQUES

Capt. William Henry Jaques was born in Philadelphia, Pa., December 24, 1848. He received his early education in the schools of New Jersey and entered the United States Naval Academy as midshipman in 1863. He graduated from the Academy with honors in 1867 and was detailed for active service immediately. He became ensign in 1868, master in 1870, and lieutenant in 1871. At various times he performed duties as aide to the President, the Secretary of the Navy, and the Commandant of the New York Navy Yard.

Between 1870 and 1874 he was assistant in the United States Coast Survey; from 1874 to 1878 he assisted the New York Board of Education in technical education; in 1881-1882 was assistant inspector of ordnance; and from 1883 to 1885 member and secretary to the Senate Committee on Ordnance and Warships. During this time he succeeded in introducing the system of fluid compression and hydraulic forging of heavy masses of steel, and was the inventor of many improvements in the manufacture of heavy ordnance and armor and the leading exponent of employing nickel in steel.

Captain Jaques resigned his commission in the Navy in 1887 to accept a position with the Bethlehem Steel Co. as ordnance engineer. In 1894, having successfully carried out the various developments he had advised, he retired. Soon after he associated himself with Horace See, eminent engineer and architect, in general engineering and consultation in connection with the manufacture and treatment of guns, armor, and other war material. In 1895, at the request of the governor of New Jersey, he began the organization of a naval reserve for that state and was commissioned captain. He held this command until 1898, when loss of health compelled him to resign.

Although he had already done his full share in bringing the ordnance and armor of the United States to a high standard of excellence, he undertook in 1897 the development of submarine torpedo boats and accepted the presidency of the Holland Submarine Boat Co. In 1909 he became president of the Hampton Water Works Co., Little Boar's Head, N. H., and in 1913 president of the Progress Mfg. Co., Boston, Mass., which offices he held at the time of his death, October 23, 1916.

Captain Jaques was the author of numerous monographs and books on heavy ordnance, armor, torpedoes, solar radiation, etc., and was an authority on water engineering. He was one of the international jury on marine transportation and war material at the Columbian Exposition of 1893.

Besides being a Member of the Society (1893), he was also a life member of the Society of Naval Architects and Marine Engineers, and a member of the American Institute of Mining Engineers, the American Society of Civil Engineers, the Iron and Steel Institute, the Institute of Civil Engineers (Great Britain), the Institution of Mechanical Engineers (Great Britain), the Institution of Naval Architects (Great Britain), and other organizations.

PAUL H. KENDRICKEN

Paul H. Kendricken was born in Galway, Ireland, in 1834. He set sail for America as a lad of seven, and landed in Boston in 1842. In 1852 he went as an apprentice to Walworth and Nason, then considered pioneers in steam and hot water heating of houses, and then became associated with the Union Steam Gauge and Low Water Detector Co. In 1859 he was put in charge of the steam works of the Massachusetts Steam Heating Company, and was later promoted to acting superintendent.

Not long after, he entered the Naval Service as third assistant engineer, was promoted to second assistant engineer, and remained in active service until the end of the war. At its termination he became associated with Clagston and Company, for whom he acted as superintendent. After some changes, the firm became Ingalls & Kendricken, and under Mr. Kendricken's guidance developed into a successful business. The firm was incorporated in 1905, Mr. Kendricken remaining as president and treasurer until the time of his retirement, five years ago.

Mr. Kendricken held various public offices, including that of councilman, alderman, state senator, park commissioner for the City of Boston, etc. He was also a member of the Executive Committee of the National Association of Master Steam Fitters.

He became a member of the Society in 1910.

JOSEPH STEHLIN

Joseph Stehlin, who was born in New York City in 1875, received his early education in the public schools here, and later in the Stevens Preparatory School and the Stevens Institute of Technology, graduating from the latter in 1898 with the degree of M.E.

Directly upon leaving school, Mr. Stehlin entered the drawing-room of P. Pryibil and soon after that of C. W. Hunt & Co. His shop experience was obtained while with J. Rupert and as assistant engineer with the Nestle Food Co., 1899. In 1900 he became associated with the N. Y. C. & H. R. R. R. as assistant mechanical engineer, and in 1903 became mechanical engineer, superintending erection of power stations, cooling plants, water stations, lighting, and power and steam equipment of yards and buildings. He severed his connection with the N. Y. C. & H. R. R. R. in 1906 and founded the Stehlin-Miller Henes Co., steam and electric engineers and contractors. In 1908 he became also associated with the Farmers Feed Co., of which his father was president, and in 1909, upon the death of his father, he succeeded to the presidency of the company and continued so until the time of his death, January 22, 1917.

Mr. Stehlin was elected an Associate in the Society in 1905.

KENNETH TORRANCE

Kenneth Torrance was born in Brooklyn, New York, in 1863. He went to Stevens High School for one year and then to Stevens Institute, and graduated with the class of 1884. He remained an active alumnus throughout the rest of his life and founded an enthusiastic association of Stevens alumni in Schenectady.

After leaving college he went to the Worthington Pump Co. and was later with the Brooklyn Water Works as Superintendent of the Ridgewood and all the Long Island pumping stations, which position he filled until 1906. He then joined the General Electric Co. to take charge, at its Schenectady Works, of its power stations, pumping stations, water, steam and compressed air systems, heating, etc. He carried out the reconstruction of the entire heating system for this works and was responsible for the design of all heating for the many new buildings erected at this works during his connection with the company. He carried out extensive additions to the power plants which resulted in very successfully meeting most extraordinary requirements in connection with emergency power supply, steam for testing, etc. He was actively connected with the development of the steam flow meter.

Kenneth Torrance had a rare gift for handling men. In Brooklyn and later in Schenectady he held the loyalty and respect of those under him as few men do. He had a host of friends, and wherever he went he made more.

He was a member of the Society for many years and also of the American Waterworks Association, the Society of Engineers of Eastern New York, the Schenectady Stevens Club, the Delta Tau Delta fraternity, the Mohawk Club, and the Mohawk Golf Club.

He died on September 13, 1916, at Mount Kineo, Maine, where he had gone to convalesce after a severe illness.

AMONG THE SECTIONS

SINCE the last issue of The Journal went to press, the President made an extended trip, which took him as far west as the Minnesota Section whose headquarters is at Minneapolis–St. Paul. En route he visited the Sections at Buffalo, Chicago and Indianapolis. At each of these places he received a rousing welcome and his spirited address on Service to the Country in This Crisis brought forth enthusiastic responses.

Although he has as yet been in office less than four months, Dr. Hollis has already visited ten Sections and eight Student Branches, addressing several thousands of engineers. He has spent a total of thirty-four days in these activities, which are additional to the time consumed in the attendance at Council and various committee meetings and in carrying on a voluminous correspondence relative to the Society's business.

As the present issue of The Journal goes to press the Secretary is starting on a trip to visit Sections and Student Branches not covered by other officers during the current fiscal year. These will include the Sections at Cincinnati, Chicago, Milwaukee, and probably Kansas City, where the members are considering organizing a Section. Several Student Branches will also be covered.

These data will serve to emphasize the national importance of the Society, which now boasts of twenty Sections located in sixteen States of the Union. It is the ambition of the Secretary that each Section and Student Branch receive a visit at least once a year by one of the Executive Officers of the Society.

Recently a visit was made by Prof. L. P. Breckenridge to the Sections at Atlanta and New Orleans, and these places wholesomely entertained the representative of the New Haven Section, and received in return the benefit of many valuable suggestions as to the methods the New Haven Section pursues

in developing engineering coöperation in Southern New England.

In the March issue of The Journal on page 241 there appeared a report presented at the Conference of Section Delegates at the last Annual Meeting, entitled Suggestions Regarding Local Section Activities. Mr. D. Robert Yarnall was one of the Committee to prepare this report and his name should have been included with Messrs. H. R. Setz and W. G. Starkweather.

SECTION MEETINGS

ATLANTA

February 5—The members of the Atlanta Section devoted February 5 and 6 to the entertainment of Prof. L. P. Breckenridge, Mem.Am.Soc.M.E., who visited their city. At a luncheon tendered him, Professor Breckenridge spoke of the advantages of the different sections and told of the activities of the New Haven Section. It was felt that his talk was a great incentive to the members of our Section.

Earl F. Scott,
Section Chairman.

BALTIMORE

March 13—A meeting of the Baltimore Section was held in the Engineers' Club and was addressed by John T. Broderick. The following resolution was moved and seconded and adopted by the Section, subject to approval by the Council of the Society.

> "In view of the grave crisis which our country is facing, and in recognition of the stand recently taken by the President of the United States for the protection of American rights and American lives on the sea.
>
> "BE IT RESOLVED that we, the members of the Baltimore Section of the American Society of Mechanical Engineers, at a meeting held Tuesday, March 13, 1917, first do pledge ourselves to the support of the President and Congress in maintaining our rights; and, second, we pledge our services to our country in case it is forced into war as the only means of securing and maintaining these rights.
>
> "BE IT FURTHER RESOLVED that a copy of this resolution be sent to the President, at the White House, at Washington, and to Senators and Representatives."

Mr. Broderick, who holds the position of Supervisor of Special Bureaus on the Baltimore and Ohio Railroad, gave an address on Safety Work on this road, showing moving pictures that this company uses to impress the Safety First idea on the men. Mr. Broderick said in part: "In the 'Safety First' movement which swept the country during the fall of 1911, the Baltimore and Ohio was the first company in the East to organize a definite campaign against personal injury to employees, renewing its efforts to safeguard passengers and its property. In the words of President Daniel Willard, the principle took precedence 'over everything else,' and still does with unabated sincerity of purpose.

"'To perpetuate the propaganda of Safety First, the Railroad has resorted to every practical means of education—precept, instruction, example, proof and discipline. A General Committee was organized in Baltimore, serving on which were the officials best adapted to the preachment of safety. Upon the various divisions, Divisional Committees were formed consisting of the superintendents and staffs as permanent members and men from the ranks selected every three months. The General Committee held mass-meetings at principal terminal points along the system, attracting large crowds of railroad men, at which addresses were made by the Committeemen and stereopticon views shown, all portraying various phases of the subject—Safety—and its allied subject—'Health and Sanitation.' Such Division Committees meet once each month, and at these gatherings receive and record many of the suggestions made by the employees themselves. The men enter into the spirit of the campaign, and divisions vie with one another to head the list of decreases in accidents. Last year the men on these Committees made 17,000 suggestions for improving working conditions, 96 per cent of which were recorded and acted upon. . .

"Through the maintenance of the 'Safety First' Bureau, which has direct charge of this work, supervising the organization and work of the Divisional Committees, thoroughly organized and sustained efforts are being made to reduce accident on each division of the System to the minimum."

A. G. Christie,
Section Secretary.

BOSTON

March 8—A joint meeting was held by the Boston Section and the American Institute of Electrical Engineers. W. B. Potter, Mem.Am.Soc.M.E., spoke on Electric Transmission for Motor Cars.

Mr. Potter illustrated his lecture with many interesting lantern slides, dividing his subject into the application of this system of propulsion to railroad cars and to automobiles, and tracing the development of the system within the last two or three years to its present condition.

W. G. Starkweather,
Section Secretary.

BUFFALO

April 14.—The Engineering Society of Buffalo will hold a meeting at the Hotel Statler, at which time there will be a discussion of Educational Systems and Apprenticeship Systems.

February 15—A resolution was passed for a preparedness post-card canvass, asking each of the 600 members to state in what way he would be most proficient in time of war and if he would be willing to volunteer his services.

Charles F. Kettering, Mem.Am.Soc.M.E., Vice-President of the Dayton Engineering Laboratories, gave a most interesting lecture on the evening of February 28, taking as his topic Pure Science Applied to Engineering, mixing humor, wit, politics, story and reminiscence with technical considerations. He showed many articles of common commerce which science has made possible, finding a substitute for scarce genuine material. He discussed the fundamental side of research, and his reminiscence concerning many problems of the experimental research engineer was of an interesting nature.

March 7—An enthusiastic and very large audience listened to addresses on March 7 by Dr. Ira N. Hollis, Pres.Am.Soc.M.E., John Younger, Mem.Am.Soc.M.E., William Elmer, Mem.Am.Soc.M.E., Major Frank S. Sidway, A. Conger Goodyear, Evan Hollister, Charles M. Manly, Mem.Am.Soc.M.E., and Herbert A. Meldrum.

Dr. Hollis spoke on Services to Our Country in This Crisis, explaining the condition of this country and impressed upon his audience that the only way to overcome this inefficient state is by unity of purpose, coöperation with our fellow workers, loyalty to our country and preparation for war against war, and showed the part the engineer must take. Mr. Younger told of classes being formed for the instruction of men in field fortification, telephony and transportation so that if necessary this city will be able to send trained men into the field. Mr. Elmer followed with a description of the part the railroads will play in time of war. Major Sidway urged action on the training of youth. Mr. Meldrum said that the mobilization of the troops on the border had shown the great need for military training and that it was time for the country to act. Mr. Goodyear urged the furtherance of the officers' reserve corps and defined its duties. Mr. Hollister spoke on compulsory military training, followed by Mr. Manly, a pioneer of aviation in the United States, who advised people to show their sentiments on the topics of to-day by continually urging their congressmen to carry out their program.

Louis J. Foley,
Assistant to Secretary.

DETROIT

April 20—J. W. Lieb, Mem.Am.Soc.M.E., will be the speaker at the meeting of the Detroit Section, taking as his subject Leonardo da Vinci—Artist, Philosopher and Engineer.

INDIANAPOLIS

March 12—A meeting held by this Section with the Engineers' Club of this city was addressed by Ira N. Hollis, Pres.Am.Soc.M.E., the subject discussed was the Relation of the Engineer in Civil Life to the Present National Crisis. A committee was

... services of the Engineers' Club with which ... affiliated to the government and also to the state and ... for such service as the emergency might indicate ... suitable for them to render.

W. H. INSLEY,
Section Chairman.

MERIDEN

March 9—At the regular monthly meeting of the Meriden members of the A.S.M.E. on March 9, Frank L. Rowntree, Mem. Am.Soc.M.E., spoke of the growth of the Society in Meriden; Charles N. Flagg, Jr., Mem.Am.Soc.M.E., read a paper on the Isolated Power Plant, after which the meeting was opened for general discussion, remarks being made by J. A. Hutchinson, Mem.Am.Soc.M.E., D. P. Griswold, Herman Minkwitz and C. K. Dechard, Mem.Am.Soc.M.E., and others. The next meeting will be held on April 5.

NEW ORLEANS

April 2—The New Orleans Section will hold a meeting, at which the subject for discussion will be Preparedness. The principal paper will be given by A. M. Lockett, Mem.Am.Soc.M.E. and member of the Naval Consulting Board which made the recent industrial census for the army and navy.

NEW YORK

March 13—Mobile Armaments formed the subject of a paper by Andrew M. Coyle, Mem.Am.Soc.M.E., before the New York Section at this meeting. The timeliness of the subject was responsible for an unusually large attendance.

Mr. Coyle, who is with the Board of Coast Defense Engineers, U.S.A., outlined the necessity for an adequate system of mobile guns of both large and small calibre, mounted on railway cars, that could be quickly moved from place to place to protect the numerous stretches of coast line between the fortifications which now guard the approaches to our important harbors. He showed a number of pictures of armored cars now in use along the European battlefronts, and told in a general way what is being done in this country. The speaker showed the various means that have been developed to take up the recoil and briefly mentioned a new device now being worked out by the army engineers in which this problem has been greatly simplified. In the discussion that followed, L. W. Luellen described and illustrated the Luellen-Dawson system of mounting mobile guns—a system that requires permanent concrete bases over which the car is run and the gun is mounted.

A. D. BLAKE,
Section Secretary.

PHILADELPHIA

April 24.—There will be an entertainment for Dr. Ira N. Hollis, Pres. Am.Soc.M.E., by the Philadelphia Section at the Engineers' Club.

March 15—A joint meeting with The Franklin Institute was addressed by Jerome C. Hunsaker, assistant naval constructor, Navy Department, Washington, on Design, Construction and Equipment of a Modern Military Aeroplane.

Mr. Hunsaker spoke of the importance attached to the mastery of the air by those engaged in the present conflict in Europe and the efforts made to gain and maintain this prestige, emphasizing the extreme rapidity with which different types were evolved, due to the keen competition for supremacy. The speaker illustrated his remarks with lantern slides, and moving pictures were also shown of the first air flights in this country by the Wright brothers and of various air crafts in Europe, among the latter of which was the destruction of a German aeroplane by French machines, and 5000 ft. drop in a parachute from a kite balloon.

W. R. JONES,
Section Secretary.

PROVIDENCE

April 23—The Providence Engineering Society will hold a meeting which has been arranged by the Efficiency and Scientific Management Department. The subject will be Routing-Principles, Machine Symbols, etc.

ST. LOUIS

April 18—At this meeting one of the leading refrigeration engineers of St. Louis will give a talk on Refrigeration Problems of a Modern Hotel.

STUDENT BRANCHES

THAT the spirit of coöperation existing in the engineering profession is extending to our coming engineers, is reflected in the plans for joint meetings of Student Branches on the Pacific and Atlantic Coasts and in the Middle West.

On March 24 a joint meeting of the Branches at Leland Stanford University and the University of California was held at the latter university. As this is taking place as The Journal goes to press a detailed account of it must be deferred until the May issue.

Meanwhile, in the East, a committee of Student Members is at work perfecting plans for a joint meeting of the Branches at Brooklyn Polytechnic Institute, Columbia University, Lehigh University, New York University, Rensselaer Polytechnic Institute and Stevens Institute of Technology. Representatives of Cornell University and Ohio State University will also probably be present. In all, more than three hundred students are expected to attend, making this the largest meeting of students ever held under the auspices of the Society.

The meeting will be held at the Engineering Societies Building in New York on Friday, April 13. A professional session will begin at 5 p. m., which will be addressed by Prof. Arthur M. Greene, Jr., Member of Council Am.Soc.M.E., and Prof. Lionel S. Marks, Mem.Am.Soc.M.E., and probably also by Prof. Robert H. Fernald, Manager Am.Soc.M.E., Prof. Charles E. Lucke, Mem.Am.Soc.M.E., and General Leonard Wood.

A buffet supper will then be served, followed by a smoker. During the evening, entertainment will be furnished by college glee clubs, mandolin and banjo club, professional entertainers, etc., and light refreshments will be served.

At the Spring Meeting in Cincinnati (May 21-24) a third joint meeting of Student Branches will be held. This will take place at the University of Cincinnati, and it is expected that all of the Student Branches in that Section of the country will participate, including those at the University of Cincinnati, Purdue University, Ohio State University, Case School of Applied Science, Carnegie Institute of Technology, University of Pittsburgh and State University of Kentucky. This is the first time such a gathering has been held in connection with a general meeting of the Society, and it is hoped all branches who can do so will make every effort to participate.

During the past month the list of Student Branches was brought to a total of forty-five by the addition of the University of Oklahoma, at Norman, Okla. Prof. J. H. Felgar, Mem.Am.Soc.M.E., Dean of the College of Engineering and Director of the School of Mechanical Engineering, has been appointed Honorary Chairman of the Branch.

ARMOUR INSTITUTE OF TECHNOLOGY

January 31—The meeting of the Student Branch of the Armour Institute of Technology was devoted to discussions by students on subjects of mechanical interest. N. Steindler explained in detail the Construction of a Water Softener. B. Robecheck followed with a paper on Heat and Emulsion Test of Oils. Mr. Kerr's subject was The Compression of Air and Mr. Bretting told of the By-Products of the Forests.

On Wednesday evening, February 14, Prof. George F. Gebhardt, Mem.Am.Soc.M.E., spoke on Advice to the Engineer, which was received with much appreciation by the members.

Mr. Sweniford and H. S. White were the speakers on February 28. Mr. Sweniford gave an illustrated talk on Safety Engineering, explaining the different ways in which accidents occur and may be lessened. His illustrations showed many ways of protecting machines in machine and wood-working shops. Mr. White followed with a very clear description of the Wood Dual Electric.

A smoker was held on March 7, to which both freshmen and sophomores were invited. This was a form of get-together movement in which each member of the branch endeavored to make the lower-classmen feel that they would be cordially welcomed at all meetings and aided in taking up the work when their turn came.

E. W. Harris,
Branch Secretary.

BUCKNELL UNIVERSITY

March 5—The Student Branch of Bucknell University held its last regular monthly meeting, F. E. Benedict and C. J. Hay giving the addresses.

Mr. Benedict gave a very comprehensive talk on Railroad Machine Shop Practice. He was followed by C. J. Hays, who spoke on The Modern Gas Producer Practice, giving a detailed description of a modern plant and also some data showing the rapid development of the industry in the last decade.

C. M. Kriner,
Branch Secretary.

UNIVERSITY OF CALIFORNIA

February 14—On this date Mr. Chilcot '15 related his experiences as a scientific manager, taking the members theoretically through both the Chalmer and Ford Automobile Works and comparing the efficiency of the plants in the East with those of the West.

At a meeting on February 28, Professor Tour of the Mechanics Department of the University, read a paper on Entropy and its relation to Temperature. The pressure-volume analogy to entropy and temperature aided materially in making clear to the members just what entropy is.

A joint banquet is being planned with the Leland Stanford Jr. University Student Branch for the evening of March 24.

John H. Fenton,
Branch Secretary.

CARNEGIE INSTITUTE OF TECHNOLOGY

February 14—The regular monthly meeting of the Student Branch of the Carnegie Institute of Technology was held, when Prof. G. H. Follows, head of the Department of Machine Design, addressed the students on The Bull's Eye: Hitting It, Chasing It, Missing It, Often. He opened his talk with a description and brief history of the science of archery and likened the aims, successes and failures of the engineer to meet his goal to the archer's attempt to strike the bull's eye of the target. He pointed out that while all engineers strive to make a bull's eye, there are very few who can predict before a machine is built just what it will do when put into operation. Professor Follows concluded by recounting many interesting and some rather amusing experiences he has had during his career as a mechanical engineer.

J. H. Davis,
Branch Secretary.

CASE SCHOOL OF APPLIED SCIENCE

February 7—A regular meeting of the Student Branch of the Case School of Applied Science was held at the Case Club. John E. Washburn, Mem.Am.Soc.M.E., of the National Carbon Co., of Cleveland, O., gave a practical and interesting talk on the Heat Treatment of Iron and Steel. Mr. Washburn has had much opportunity to observe the peculiar characteristics of our industrial metals and was therefore in position to cite many interesting examples of the behavior of steel under heat treatment. To illustrate extreme properties obtainable by heat treatment, he displayed two rods made from the same piece of stock but differently treated. One of the rods possessed such strength that when secured in a vise, it could not be bent by one man's pulling at a distance of several feet from the jaws; on the other hand, the other was so weak that it could be broken by the fingers. The latter sample, he explained, if properly reheated and treated could be made as strong as the first.

March 14—Frederic A. Parkhurst, Mem.Am.Soc.M.E., was a guest of the Student Branch of Case School of Applied Science at their dinner and meeting.

Scientific Management was the topic of Mr. Parkhurst's talk. He traced the origin and development of the Taylor principles and described the elements requisite for the successful operation of that system. Mr. Parkhurst, who is organizing engineer of the Aluminum Castings Co., is to deliver a series of lectures on the same subject to the senior mechanical engineers, this being the initial talk.

A. Treuhaft,
Branch Secretary.

UNIVERSITY OF CINCINNATI

February 16—At the regular monthly meeting of the Student Branch of the University of Cincinnati, H. S. Ernst and A. W. Schneider, both seniors, gave the addresses. Mr. Schneider spoke on Mining Methods in Anthracite Coal Fields of the Lehigh Coal & Navigation Company in Pennsylvania. He pointed out the various duties and responsibilities of mechanical engineers in keeping all equipment in good repair and operation with shut downs. Mr. Ernst followed with Modern Automobile Production at the Willys Overland Company of Cleveland, Ohio. Starting with the parts of the car from raw stock, he added each part in its turn of assembly, until the car was completed. Designs, methods of machinery and intricate parts of the construction were fully explained by Mr. Ernst.

Henry A. Wolsdorf,
Branch Secretary.

COLORADO STATE AGRICULTURAL COLLEGE

February 19—The Student Branch of the Colorado State Agricultural College held a meeting, at which time the speakers were E. C. Johnson, M. L. Gorton and Prof. L. D. Crain, Mem.Am.Soc.M.E.

Mr. E. C. Johnson gave a paper regarding the methods and systems used in the Denver Rock Drill Machinery & Manufacturing Co. Mr. Gorton gave a talk in the form of advice regarding the value of summer work and the advantages gained which the college course cannot give. Professor Crain told of the methods used at other institutions which he visited recently, giving advantages and points of comparison, thus bringing those present into closer touch with other institutions doing a similar work.

E. C. Johnson,
Branch Secretary.

COLUMBIA UNIVERSITY

King of the Rails was the subject of the highly interesting and instructive moving picture shown before the United Engineering Society of Columbia University. Prof. W. I. Slichter, Mem.Am.Soc.M.E., and Professor of Electrical Engineering at the University, accompanied the picture with explanatory notes. It included a historical review of the transportation field, leading up to the development of the electric operation of the Chicago, Milwaukee and St. Paul R.R. over the Continental Divide. Professor Slichter gave some very interesting data concerning this development and went thoroughly into the scheme of power distribution.

John L. Kretzmer,
Branch Chairman.

UNIVERSITY OF ILLINOIS

February 22—The Development of the Locomotive in the United States since 1829, was the subject of a paper, with slide illustrations, by J. H. Westbay, '17. Announcement that four prizes for the best papers delivered before the Branch and sent to the judges in manuscript form, would be given by the Pi Tau Sigma, the honorary mechanical engineering fraternity at the University, was made at this meeting.

[illegible] G. I. [illegible] President of the [illegible] Machine Co., were the speakers. Mr. [illegible] explained the special types of [illegible] design and told of the manner in which the [illegible] machines are [illegible]. The talk was [illegible] pictures showing several of these [illegible] in making a block [illegible].

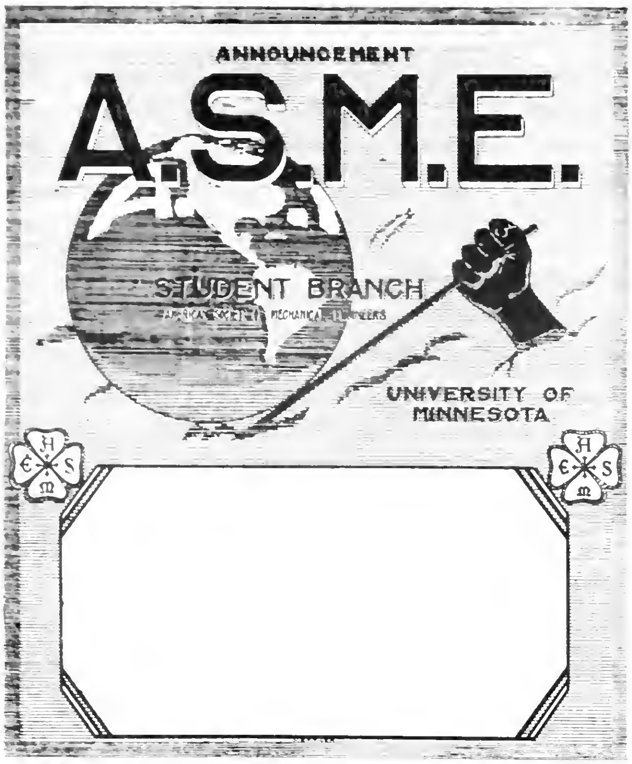
H. C. Dieserud,
Branch Secretary.

JOHNS HOPKINS UNIVERSITY

[illegible] 12—The Engineering Society of Johns Hopkins University [illegible] meeting of the year, with the Student Branch of the Am.Soc.M.E. in charge. Thomas W. Hind, of the Crown Cork and Seal Co., gave an instructive talk on the Harris-[illegible] Two-Cycle Diesel Engine, which he assisted in perfecting. With the aid of lantern slides he clearly showed its adaption to pleasure craft and boats of larger size, and gave among its many lucrative features the low fuel consumption, small upkeep and the simplicity of regulation.

[illegible] S. J. K. Shanahan, Secretary to the President of the Sparrows Point Branch of the Bethlehem Steel Co., gave a lecture [illegible] Ore to the Finished Product. Mr. Shanahan illustrated his talk by the use of moving pictures, thus showing in detail steps in the manufacture of steel from the mining of the ore in Cuba to the finished product ready for market. Both the talk and pictures aided greatly in giving the members clear and practical ideas on the methods used in the steel industry.

B. A. Sullivan,
Branch Secretary.



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LEHIGH UNIVERSITY

[illegible] 25—D. MacIsaacs '17 and W. A. Haupt of the Bethlehem Steel Co. were the speakers at the meeting of the Student Branch of Lehigh University.

Mr. MacIsaacs spoke on Subway Underpinning, describing in detail the different methods and the reasons for underpinning. Mr. Haupt's subject was The Bonus System of the Bethlehem Steel Co. He stated that the cost of work depends upon having proper equipment, systematizing and planning the work and also upon obtaining the coöperation of the men. The last was secured through the bonus system. He explained the different methods of the system and showed how each was beneficial to both men and company.

F. M. Porter,
Branch Secretary.

LELAND STANFORD Jr. UNIVERSITY

February 7—H. P. Miller, Jr., '17 discussed the Lining of Tunnels with Reinforced Concrete at the meeting of the Stanford University Student Branch. He explained the various types of tunnels required on a hydro-electric development and described in detail the methods employed in lining those of the high-pressure type. The collapsible forms used and the manner in which they are set up in the tunnels was illustrated by means of sketches. He next explained the apparatus used for forcing the concrete into the tunnel through steel pipes under pressure and the procedure in placing and pouring the molds so that the work can proceed without interruptions.

A. L. Morgan,
Branch Secretary.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

February 27—F. L. Fairbanks, Mem.Am.Soc.M.E., described briefly the general layout and features of the apparatus at the Quincy Market Cold Storage and Warehouse Co. The meeting was followed a few days later by a trip through the plant by about fifty men who were conducted by Mr. Fairbanks and other engineers. The visitors were much interested in a 1000-ton vertical ammonia machine designed by Mr. Fairbanks, his description of the troubles he encountered and the resulting new features embraced in the construction proving most interesting and instructive.

Edward W. Rounds,
Branch Secretary.

UNIVERSITY OF MICHIGAN

March 1—The Branch held a regular monthly meeting, with T. Tobey, Fred Sawin and A. E. Hecker as the speakers. Mr. Tobey's subject was Fuel Oil Testing and he discussed the production of fuel oils from the raw material, the government specifications for purchasing of oil and the advantages of oil over coal as a fuel. In his paper on Alcohol as a Fuel, Mr. Sawin brought out the fact that the raw material was unlimited in supply and spoke of the special design of engines burning alcohol. Mr. Hecker showed the distribution of concrete from the mixer to the forms by the most modern methods in his lecture on The Mechanical Handling of Concrete, which was accompanied by lantern slides.

Karl Bintz,
Branch Secretary.

UNIVERSITY OF MINNESOTA

The accompanying novel and attractive poster has been designed by one of the members of the Student Branch of the University of Minnesota. The original, which measures 11 in. by 13 in., is to be used by the branch to announce its meetings; notice of these will be inserted in the blank space provided for that purpose.

February 12—An illustrated lecture was given by Mr. Goetzenberger, '14, on Power Driven Machinery. E. F. Jones and A. E. Rosenbloom discussed seminar subjects.

March 11-12—The branch held their annual meeting and were most fortunate in having Dr. Ira N. Hollis, President Am.Soc.M.E., address them. Dr. Hollis gave an extremely interesting talk which defended the profession against the assertion that machines have no emotional appeal, pointing out clearly that one who does not feel such an appeal has not the nature to be inspired by it.

Harry G. Fortune,
Corresponding Secretary.

UNIVERSITY OF NEBRASKA

March 6—J. S. Kelley, a member, gave an interesting lecture on the Manufacture and Use of S. K. & F. Ball Bearings. Mr. Kelley illustrated his talk with slides secured through the Society by courtesy of the company.

Orlo A. Powell,
Branch Secretary.

NEW YORK UNIVERSITY

Instead of the regular meetings in March two inspection trips were made by the Student Branch of New York University. The first to the Singer Sewing Machine Company's plant at Elizabethport, N. J., where the conveyor or continuous system of casting sewing machine frames was of especial interest; the other to the De La Vergne Machine Company's plant in New York where the blast furnaces, drop forging department, automatic cam cutting machines and the rolling mill and work on the testing floor proved both interesting and instructive.

Joseph Gilman,
Branch Secretary.

OHIO STATE UNIVERSITY

February 15—The Student Branch of the Ohio State University held the first meeting for the second semester, when the following officers were elected: chairman, R. H. Wasson; vice-chairman, S. W. Bowser; secretary, F. E. Smyser; treasurer, R. R. Brown, and sergeant-at-arms, W. G. Owens.

March 7—H. W. Mowery, Mem.Am.Soc.M.E., and Mr. Morgan, Safety Expert of the Norton Mfg. Co., were the speakers at this meeting.

Mr. Mowery, who is connected with the American Abrasive Metals Co., spoke on Slipping Hazards, illustrating various slipping surfaces such as poorly constructed steps and other conditions in industrial life which are the cause of many accidents. The speaker stated that the companies taking precautionary measures to prevent such accidents were not only preventing them but were saving money in so doing; the application of the product which his company manufactures was also shown. Mr. Morgan followed with some general ideas on safety work describing how his company has saved money by the prevention of accidents.

March 8—An interesting paper on The Werkspoor Diesel Oil Engines was read by Mr. Rehn, a member of the senior class.

March 13—A large meeting was addressed by Ira N. Hollis, President Am.Soc.M.E., on Armed Neutrality of the United States and Will It Lead to War. Dr. Hollis explained the position of the engineer, who is the fundamental cause of all history and the basis of all civilization; he said that the real issue of this war is citizenship and the result shall be the life and triumph of democracy.

F. E. Smyser,
Branch Secretary.

OREGON STATE AGRICULTURAL COLLEGE

March 11—The Use of Powdered Coal as a Fuel was the subject of a paper by Mr. Thorne. Plans for future meetings were discussed and the committee reported on the new constitution.

Archer O. Leach,
Branch Secretary.

PENNSYLVANIA STATE COLLEGE

February 8—The Pennsylvania State College Student Branch held a regular meeting, when C. W. Holmberg '17 discussed Surface Resistence of Materials. This was followed by a description of the boiler test recently made by the senior mechanical students at Harrisburg.

At a meeting of the student branches of the various engineering societies, R. L. Sackett, Dean of the School of Engineering, and Arthur Holmes, Dean of the General Faculty, told of the proposed plan to publish an engineering paper in which each department of the School of Engineering will coöperate.

James A. Mease, Mem.Am.Soc.M.E., has resigned as Associate Professor of Machine Design at the College to take up other work. Practically every member of the Student Branch attended the farewell dinner tendered Professor Mease to express their sincere regrets at the loss of his active interest in the Student Branch, and to wish him every success in his new work.

Robert R. Rinkenbach,
Branch Secretary.

UNIVERSITY OF PITTSBURGH

March 8—The first meeting of the Branch was held on Thursday, March 8. Thomas Preston read a paper on Protective Coatings for Steel to Prevent Corrosion. [illegible] pared discussions by W. Thomas and [illegible]

[illegible]
Corresponding Secretary.

POLYTECHNIC INSTITUTE OF BROOKLYN

March 3—The Student Branch of the Polytechnic Institute of Brooklyn held a meeting, with B. Postman '17 as the speaker.

Mr. Postman illustrated his talk on Coal Gas Manufacture and Purification with cuts and diagrams. He gave a brief history of the first application of coal gas to useful purposes, going through all stages of the manufacture and purifying of the gas, clearly describing the apparatus used in each step.

George Chuer,
Branch Secretary.

PURDUE UNIVERSITY

February 20—W. T. Miller, Purdue '16, efficiency engineer with the Lafayette Boxboard Plant, spoke on the process of boxboard manufacture, at the meeting of the Student Branch of Purdue University. Mr. Miller spoke also of the efficiency work which has been carried out by this company which proved of much interest as this plant has been tested many times in the past by members of the faculty and of the student body and as a result has been equipped with all sorts of testing apparatus. Another result has been the increased efficiency of the power plant, which was originally designed for a 40 ton plant, to such a point that the present output is 102 tons per day. This was accomplished without any increase in the power equipment other than the addition of an economizer. Further tests on this plant will be made by the senior mechanical engineers under the direction of three of their body who will base their thesis upon it.

February 27—E. F. Hamilton, Purdue '14, with The Development of Radio Telegraphic Communication as his subject first gave a résumé of the history of the development of radio telegraphy, and then by means of formulae and diagrams brought out some of the more simple of its principles. His explanations were made more understandable by reference to actual pieces of apparatus which had been set up and connected to the University aerial. At the end of the meeting messages were intercepted from several stations, the sounds being heard by the audience through a megaphone to which a loud speaking telephone receiver was attached.

W. G. Schutt,
Branch Secretary.

RENSSELAER POLYTECHNIC ISTITUTE

March 5—Dr. Ira N. Hollis, Pres., Am.Soc.M.E., addressed the Student Branch and students of Rensselaer Polytechnic Institute. The Engineer and the National Crisis was the subject of his talk, which was both interesting and instructive, as it brought before the audience the important role the engineer may play in serving his country.

Eugene E. Harris,
Branch President.

VIRGINIA POLYTECHNIC INSTITUTE

March 10—A. H. Cox spoke on The Steam Turbine vs. the Steam Engine. He described the development of the engine and turbine, the natural applications and efficiency of each and the various types of turbines.

G. F. Minor,
Branch Secretary.

WASHINGTON UNIVERSITY

March 13—Training Workmen was the subject of a talk by Prof. Franz A. Berger, Mem.Am.Soc.M.E., at the meeting of the Student Branch of Washington University.

Professor Berger spoke in particular of vocational training and its development in foreign countries, illustrating his remarks with photographic views of the different shops and plants in general. He described one plant employing a very large force and building a

. . . of variety of machines, explaining in detail their system of apprenticeship and training.

Walter H. Kelz,
Branch Secretary.

UNIVERSITY OF WISCONSIN

January 11—Prof. G. L. Larson, Mem.Am.Soc.M.E., addressed the Branch on the benefits which could be gained from the organization. He also pointed out the advantages accruing from membership in the national society, to which the Student Branch is a stepping stone.

February 15—The election of officers for the following semester was the purpose of the meeting. The new officers are: President, Asher E. Kelty; vice-president, J. Frank Roberts; secretary, John M. Wood and treasurer, Arthur O. Bushholtz. On March 1 the members participated in a theatre trip.

March 11—Before a large audience, the past work of the Branch was reviewed by the president and new plans outlined; following this Prof. C. I. Corp, Mem.Am.Soc.M.E., and Prof. G. L. Larson, Mem.Am.Soc.M.E., incoming and outgoing Honorary Chairmen respectively, addressed the members.

Professor Corp pointed out the benefits to be gained by membership in the Branch, gave suggestions for coming meetings, emphasized the need for training in public speaking, and advocated Junior membership in the Society at the earliest date possible. It was also announced that Calvin W. Rice, Sec. Am.Soc.M.E., would shortly visit the Branch.

John M. Wood,
Branch Secretary.

WORCESTER POLYTECHNIC INSTITUTE

March 2—Victor W. Kliesrath, Mem.Am.Soc.M.E., gave an address on Modern Ignition Systems. Mr. Kleisrath divided his talk into two parts: in the first he gave a résumé of the progress of engineers along the subject of ignition systems, and in the second he brought home his points very effectively by means of lantern slides.

He described the spring type of magneto which the company first manufactured, taking his listeners step by step to the high-tension rotary magneto, then describing the new field opened up by the advent of the Dual and Duplex systems of ignition. Aided by the valuable apparatus which he had with him the speaker was able to demonstrate each type of which he spoke. At the close, Mr. Kliesrath exhibited a newly designed and built magneto for use on 12-cylinder engines, which will not appear upon the public market for several months.

H. P. Fairfield,
Branch Secretary.

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping anyone desiring engineering services. The Society acts only as a clearing house in these matters.

POSITIONS AVAILABLE

In forwarding applications, stamps should be enclosed for transmittal to advertisers; applications from non-members should be accompanied by a letter of reference or introduction from a member, such reference letter to be filed with the Society. Copy for notices must be in hand by the 15th of the month.

MECHANICAL ENGINEER, single, with experience in petroleom refining and training in Europe, for work in Mexico. State experience and education. 543.

ENGINEERS to train and develop in fundamentals of firm primarily engaged in distillation of coal tar, with resultant principal production of bituminous road and roofing materials. Ultimate object, filling operating positions in various plants as foremen, head chemist, assistant superintendents, or superintendents. Preferably men with chemical-engineering training. As contemplated work will eventually be executive, ability to handle men is desirable asset. 796.

DESIGNERS and SPECIAL ENGINEERS. High-grade technical engineers for heavy machine-tool and press designing; high-grade engineers capable of working out problems and designing conveying machinery for handling heavy material between machines; engineers to work out automatic press feeds, and layout draftsmen as assistants to head designers. Location Wisconsin. 871.

SALES ENGINEER, man 25 to 28, couple of years out of college. 879.

DRAFTSMAN who would invest some money in a prosperous shop and is familiar with horizontal return-tubular boilers and boiler-shop work in general. State age, experience and salary desired. Location New Jersey. 881.

DRAFTSMAN, first class, experienced in Corliss engines and heavy machinery for shop in Southern Ohio. Give all particulars in first letter. 888.

STRUCTURAL STEEL DRAFTSMAN. Salary depends on man. 889.

MACHINERY DESIGNER in steam-turbine department. Location Massachusetts. 894.

MECHANICAL or ELECTRICAL ENGINEERS, at least three years' training in technical school of standing, and one year's experience in some branch of electrical industry. Salary $90 per month. Location New York. 895.

OFFICE and FACTORY MAN with general experience. Must be qualified to investigate conditions of any department, report to office manager, and make suggestions of value. Salary to start, $20 to $25 per week. Location Connecticut. 896.

YOUNG ENGINEER on special-plant operation and investigation work in development of oil burners. Location Minnesota. 899.

MECHANICAL ENGINEER, 25 to 30, experienced in power pumps, power working heads as used in agricultural districts and pneumatic water-supply systems of various kinds installed to supply water for domestic use where waterworks are not otherwise available. Experience in design and construction desirable. Location Iowa. 900.

SALES ENGINEER. Technical knowledge of steam turbines, centrifugal pumps, fans and blowers essential. Selling experience desirable. Prefer college man under 30, with several years' practical operating experience and some sales work. First letter must contain complete record together with minimum salary. Location Pittsburgh. 903.

TRACER for drawings and blueprints and detail work in connection with engineering office. Location Pennsylvania. 905.

MASTER MECHANIC for lead-smelting plant, operating blast furnaces and concentrating mills; must be man of strong personality, capable of handling varied classes of mechanics. Give full details of education and experience. Location Utah. 906.

COMBUSTION ENGINEER, experienced in power-plant and stoker operation. Familiar with modern instruments. Location Philadelphia. 907.

ASSISTANT in setting premium wage rates in Ohio plant, manufacturing gas tractors. Young man who has had machine-shop experience. Excellent opportunity in line of work which is not crowded. College man preferred. 908.

SUPERINTENDENT of steel foundry. Strictly confidential. Eastern location. 909.

ASSISTANT to head of experimental department. Location New England. 911.

MECHANIC, high-grade, experienced in erecting machinery. Location Philadelphia. 913.

YOUNG ENGINEER to train in sales work in territory around New York and New England. Good personality and some commercial training. Salary $75 to $120 a month. 914.

DRAFTSMAN for same company as 901, accustomed to machine design, ventilating and heating work, to train in. Salary $18 a week to start. Location New York. 915.

SALES ENGINEERS to take charge of territory in Cincinnati, Indianapolis, Chicago, Detroit districts, or work can be handled by men working some other line. 916.

DRAFTSMAN for engineering department of New Jersey plant, with engineering education and experience; laying out and installation of new machinery in various departments of plant, providing for drives, foundations, etc., making drawings and plans for changes and improvements in equipment, and location, which include roofing, machinery, fire and steam stills for manufacture of asphalt, power equipment, crushing and conveying machinery. Salary $175 per month. 918.

STEAM EFFICIENCY ENGINEER for New York concern. Man thoroughly qualified, with operating experience and theoretical training. Duties involve traveling, principally examination of large steam-turbine plants, analysis of operation and introduction of improvements and economies. Position responsible and important. Salary adequate. Tact a requisite. Replies should give full record of qualifications and experience and should state salary. 921.

ASSISTANT CIVIL ENGINEER, CORPS OF CIVIL ENGINEERS U. S. NAVY. Examination will be held at the Navy Department, Washington, D. C. Address the Chief of Bureau of Yards and Docks, Navy Department, Washington, D. C. 924.

THREE DRAFTSMEN, pipe work, covering steam, hydraulic water, and air piping. Also machine designers and plant-layout men. Also first-class structural-steel and power-plant man. Location Ohio. 927.

DRAFTSMAN familiar with valve detail and design and with experience on estimating and layout work. Excellent opportunity for competent man. State age, experience in detail, references and salary expected. Apply by letter. Location New York State. 928.

HIGH-GRADE DESIGNER on hydraulic machinery. Permanent position. Must be reliable and have capacity for work. State age, nationality, experience, and salary expected. Location Michigan. 929.

ASSISTANT ENGINEERS, one to be responsible for the layout and installation of mechanical equipment in connection with power plants and industrial-building design; the other, a man who can take the responsibility of complete design on industrial buildings and write specifications. Positions pay $2,000 a year. Location Connecticut. 930.

ASSISTANT TO PURCHASING AGENT, to take care of engineering specifications and contracts and act as consulting engineer; position calls for general experience in mechanical engineering and in all matters relating to construction. Location New York State. 932.

MEN AVAILABLE

Only members of the Society are listed in the published notices in this section. Copy for notices should be in hand by the 15th of the month, and the form of the notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

RAILWAY MECHANICAL ENGINEER, at present employed, age 37, technical education. Seventeen years' experience as railway machinist, draftsman, chief draftsman and mechanical engineer. Desires position with railway company, railway supply house or industrial plant, with greater responsibility and opportunity. Location immaterial. Salary $2400. D-118.

FUEL TESTING ENGINEER. Graduate, age 34. Seven and half years' experience in scientific testing of coal in industrial plants, for large coal company in Middle West. Desires position as combustion engineer for large user of coal. At present employed. D-119.

SALES ENGINEER. Graduate, [illegible] and selling of coal. Desires position [illegible] operating company. At present employed. D-120.

SUPERINTENDENT OF MACHINE SHOP or MASTER MECHANIC. Graduate M. E. High-grade tool designer and expert in standardization of product. Good organizer and executive with [illegible] years' practical experience in manufacture of high-grade machinery and precision tools. Salary $3600. D-121.

RESPONSIBLE POSITION with manufacturing or consulting engineering firm or with a high-grade school of technology desired by mechanical engineer with ten years' experience in machine shops and engine works. Fifteen years as head of a well-known engineering school. East preferred. D-122.

MECHANICAL AND DIESEL-ENGINE ENGINEER, with practical and theoretical experiences, who held successfully executive positions in design and manufacture of, and experimenting on marine and stationary Diesels in Europe and in America, desires to associate with engineering concern contemplating building Diesels, or already producing oil engines. Best references of ability, business knowledge, etc. D-123.

INDUSTRIAL ENGINEER. Technical graduate, age 29. Three years' experience as designing draftsman of industrial plants, transmission machinery and labor-saving devices. Past two years on industrial-engineering staff; experienced in time study, scheduling, planning, modern cost system, etc. Ability to increase production and decrease costs, standardize equipment and improve method of manufacture. At present employed but desires change. D-124.

WORKS MANAGER wishes to make change. Has had more than twenty years' experience, having for the past fifteen years held position as factory or production manager in plants employing from 800 to 1500 men. At present employed. D-125.

MECHANICAL ENGINEER. Technical graduate. Over 20 years' mechanical and executive experience. Now employed. Desires to locate with large manufacturing concern as chief engineer. None but high-class executive position will be considered, where waste and patronage do not prevail but efficient plant operation is demanded. D-126.

ASSISTANT MANAGER or SUPERINTENDENT. Will consider position as chief engineer or resident engineer. Location immaterial. D-127.

DIRECTOR or PRINCIPAL of trade or vocational school. At present director of trade school. Technical education. Twenty years' practical experience in machine work and teaching. Best references. Desires to make change. D-128.

CHIEF ENGINEER. Age 35. Desires position of responsibility with live company, as head of engineering department. Successful in designing with view of low-cost quantity production, interchangeability, etc. Has held present position eight years, in charge of engineering department and drafting office with large corporation in Middle West. Desires to locate where ability counts and greater opportunity for advancement exists. Salary $250 to $300 per month. D-129.

EXECUTIVE ENGINEER. Age 30. University of Wisconsin M. E. graduate. Seven years' experience in industrial plants and consulting engineering, embracing power-plant design and testing; specifications; reports; efficiency in power generation and utilization. Employed at present, but desires change to position with better prospects. Location preferred, Middle West. D-130.

YALE GRADUATE mechanical engineer. Six years' practical experience. Desires to change his position for one with either manufacturing company or consulting engineer. D-131.

SPECIALIST in design of boiler furnaces and boiler-room equipment. Mechanical engineer. Age 42. Twenty years' experience in power-plant design, construction and operation. Would take charge of power-plant-construction work; now superintendent of large power station. Present salary $3,000. D-132.

MECHANICAL ENGINEER. University graduate. Age 34. Ten years' experience in West on contract work, design and superintending construction of industrial plants and varied projects; operation and plant efficiency; plans, estimates and reports, design of special machinery. Now in charge of mechanical and civil engineering work for Western concern, but desires to make new connections. D-133.

STUDENT MEMBER. Bucknell University; graduate '17 in mechanical-engineering course. Three years' practical shopwork;

[illegible] D-134.

MECHANICAL AND ELECTRICAL ENGINEER. Graduate [illegible] years' experience [illegible] in present [illegible] position [illegible] Can produce results [illegible] power plant. Has $40,000 worth of [illegible] anywhere. D-135.

GENERAL MANAGER [illegible] MANUFACTURING EXECUTIVE. Age [illegible] Twenty-two years in various executive [illegible] shop foremanship to vice-president [illegible] in large establish[illegible] Experience [illegible] general, covering foundry and machine [illegible] and [illegible] including engines, turbines, blowers, [illegible] pumps, condensers, miscellaneous machine shop products, [illegible] parts, tools, jigs, gages, etc. Knows men and how [illegible] them. Expert in cost accounting and control. Has done [illegible] travelled extensively at home and abroad. Capa[illegible] charge of large plant. Satisfactory reason for desiring change. Highest references. Available thirty days. Location Philadelphia or vicinity. D-136.

MECHANICAL ENGINEER. Technical graduate, age 39. Twenty years' experience in shop and office on small intricate work, such as guns, type-setting machinery, typewriters, adding machines, and cash registers. D-137.

MANAGING EXECUTIVE. Age 37. Fifteen years' experience in mining, quarrying, and manufacture of gypsum and gypsum products, as purchasing agent, designer, and operating manager. Thoroughly familiar with the business in all branches, especially organization and development of efficient machinery and working forces and value of costs and their application to manufacturing. Desires responsible position with financially responsible concern in same or similar business, in which interest may be attained at later date. Now engaged in consulting work; free for appointment after April 1. D-138.

ENGINEER. Technical graduate, twelve years' engineering and manufacturing experience, combined with business and sales. Opportunity desired where technical training and with good business judgment will be of value. D-139.

FACTORY MANAGER or PRODUCTION MANAGER. Technical graduate, 31, ten years' experience in costs, efficiency engineering and factory reorganization and management. Trained in stopping leaks and increasing output. Reference to several concerns as to ability and results secured. D-140.

COMBUSTION ENGINEER. Age 30, married, technical graduate. Four years' experience in boiler-efficiency work, thoroughly familiar with hand and stoker-firing methods and handling boiler-room labor; anthracite or bituminous coal; former assistant smoke inspector of large city. Experienced in fuel analysis, furnace design and other essentials of boiler-room practice. Location preferred, 100 miles from Philadelphia. D-141.

MECHANICAL ENGINEER. Technical graduate, age 35. Eight years' practical experience in design, construction, erection, testing and maintenance of power-generating and distributing equipment. Fully competent to handle problems in station-betterment work. Can qualify as inspector of apparatus under construction. Has had A1 experience on boilers, turbines, steam, oil and gas engines, condensers and electrical equipment. Aggressive, resourceful and capable. Can furnish best references. At present employed as estimator and sales engineer, but desires larger field of action. Available on short notice. Location immaterial. D-142.

CHIEF ENGINEER. Graduate M.E. Age 35. Now construction and maintenance engineer in charge of construction, maintenance and power departments of large electrically driven dye plant; wide experience in construction and maintenance along both electrical and mechanical lines. Seven years chief engineer Western sugar factory. Four years erecting engineer for manufacturer of large steam turbines. Minimum salary $2750. D-143.

GRADUATE ENGINEER. Will graduate from mechanical engineering in June; two years' practical experience in machine-shop work, some experience in turbine design. Will accept any good position offering advancement. References available. D-144.

WORKS MANAGER or ASSISTANT TO EXECUTIVE. Mechanical engineer, age 37. Technical graduate. Fourteen years' varied experience in design, construction, and installation work, including ordnance, ballistic apparatus, hydraulic machinery and structural steel. Well grounded in the fundamentals of steam and electrical engineering. Thoroughly practical, with executive ability, and not afraid of work or responsibility. Location preferably East or South. D-145.

ASSISTANT PROFESSOR or INSTRUCTOR, if there are possibilities of advancement, in mechanical engineering. Degrees of E.E., M.E. and Sc.D. Six years' teaching experience in two of the leading technical schools and some in power plant work. Will be open for engagement after June 15. Location in or near New York preferred. D-146.

ASSISTANT SUPERINTENDENT, age 25, M. I. T. graduate. Experienced in woodworking and in the design of package conveyors. At present employed. Location preferred, New England. D-147.

MECHANICAL ENGINEER, age 31, married. Technical and practical shop work. Wide experience in testing of materials and equipment for large modern factory. Seven years' work on the designing, testing and installation of valves, fittings and steam specialties. Competent in getting out concise reports and business correspondence. Desires position where ambition and hard work are prime necessities. D-148.

WORKS ENGINEER or ASSISTANT WORKS ENGINEER. Mechanical engineer married, age 32. Graduated from prominent engineering school. Three years' experience in operation, erection and maintenance of large boilers, steam engines, gas engines, piping systems and small steam turbines. Three years' experience teaching mechanical, steam and gas engineering practice. Resourceful, tactful and can handle men. Will start at $2000 per year if with good concern, and there is opportunity for advancement and responsibility. Available July 1. D-149.

MECHANICAL ENGINEER with experience in the design and manufacture of aeroplane motors, also expert tool designer, desires executive position in connection with engineering department. Now employed. Location immaterial. D-150.

TECHNICAL GRADUATE, age 31, experienced as a general machinist in locomotive repairs, gasoline-engine construction, foreman in the motive-power department of a leading railway, draftsman in the manufacture of brass goods, pressure regulators and tools connected with the same, and, in the factory system connected with the latter position, desires to locate with a going concern in the industrial field with aim of developing into a position of responsibility. Other conditions considered. Prefers medium-sized cities of Middle West. D-151.

COMBUSTION ENGINEER, age 34, technical and practical. Ten years' experience in combustion and boiler-house efficiency. Familiar with large and small boiler-house practice, different types of boilers and stokers. At present employed by large concern, having produced their best results. Desires a change. Would like to connect with firm having large boiler house or chain of boiler houses requiring the services of a progressive man. Highest references. D-152.

MECHANICAL ENGINEER. Technical graduate with ten years' experience as draftsman and superintendent of construction desires position where his four years' railroad shop training and knowledge of works management will be of value. D-153.

MECHANICAL ENGINEER, age 25, technical graduate. Has machine-shop and drafting experience, knowledge of accounts and up-to-date efficiency methods. Desires position as assistant to executive or works manager. Successful experience as executive. Now employed. D-154.

POWER ENGINEER or FACTORY MAINTENANCE ENGINEER. Technical education and six years' experience in gas, oil, and steam plants, light, heat and power transmission, factory upkeep and extensions. At present employed. D-155.

ASSISTANT PROFESSOR in mechanical engineering or electrical engineering or similar position as supervising technical instructor. Graduate M.E. from one of the leading engineering universities. Eight years' experience in teaching engineering subjects. D-156.

MANAGER, ASSISTANT, SUPERINTENDENT, EXECUTIVE or SALES ENGINEER. Technical graduate in mechanical engineering; varied experience in mechanical, electrical, and civil engineering lines, involving design, inspection, reports, responsible charge of construction work, plant operation, management, purchasing, etc., in connection with power, lighting, and industrial plants, electric railways, etc. Salary $3,000-$3,600.—D-157.

ENGINEERING SURVEY

A Review of Engineering Publications in All Languages. All the leading periodicals of the engineering world, embracing over 1000 different publications, are received at the Library. These are systematically examined for review each month in the Survey.

SUBJECTS OF ABSTRACTS

Arranged in the Order of Their Appearance in the Survey

One of the most significant movements brought about by the European War is an intensification of scientific and engineering research. The reasons for this are fairly obvious. In the first place, it is due to the effort to satisfy the tremendous demand for war materials and necessities of life, where the supply of the latter has been interrupted. In the second place, the search for new ways and means of production is caused partly by the desire to make the country independent of foreign supply of basic essentials of manufacture; and further, it expresses the effort to pay the cost of the present struggle by a production increased in volume and more economical in method.

In the present issue, this tendency is exemplified by the article of Le Chatelier on Scientific Problems Awaiting Solution.

THIS MONTH'S ARTICLES

In the section Aeronautics attention is called to a description of sand-load tests on wings of a Curtiss flying boat.

Data on the structure of the coating of tinned sheet copper, in relation to a curious case of corrosion of this material, are reported from a Technologic Paper of the Bureau of Standards, of which an advance abstract has been courteously supplied to The Journal by the Bureau.

At Queens University, Kingston, Ontario, an investigation on cobalt alloys with non-corrosive properties has been carried out.

Also from an advance publication of the Bureau of Standards is reported a description of a specific-gravity balance for gases.

The limits of inflammability of gaseous mixtures form the subject of an investigation by Prof. W. M. Thornton, abstracted from the (British) *Philosophical Magazine*.

The engineering phases of smoke abatement are discussed by Osborne Monnett, who considers draft as by far the most important factor in the question of reducing smoke effectively.

An editorial in a British publication, *The Auto*, reports a discussion at the Midland Institute of Mining Engineers, Birmingham, England, on the use of benzol as a fuel in Great Britain after the War. The discussion is of particular interest because it covers the question of distribution as well as the more strictly technical features of use.

In the section Hydraulics will be found a description of a California water-power installation, claimed to constitute a record for low-head development. Its turbines are so designed as to handle hydraulic heads of but 8 ft. In this description particular attention is called to the design of the sliding-jaw clutches and the oil-pressure governor.

From the *Cornell Civil Engineer* is briefly abstracted a paper, by G. C. Brown, entitled Some Notes on Stream Flow. In addition to the information reported in the abstract, the paper contains highly interesting passages which could not be reported on account of lack of space.

Experiments carried out at Purdue University on carburetor performance have been reported by Prof. R. C. Berry in a paper before the Society of Automobile Engineers. They present coördinated data on the performance of the carburetor proper, apart from that of the engine, and show clearly the variation of output and efficiency of the engine as functions of fuel consumption.

A novel type of combustion engine invented in this country by R. M. Hvid is described by E. D. Blakely. While it works essentially on the same principle as the Diesel engine, its cycle is rather different from the latter.

The Railroad Engineering section contains three articles of interest. The question of superheat in locomotives is treated in an abstract of the discussion at the last convention of the American Railway Master Mechanics' Association.

A description of the application of Mogul running gear and machinery to a Mikado locomotive is taken in abstract from the *Railway Mechanical Engineer*.

From a paper by [illegible] Fowler are abstracted some [illegible] water conditions in the locomotive boiler which [illegible] [illegible] depend on the analysis of the raw [illegible] to determine the conditions prevailing [illegible] boiler.

[illegible] contain two articles de[illegible] subject, viz., power generation [illegible] Wilson describes the Ford [illegible] boilers. The editorial [illegible] devoted to the description [illegible] Company, presents data on [illegible] plant for 200,000 kw. capacity, in [illegible] kw., using pressures and superheats [illegible] ago would have been deemed practically [illegible]

Aeronautics

Sand Load Tests on Wings of Curtiss Flying Boat H-12, John H. DeKlyn and G. E. Hawthorn

The tests described here were conducted at the order of and according to the standard instructions of the British Admiralty. The wing was the largest ever tested in this country, the overall span being 92 ft. The wing on but one side of the boat was tested.

The loading required is given by the formula:

$$P = N(W + W_1 - W_2) - W$$

in which P = weight of sand on wing surface; N = required factor of safety; W = net weight of machine; W_1 = useful load carried, including gasoline, pilot, passenger, and any other useful load; and W_2 = weight of wings. The total load applied was 28,110 lb., of which the upper plane carried 69 per cent, or 19,400 lb.; and the lower plane 31 per cent, or 8700 lb.

As a result of the test (fully described in the original article) it was found that the wing withstood the load specified by the Admiralty instruction without permanent deflection or signs of failure.

An illustration of the strength of the wings is afforded by the fact that the wing was tested with a load of sixty people, amounting to 9930 lb., which is, however, only about half the maximum load. (*Aviation and Aeronautical Engineering*, vol. 2, no. 3, March 1, 1917, pp. 136-137, 2 figs. *c*)

Note on Stresses in Built-up Rectangular Bodies Due to Rudder Forces, Alexander Klemin and W. B. Ford

The article discusses the stresses in a body produced by a rudder when its center of pressure is fairly high above the center line of the body. In this case the wire and longeron stresses induced by the forces of the rudder are worked out for a single panel of a typical rectangular body, assuming the stabilizer to be 35 sq. ft., the elevator 11 sq. ft., the rudder 8 sq. ft., and the vertical fin 45 sq. ft., in area.

The rudder forces produce, first, bending in a vertical plane through the middle of the aeroplane; and second, twisting about the axis passing through the centers of the transverse diagonal wires in any panel. To allow for bending, it is sufficient to divide the rudder load equally between the upper and lower planes of the body, and to draw stress diagrams in these planes in the usual manner. A process is indicated to allow for twisting.

The article presents complete computations for one panel of a body under rather severe air-load conditions; these computations including also the landing stresses. The data are presented in the form of a table, showing, among other things, that the effect of the rudder loads is by no means negligible; while the air loading assumed (speed 100 miles per hour; rudder of 7 sq. ft. area, turned at 20 deg. simultaneously with stabilizer at 6 deg. and elevator at 20 deg.) is rather severe, it may well occur after a steep dive. In such an event the factor of safety would be considerably smaller than that which would follow from the ordinary calculations under Army specifications. Incidentally, it is shown that the stresses due to landing are sometimes of lower and sometimes of greater value than those obtained from the combined air loads, showing the advisability of carrying through both air- and landing-stress calculations. (*Aviation and Aeronautical Engineering*, vol. 2, no. 3, March 1, 1917, pp. 142-143, 4 figs. *t*)

Engineering Materials

The Structure of the Coating on Tinned Sheet Copper in Relation to a Curious Case of Corrosion of This Material, Paul D. Merica

The attention of the author has been directed to a curious and instructive case of local corrosion or pitting in tinned sheet-copper roofing. The pits occur in general along the line of surface scratches, having appeared some eight or ten years after completion of the roof. These pits are apparently unrelated to the service conditions and to the direction of rolling of the sheet.

A study of the structure of tin coating on copper has been made, and has shown that this coating consists of at least three layers, viz., a thin layer of Cu_3Sn immediately next to the copper, then a layer of Heycock and Neville's constituent N, containing about 60 per cent by weight of tin, and, finally, a layer of the eutectic of tin and copper, in which is found most probably also the lead when it is present in the tinning mixture. This coating in the case of the corroded sheet was thin, averaging about 0.012 mm. in thickness, and quite variable in both thickness and structure, varying from 0.006 mm. to 0.03 mm. in thickness. At many points there were breaks in the continuity of the alloy layer; at others, breaks in the continuity of the eutectic layer.

Etching experiments and measurements of electrolytic e.m.f. of these layers towards various solutions, such as water, dilute acids, and acids to which ferric or stannous chlorides had been added, showed that the constituents of these intermediate alloy layers are more electronegative, i.e., less corrodible than either the tin or the copper. Values were found for the e.m.f. of these alloy constituents against copper in various solutions varying from — 5 to — 80 millivolts.

When the copper becomes exposed, therefore, as in the present case at the bottom of the scratches on the surface, it forms together with the alloy layer a galvanic couple, electrolytic action sets in, and the copper at these points is corroded, forming the pits described.

Many instances are known, of course, of roofs of such material which have been in service for twenty or more years, under severer conditions as regards soot, smoke, etc., than were those under which the roofing in question failed, and which nevertheless have not shown signs of such pitting. Explanation of this variation in service rendered by different samples of the same type of roofing material must be sought in the variation of mechanical abuse, such as scratching, which it receives, and also in the uniformity of structure and thickness of the tin coating. (Abstract of *Technologic Paper No. 90*, Bureau of Standards, Washington, D. C., July 11, 1916.)

COBALT ALLOYS WITH NON-CORROSIVE PROPERTIES, Herbert T. Kalmus and K. B. Blake

Data of an investigation conducted at Queens University, Kingston, Ontario, for the Mines Branch of the Department of Mines, Ottawa, with a view to determining the use of cobalt as an inhibitant of corrosion.

The main purpose of the present investigation was to determine the effect of the addition of small quantities of cobalt on the atmospheric corrosion of iron and mild steel—in particular, very pure iron prepared by the open-hearth method for sheet roofing material.

The comparative effects of small amounts of cobalt, nickel, and copper were studied.

The experiments cannot be considered as conclusive, partly because of the methods used and also because no heat treatment was given to the alloys. But from these premiminary experiments it appears that additions of small percentages of either cobalt or nickel to very pure ingot iron add to its non-corrosive properties. When used in like amounts, cobalt seems to be more effective than nickel.

It was also found that the rust on the cobalt samples is more tenacious than that on the other samples, and particularly that it is of a much darker color and is removed by mechanical means with very much greater difficulty than the rust formed on very pure ingot iron containing no cobalt. In this connection it has also been found that annealed samples differ from unannealed in that for the annealed samples the rust is light in color and much more readily removed than in the case of unannealed ones.

In addition to ordinary corrosion tests with long exposure, a few accelerated corrosion tests were made on some of these alloys. These tests, which must be considered as only preliminary, would indicate that the addition of monel metal to American Rolling Mill Company ingot iron to the extent of about one per cent produces a more non-corrosive alloy for sheet roofing materials than the addition of similar small percentages of cobalt.

It has also been found that the addition of copper to American ingot iron to an extent between 0.25 and 0.75 per cent seems to be conducive to reducing the corrosion of this quality of iron under atmospheric conditions. It is difficult to say, however, whether or not the addition of copper in these amounts has a greater or less effect than the corresponding amounts of nickel or cobalt. (*Researches on Cobalt and Cobalt Alloys* conducted at Queens University, Kingston, Ontario, for the Mines Branch of the Department of Mines, Part IV Canada Department of Mines, Mines Branch, Ottawa, 1916, 37 pp., illustrated, *e*)

Fuel and Firing

ENGINEERING PHASES OF SMOKE ABATEMENT, Osborne Monnett

The writer states that if he were to answer the question: What are the three most important things in smoke abatement? he would be tempted to say: first, draft; second, *draft;* and third, DRAFT.

In investigating the smoke problem in Chicago, where he was formerly Chief Smoke Inspector, it was found that draft was so important as to overshadow every other consideration; and through a long series of investigations covering some thousand separate and distinct studies of boiler settings, the curve was developed (Fig. 1) which tells how much draft is needed for different rates of combustion. Roughly, the rule is this: We need 0.1 in. draft over the fire per pound of coal burned per square foot of [illegible] tells the story almost entirely [illegible] of the curve. Beginning with 0.15 in. per [illegible] fire, we are able to burn 15 lb. coal per square foot [illegible] surface per hour smokelessly. Cases can be cited [illegible] burned, but not smokelessly.

The limit rate of successful smokeless combu[illegible] fired units is about 28 lb. coal per square foot of grate surface per hour.

The rate of combustion in any plant is fixed, first, by the load. When the load is known, the ratio of grate surface to heating surface has to be fixed. These two factors decide the rate of combustion, and with these the curve will show how much draft is needed over the fire.

In laying out a stack it is necessary to know how much draft loss there is in the particular type of boiler setting selected, so as to know the proper amount of draft over the fire to be provided. This loss runs from 50 to 65 per cent of the draft available at the stack side of the damper. For

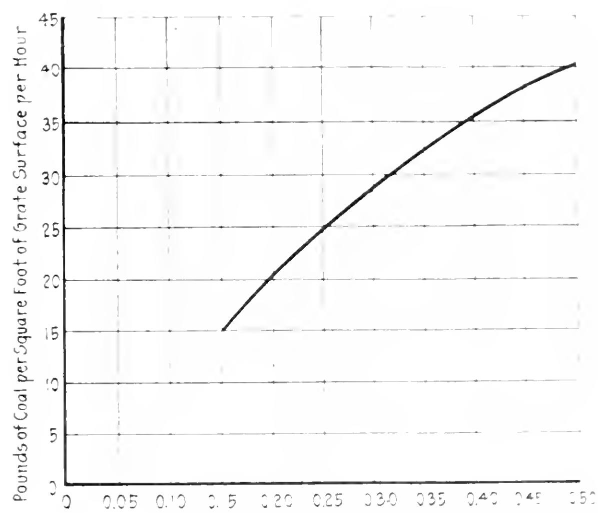

FIG. 1 DRAFT FOR SMOKELESS COMBUSTION

determining the height of stack the author recommends the Stirling formula.

In studying the smoke problem in Chicago, it was realized that it would be necessary to develop some type of hand-fired furnace that could be operated within the smoke limits. After several designs had been tried, they came to flush-front Dutch-oven settings. These settings, however, made more smoke than the standard Hartford setting. The reason for this is supposed to be as follows: When high-volatile coal is thrown on a fire, there is a normal distillation of volatile matter due to the heat of the firebrick. But when you throw coal on a fire with a Dutch oven, there is not only the normal distillation of volatile matter, but in addition an artificial distillation due to the high temperature of the heat radiating from the red-hot firebrick over the fire, resulting in a double distillation of volatile matter. This causes dense smoke in spite of all efforts to prevent it.

By taking off the brickwork over the fire the rate of volatile distillation was reduced, because there was no radiation of heat from the red-hot firebrick. This not only gave a smokeless furnace, but also increased the steaming capacity of the boiler, because there was a direct radiation from the grate into the boiler.

The next problem discussed in the paper is that of burning coal at lower rates of combustion. Here, after a long evolution, we have come to a down-draft boiler with a water-cooled grate, which, if properly handled, is smokeless. (*Proceedings of the Engineers' Society of Western Pennsylvania*, vol. 32, no. 9, December 1916, pp. [illegible]-295, 10 figs. *dp*)

Benzol After the War

The demand for explosives created an enormous increase in the production of benzol in Great Britain. A certain amount of this product and of toluol, which is produced side by side with benzol, will be required for dyes, even after the cessation of hostilities, but a market will have to be found for the excessive production, or approximately forty million gallons of benzol per year.

W. Newton Drew touched upon this question in his paper on The Rectification of Benzol, recently read before the Midland Institute of Mining Engineers, Birmingham, Eng. He expressed the opinion that this excess of benzol will have to be sold as a motor spirit to take the place of gasoline. To make this possible, the benzol must be of standard quality as regards distillation tests, purity and dryness, and must be easily obtained everywhere in convenient form, and at a standard price.

While nothing has been done as yet to prepare for this emergency, the speaker urged that the by-product installations of each district throughout the country should be linked up in some association or associations outside thé coal and coke industries.

As regards the advantages and disadvantages of benzol as motor fuel, the President of the Institute, C. C. Ellison, remarked that he was one of the first to use benzol in cars, but had to give it up because of its objectionable smell. Since then, however, improvements in washing it have progressed so far that now a very good spirit is obtainable.

W. Newton Drew pointed out that 90 per cent of benzol contained approximately 84 per cent benzene, 15 per cent toluol, and 1 per cent xylene, and that standard benzol consisted of 96 per cent benzene and 4 per cent toluol. It is important to bear in mind that a small addition of toluol is not only not an adulterant, but has proved of great benefit in that it increases the calorific power of the fuel, and in winter it prevents its freezing. (Editorial in *The Auto,* vol. 22, no. 6, 840. February 9, 1917, pp. 92-93, *g*)

Vertical Furnaces

A furnace has been recently completed to a Government order in England by the Monometer Manufacturing Co., Ltd., Birmingham, in which a novel method is used.

The problem was to have several long tubes heated uniformly throughout their length to a red heat, the temperature to be kept constant within small limits. This was effected by supporting the tubes in a vertical position in the furnace and applying automatic heat control. Several rings or series of burners are arranged round the furnace at different heights in order to obtain a uniform distribution of the heat, a muffler or protection tube being interposed between the burners and the tubes to be heated in order to prevent heat from impinging directly upon the inner tubes. By this means the temperature throughout the periphery of the furnace as well as the height of the furnace is made uniform.

One control is provided for each ring or series of burners. The control operates on the thermostatic principle and is adjustable to suit the temperature desired. (*Aeronautics,* vol. 12, no. 170, January 17, 1917, p. 55, 1 fig. *d*)

Gas Engineering

A Specific-Gravity Balance for Gases, Junius David Edwards

The need for an accurate method of determining gas density has been especially urgent in the natural-gas industry, where the measurement of gas by means of orifice meters requires a knowledge of the density of the gas. An investigation by this Bureau of the effusion type of apparatus, which has been generally used for this purpose but which has proven unreliable in practice, has shown the need of more precise methods. To supply this need the present method was adopted and suitable apparatus designed.

The principle of the method employed is based upon the laws of the compressibility (Boyle's Law) and the buoyant effect of gas. The balance contains a beam which carries on one end a relatively large globe and on the other a small counterweight; the beam is enclosed in a gas-tight chamber. The buoyant force exerted upon the globe is proportional to the density of the gas and therefore to its pressure. Therefore, if the buoyant force exerted upon the globe is made the same as shown by its position of equilibrium when it is suspended successively in two different gases, then the densities of the two gases must be the same at these pressures, or the specific gravity is the inverse ratio of the pressures. In operation the balance case is filled with air and the pressure adjusted until the beam balances. It is then filled with gas and the pressure required to secure a balance is determined in the same way.

The apparatus described provided a quick, accurate means of determining gas density. The balance beam is supported on two needle points, which give high sensibility. The needles are easily adjustable and in contrast with the metal or quartz knife edge usually used can be obtained almost anywhere, are inexpensive, and can be replaced as often as necessary. The success obtained in the use of this apparatus is mainly due to the high sensibility afforded by this means of support. It is necessary to remove the beam from the case only when it is desired to transport it. No leveling bottle is necessary in adjusting the gas pressure within the balance, this being accomplished by means of a needle valve which affords precise control. A portable outfit is described which combines lightness of weight, convenience in use, and durability without any great sacrifice in accuracy. No preliminary calibration of the apparatus is necessary. The results obtained with this balance were compared with those obtained by a direct weighing method and it was shown that an accuracy of one or two parts per 1,000 could be obtained quickly and without elaborate precautions. (Abstract of *Technologic Paper No. 89,* Bureau of Standards, Washington, D. C.)

. Gas Gate Valve, D. E. Keppelmann

Gate valves depend upon a disk or disks riding into a groove between two seats for their tightness. As a rule, leaks develop either because of accumulation of foreign matter in the valve or through the scoring of its disk or seats by the pressure.

In fact, the groove in the bottom of the valve acts as a constant trap for deposits of foreign matter. If the groove has been filled with foreign matter, however, it becomes finally impossible to lower the disk, which causes leaks.

The valve described in this article does away with this difficulty by eliminating the grooved trap. The opening and closing feature consists of a solid wedge with the port constantly riding on its seats located in the sides of the valve, creating a clean opening through the valve. This makes the valve self-cleaning, for with the valve open it presents a clean surface flush with the body of the valve. Consequently the foreign matter rides through since there is no trap or groove or restriction of any kind for the accumulation of foreign matter, making it possible at all times to close the valve whenever necessary. When the valve is closed the foreign matter will accumulate against the wedge, and simultaneously with the lifting of the wedge this accumulation is immediately cut from the wedge and carried through the valve by the liquid or gaseous substances in the line.

An additional advantage claimed for the new valve is that no by-pass is necessary to equalize the pressure on both sides of the disk before the latter has been raised, for the seats are never exposed to the elements passing through. Hence scoring is impossible and leakage from this source is eliminated. (*The Gas Age*, vol. 39, no. 3, February 1917, pp. 121-123, 6 figs. *d*)

The Limits of Inflammability of Gaseous Mixtures. Prof. W. M. Thornton

The ignition of an inflammable gas mixed with air depends in a variety of ways upon the proportion of oxygen present. With impulsive sparks or condenser discharge the ignition passes through critical stages when the ratios of the number of oxygen atoms to one molecule of gas are whole numbers. The writer shows that the proportions of oxygen in a limiting mixture are in regular systems.

Burgess and Wheeler have shown that in the case of the paraffins the lower limit of inflammability is inversely proportional to the calorific value of the gas. But this is also the case when the number of oxygen atoms in the limiting mixture bears the same proportion in each case to those required for perfect combustion. The present paper is devoted to an examination whether in general the proportion of oxygen in the limiting mixture has any direct relation to that for perfect combustion. The author finds that in the upper-limit mixtures of the paraffins there is twice the volume of inflammable gas there is in the mixture for perfect combustion, and that, further, the ratio of the upper to the lower limits of inflammability should be nearly constant. He points out that while the upper and lower limits of inflammability can be considered as controlled by the heat liberated in the reaction, it is not the heat set free that controls the oxygen that can be present (and so decides the percentage of gas), but the oxygen that controls the heat. Hence inflammation can only occur when certain numerical relations exist between the oxygen and gas molecules. From this the author derives certain data from which may be predicted the limits of inflammability of certain groups of compounds with fair hope of accuracy. (*The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science,* vol. 33, no. 194, February 1917, pp. 190-196, 1 fig, *et*)

Heating

Relative Economy of Heating by Steam at Different Pressures. A. Bement

Recently in Chicago tests were made to determine the relative cost of heating with steam at atmospheric pressure as against 3 to 5 lb. pressure in modern office building plants.

In an analysis of the problem a heat requirement of 5000 B.t.u. per hour was taken. On the whole it appears that there is no appreciable difference in cost of heating at different pressures. There is, however, an advantage in higher pressure from the standpoint of first cost of plant because as the pressure is greater the plant may be smaller. This factor, however, has a limited value in practice unless excessive pressures are used. As a matter of fact, any plant designed to work at 5 lb. should have margin enough to work perfectly at atmosphere, and vice versa, so that in the end the cost of heating will be identical in both cases. (*The Heating and Ventilating Magazine,* vol. 14, no. 2, February 1917, pp. 27-29, *ce*)

Hydraulics

A New Record for Low-Head Development. Rudolph W. Van Norden

Description of an unusual water-power installation of great interest in that the turbines are so designed as to handle hydraulic heads of but 8 ft. The installation was built by the labor of the convicts at the State Prison, Folsom, Cal., and it is stated that the work was free from accident. The prison is situated two miles east of Folsom, on the south side of the American River, tributary to the Sacramento, having its source among the high altitudes of the Sierra Nevada range. For about nine months in the year there is sufficient water in the American River to operate the Pacific Gas & Electric Company's plant at the end of the canal line. During the remainder of the year the river's flow dwindles until in most years it will not exceed 100 cu. ft. per sec. With a canal full of water flowing, and the water level above the prison plant at the spillway line, the difference in water level above and below the prison power house is actually 8.5 ft. During the period of low-water flow the tail-water level falls until the difference in head may be as great as 12 ft. In other words, a variation in head on the turbines may be almost as great as 50 per cent of the normal head. It was required to supply a plant which would deliver continuously not less than 400 hp.

A runner design for high specific speed and consequent great water capacity was essential, and one was adopted of 51 in. mean diameter, operating at 100 r.p.m. and having a nominal shaft horsepower of 215 while operating under 8.5 ft. head with a flow of 285 sec-ft. The design of the turbine was such that while the power output increases more than 50 per cent when the head is increased to 12 ft., the efficiency also increases several per cent.

All machinery is driven by induction motors.

The total weight carried by the thrust bearing is 19,000 lb., to which must be added a hydraulic thrust on the runner of 6000 lb., making 25,000 lb. total load. The two vertical steady bearings are oiled from a glass cup having a capacity of 0.6 gal. of lubricating oil. To prevent the oil following the shaft after passing through the bearing, there is provided between the lower end of each bearing and the annular cup a baffle ring which solidly clamps the shaft, thereby deflecting the oil into the cup.

A horizontal jackshaft extends between the vertical shafts of the two turbines and runs at 300 r.p.m. Upon each end of the jackshaft is mounted a rawhide bevel gear driven from the turbine shafts by cast-iron bevel gears having split hubs mounted on the turbine shaft. As it is intended to drive the

quickly from either turbine but not from both at one time, there are two sliding jaw clutches operated by levers which extend above the generator floor. In the design of these jaw clutches, the following problem had to be solved. In throwing out one clutch in order to engage the other, with both turbines running, it must be possible to momentarily engage the idle clutch before disengaging the running clutch. The generators operating in synchronism, there are 36 points of relative position between the two rotors, any one of which may take place when the machines are synchronized. As the bevel gears have a ratio of three to one, there are 36:3 = 12 positions in a jaw clutch when the two halves of the clutch might engage. In order that the incoming clutch may always be in a position to engage, the jaw clutches are built with twelve radial jaws. The object of the jackshaft was to furnish by belt drive the power to drive the exciter, the governor head and the oil pump furnishing oil under pressure to operate the governor.

One oil pressure governor controls both turbines. It is so arranged that both turbines may be controlled by the governor or one turbine by governor and one by hand, or both by hand. The governor proper stands on the station floor midway between the two generators, the operating cylinder being horizontal and close to the floor. The piston rod of the operating cylinder extends through both heads. Close to either generator and in line with the direction of motion of the governor are the two handwheel mechanisms, which are mounted on a cast-iron frame that carries the crosshead into which the piston rod is fastened: an arm of this frame, which is flush with the floor, carries at its extremity a ball thrust bearing, and passing down through the arm and supported by the thrust bearing is the rotating gate shaft which operates the turbine gates through push-and-pull rods at the lower end of this shaft. Above the thrust bearing and keyed to the gate shaft is a bell crank, and this is operated through two links from the crosshead. The handwheel is on top. Its vertical shaft carries a spur gear which engages a pinion for the purpose of a gear motion reduction. The pinion shaft carries another pinion which engages a rack on the back of the crosshead. The handwheel rigging is contained in a housing integral with the main frame, but is mounted on an eccentric which is moved by a lever fitted with a hand pull. By this means the handwheel mechanism may be thrown out of gear with reference to the crosshead. On the handwheel shaft is a brake operated by a small crank. The piston passes through the crosshead freely, but engages the crosshead by means of a spring bolt operated by a swinging handle. While governing, the spring bolt is in and the handwheel mechanism by means of the eccentric is entirely out of gear. When operating by hand, the pin is pulled out and the eccentric thrown in, and the brake is used to hold the handwheel where desired. The turbine gates are designed to be so balanced as to have an opening tendency up to 0.4 load and a closing tendency above this point. While the gates and mechanism are heavy, one man can handle the gates without difficulty, while the governor moves them easily with an oil pressure as low as 60 lb. (*Journal of Electricity*, vol. 38, no. 3, February 1, 1917, pp. 65-69, 6 figs, *d*)

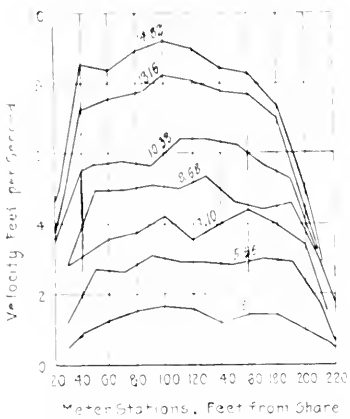

FIG. 2 SURFACE VELOCITIES FOR EACH 20 FT. STATION

SOME NOTES ON STREAM FLOW, G. C. Brown

While taking current-meter readings in the Beaver River at Newport, Pa., a certain measurement was about three-quarters completed when the meter refused to tick off the revolutions. Eight sections had been measured and the stage of the river was such that it was highly desirable to have a reading at that point. Accordingly, the discharges for the eight stations measured were computed for stages just above and below the one under consideration, and also their ratio to the respective total discharges. The results proved to be surprisingly alike, and this prompted a more thorough investigation of the relations that might possibly lie hidden in the field notes gathered from that same stream.

The Beaver River is a stream of no unusual characteristics. A cross-section of the river where the current-meter measurements were taken shows a stream with fairly uniform sand and gravel bottom paved with hand-laid rip-rap on one bank and having a natural dirt slope covered with weeds and brush on the other bank.

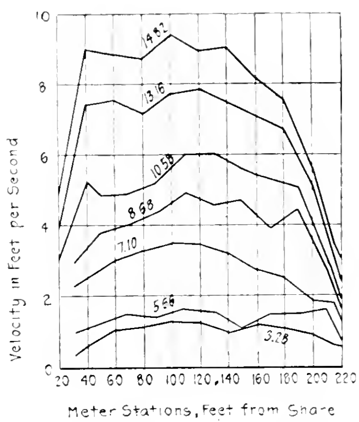

FIG. 3 MEAN VELOCITIES FOR EACH 20 FT. STATION

Gage height 3.28 indicates a very low stage of the river and 14.28 a high flood stage. It might naturally be supposed during this wide variation in height, velocity and discharge that increased cross-current eddies and other disturbances would so confuse the natural line of flow in the stream that no similarity could possibly exist in the curves of low and high stages. It is a surprising fact, however, that marked relations do exist. Fig. 2 shows the surface-velocity curves at each 20-ft. station for different stages. While there are marked variations in some of the curves, there is also a great similarity among them all. The same likenesses, but in greater degree, are seen in the curves of mean velocity given in Fig. 3. The curves of discharge in each 20-ft. section show a more marked similarity. The effect of the difference in roughness between

the paved slope and the natural-earth slope is very clearly indicated in each set of curves. The section of deepest water and freest flow is also indicated by a high point in the curves.

Other curves show that the discharge in any 20-ft. station of the stream for any given stage bears a certain relation to the total discharge for the same stage, and nearly the same relation holds true whatever the stage of the river. For sections outside of approximately the middle third of the stream, the ratio of discharge in any section to the total discharge is nearly constant, except for very low stages.

In the main body of the stream, where the conditions of flow are such that the effect of friction is practically constant, the mean velocity of all sections is increased to the same fold for any change in state when the form of the curves showing this relation remains almost constant.

The paper is of particular interest in showing how an intimate study of a single discharge section of a river brings out the interesting features of stream-flow measurements. (*The Cornell Civil Engineer*, vol. 25, no. 4, January 1917, pp. 161-169, 5 plates, *et*)

Internal-Combustion Engineering

New Rotary-Valve Engine Design

Description of the Van Keuren mono-valve engine which is about to undergo tests in one of the Detroit laboratories. It

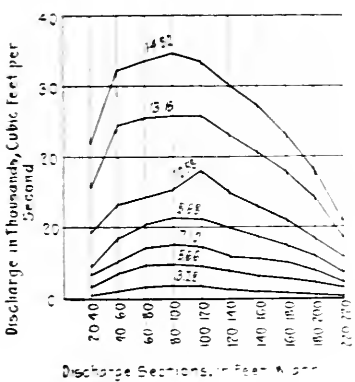

Fig. 4 Discharge for Each 20 Ft. Station

is of interest because of its use of an overhead rotary valve. The difficulty hitherto has been of properly cooling the valve, with the result that warping soon occurred and the engine failed. In this particular engine the cooling water is free to circulate through the entire length of the overhead cylindrical valve. The valve is lubricated by mixing the oil with the gasoline in the proportion of about 1 pt. of oil to 5 gal. of gasoline.

In this engine the cylinder block is suspended over the valve cylinder. In this way all upward reactions are transmitted to the valve and the valve operates under about 60 lb. maximum pressure per square inch of bearing area. The purpose of this is to allow the cylinders to seat upon the valve members and maintain gas tightness in the cylinder ports. In other words, the seating is directly opposite to that of the poppet-valve type, as the cylinders are brought to their seat inside of the valve. To eliminate the carbon troubles which have also been prevalent on overhead-rotary-valve engines, the valve is so shaped as to scrape the carbon from the seat as it is formed.

Another feature of an engine of this type is the possibility of obtaining proper combustion-chamber [illegible] In this case the chamber is conical and machined all over. The spark plug at the side fires directly into the charge. ([illegible] *Automobile*, vol. 36, no. 8, February 22, 1917, p. 412, 1 [illegible])

The Hvid Engine, E. D. B[illegible]

Description of an oil engine invented in [illegible] by R. M. Hvid and working on a cycle approaching that of the Diesel engine.

The engine is of interest because of the wide variations in fuel which it is able to use. The writer claims to have actually run a Hvid-type motor on the following fuels: kerosene, crude oil, fuel oil, road oil (35 per cent asphaltum), cod-liver oil, castor oil, lard oil, cylinder oil, melted butter, and thick cream. It is not claimed of course that all these fuels could

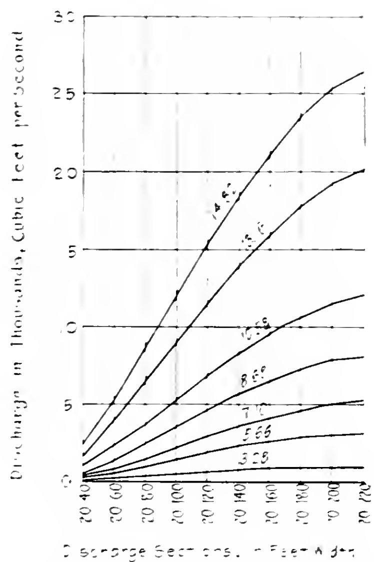

Fig. 5 Total Discharge Progressing Across Stream

be used practically, but the fact that the engine will run on them speaks for the principles involved.

The Hvid-type motor may be made either four-stroke or two-stroke cycle. Ignition is secured by the heat of compression, but unlike the Diesel motors the Hvid motor requires no air compressor.

Fig. 6 is a cross-section of the Hvid injector valve, the extreme end of which projects into the combustion chamber and operates as follows:

On the suction stroke of the motor, pure air only is admitted to the cylinder through the inlet valve 1. While this air is being drawn into the cylinder, the fuel valve 2 is mechanically opened and some fuel flows out of a hole 3 into a steel cup 4, the amount of oil being controlled by the needle valve 5. The fuel valve 2 closes again just before the end of the suction stroke and seals hole 3. The compression stroke follows next and the air previously admitted to the cylinder is compressed to about 450 pounds per square inch, which renders it incandescent. The compression pressure enters cup 4 through holes 6 at the bottom of the cup, and a minute amount of the oil lying at the bottom of the cup is ignited by the incandescent air. The combustion which takes place gives rise to a pressure within the cup far in excess of the compression pressure in the cylinder, and the oil lying at the bottom of the cup is forced out of cup 4 through holes 6 into

the incandescent air in the cylinder, where it ignites spontaneously, the pressure arising from combustion forces the piston forward on the working or expansion stroke.

The Hvid cycle is as follows:

First, a charge of pure air is drawn into the cylinder at or near atmospheric pressure and temperature. During part of this suction stroke, fuel is admitted by gravity through a mechanically operated valve into a small steel cup, the inside of which is connected with the main cylinder by two small pinholes which are located at the bottom of the cup and point toward the piston. The amount of oil admitted is controlled by the governor by means of a needle valve.

Second, the pure air in the cylinder is compressed to between 400 and 500 lb. per sq. in., which gives rise to temperatures of from 950 deg. to 1050 deg. fahr.

Third, as the temperature of the air in the cylinder rises, due to compression, so does the temperature of the small amount of air which is in the steel cup, since the cup is connected by the two small pinholes with the main cylinder. There ensues then within the cup an ignition and combustion of a very small amount of the oil previously admitted to it.

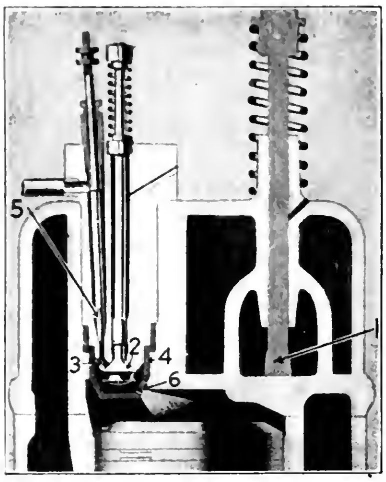

Fig. 6. Cross-section of the Injector Valve of the Hvid Engine

(The amount of oil consumed by this preliminary or primary combustion within the cup must necessarily be infinitely small because there is not sufficient air in the cup to support the combustion of more than a minute amount.) As this combustion takes place, the pressure within the cup rises above that in the combustion chamber and drives the surplus oil out through the two pinholes in a heated spray, which, on coming in contact with the hot compressed air in the cylinder, ignites and burns at approximately uniform pressure.

Fourth, the products of combustion are exhausted. The cycle is then repeated.

It is stated that recently a test of a three-cylinder Hvid-type engine was made in Lansing, Michigan. The same size of engine operating as a conventional type of gasoline engine was rated at 60 hp., with a maximum output of 70 hp., but when converted into a Hvid type it showed a maximum output of 87 hp. and was rerated at 75 hp. The fuel consumption during this test with fuel oil as fuel was 0.42 pint per hp. The complete log of the tests is not given. It is also stated that the Hvid type can be built in units as small as 1 hp. (*Motor Boating*, vol. 19, no. 1, January 1917, pp. 25, 56 and 58, 2 figs., *d*)

A Standard of Carburetor Performance, Prof. R. C. Berry

Carburetor performance is often reported in terms of engine performance. This may serve the purpose when it is desired to compare the merits of different carburetors for use on a good engine, but it does not throw much light upon the performance of the carburetor itself. There ought to be established a standard of carburetor performance that would be expressed in terms of the ability of a carburetor to perform those functions for which it was designed.

The best carburetor is the one maintaining a sufficient volume to atomize the fuel properly, and at the same time adding just enough heat to gasify the mixture. The amount of vacuum required will depend partly upon the scheme used in atomizing, and partly upon the character of the fuel. The amount of heat required will also depend partly upon the way in which it is applied, and partly upon the character of the fuel.

Some experiments have been recently carried out in the laboratories of Purdue University, on a Haynes "Light Six" engine mounted on a Diehl electric dynamometer. The paper reports in detail the methods used in the tests. Curves similar to Fig. 7 were drawn in each case. In this figure the vertical (at 0.0671 lb.) represents the theoretically perfect mixture of fuel and air, or the one in which there is just enough oxygen in the air to burn the fuel, and no excess of either fuel or air. The curve shows that the engine will run with a *mixture* of less than 0.055 lb. of gasoline per pound of air, but will not pull well with so lean a mixture. As more fuel is added, the power will increase rapidly until nearly full power is reached, when the curve becomes almost horizontal, increasing slowly to a maximum, then decreasing slowly for a time but finally reaching a point where it falls off rapidly.

The richest mixture with which the engine could be run was 0.155 lb., or nearly three times as rich as the leanest mixture. In other words, a carburetor can be adjusted with as lean a mixture as can be used to carry full load, and the amount of gasoline can be nearly doubled without greatly affecting the power capacity of the engine. It is practically impossible to stand by the side of an engine mounted on a test block and distinguish any difference whatsoever in its performance as the mixture is being changed through this range. But the effect of this change upon the *efficiency* of the engine is very different. The point of highest efficiency seems to coincide almost exactly with the point of the theoretically perfect mixture. As the mixture is made richer than this the efficiency will decrease, even while the power is increasing slightly, and will decrease rapidly after the point is reached where the power is also decreasing.

Another set of curves given in the article shows that the mixture for maximum power is not noticeably affected at *half-load* by the speed, but that at high speeds the engine cannot hold up its power with quite as much excess fuel as at lower speeds. With a leaner mixture the power holds up equally well at all speeds.

The above curves offer the explanation as to why of two cars of the same make, and of equally good mechanical characteristics, one can travel 10 miles on a gallon of gasoline and the other 15 miles. This is because on one car the carburetor gets a powerful but lean and therefore efficient mixture; while the other carburetor receives too rich a mixture.

The following rule is suggested for adjusting a carburetor: Decrease the quantity of gasoline until the engine loses power; and then increase it slowly until good power is restored, but not a notch beyond this point. (*S. A. E. Bulletin*, vol. 11, no. 5, February 1917, pp. 556-564, 5 figs. *ep*)

Machine Parts

Notes on Screw Gages, Col. R. E. B. Crompton

Paper presented to the Institution of Automobile Engineers. It begins with definitions of various terms used in discussion of screw gages as adopted by the Engineering Standards Committee (Great Britain), and then, after a brief history, proceeds to the discussion of the various threads, such as the Whitworth and British Association (B. A.).

The writer points out that notwithstanding the work done at Woolwich, at the National Physical Laboratory, and elsewhere, when the war broke out there was no satisfactory system in use for gage making. If gages had at that time been so designed that they could have been cheaply and readily produced in quantity, England would have saved many thousands of pounds and much delay in the turning out of shells.

One of the opinions as to the causes of difficulty in producing gages in England was that the rounded roots and crests of the Whitworth form of thread require elaborate plants and form a costly item in gage work. The American Sellers form and the Continental International thread use an angle of 60 deg. with flats on crests and roots, for which gages are more easily made.

The writer states further that when the demand for interchangeable screw work for shells became so pressing that a large supply of accurately made gages became necessary, it was found that many of the gages proposed in Report 38 of the Engineering Standards Committee were very difficult to make, especially those parts where accurate machining or lapping of the grooved portions of the thread at crests and roots were supposed to be necessary and were insisted upon in many of the government specifications. Of all the gages the most difficult to make accurately are the full-form "go" gages. As regards the theory and practice of these gages, it is evident in the first place that in order to secure interchangeability and at the same time take the fullest advantage of any tolerances which can be allowed on the work, the "go" plug-and-ring screw gages should each follow the same mathematical outline which is most naturally defined by the theoretical nominal size and form of thread. The tolerances on the work should be such that all screwed plugs are on or below this size and all screwed holes on or above it. In practice, however, it is not possible to make either gages or work so perfectly that the plug and ring of the *same* mathematical size will screw together. Some tolerance needs to be allowed on the gages themselves, and reference and check gages have also to be considered.

As regards tolerances on screwed work, the writer believes that part of a tolerance is a fixed quantity, i.e., that made necessary by roughness of surfaces, films of dirt, or similar physical matters, and this applies equally to a small screw and to a large one. It follows that the proportion which this constant tolerance bears to the thread depth in the small screw is very large as compared with the same constant tolerance applied to the large screw. This was not at first realized, so that it was found in practice that although the tolerances for the large screws laid down in Report 38 are workable, those for small screws on the Whitworth or B. S. F. scale (½ in. to ¼ in.) and the B. A. series were far too fine and are practically non-workable.

Hence the writer suggests that the whole series of screws, from 3 in. down to the tiny screws used for instruments, should follow one law for tolerances modified only by considerations of the method of manufacture. Small tolerances or close fit on effective diameter are chiefly required to prevent the screws and nuts from working loose.

As regards clearances, although decisions on this point are urgently needed, nothing definite has been done.

It is further evident in the opinion of the writer that if high-crested taps having a core diameter somewhat above the nominal are used for all nuts, the high crests will insure triangular clearances at the crests of the male threads and the increased core diameter of the tap will reamer away the inner salients of the nuts so that the threaded surfaces of bolts and nut will come in contact only on the slopes. Their fit, therefore, is a question of the tolerances on effective diameter. The full diameter and core diameter of the bolts may take care of themselves and, if specified at all, very wide tolerances might be allowed on them.

But if we allow the above clearances before addressing ourselves to securing a good fit by tolerances graduated according to the requirements of the work on effective diameter, we can greatly simplify the gaging question by practically confining it to the gaging of the male screws by means of an

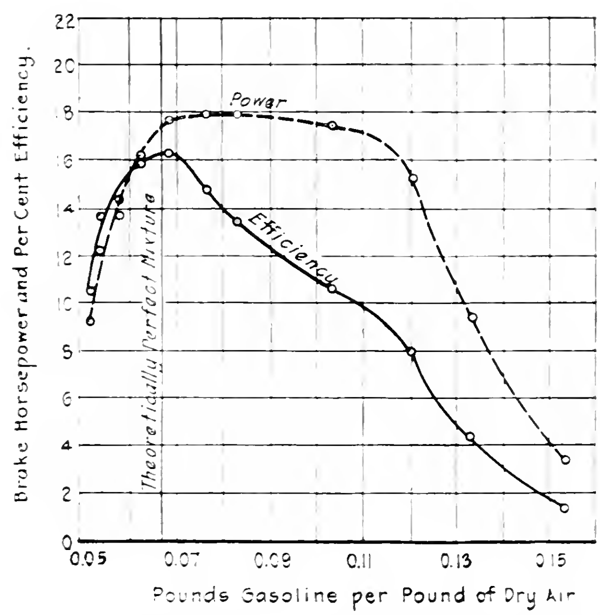

Fig. 7 Engine Performance Curves (1300 R.P.M.)

adjustable split nut accurately made as to pitch and thread form and cleared in such a manner that it only bears on the slopes of the threads that are to be tested and, therefore, tests the effective diameter only. Such a method of testing is not new but has rather been lost sight of.

As regards the gaging of nuts, the writer believes that the real gage for nuts is the tap, and nothing may improve screw interchangeability so much as improvement in tap manufacture. Errors in pitch introduced in the process of hardening taps must be minimized and a system of cutting the taps directly and accurately out of hardened blanks should be encouraged. (Paper presented before the Institution of Automobile Engineers, abstracted through the *Automobile Engineer*, vol. 7, no. 99, February 1917, pp. 35-37, *gp*)

Munitions

Heat Treating Shrapnel Forgings

Description of the methods used at the Hofman plant of the Symington Machine Corporation, at Rochester, N. Y.,

wh[illegible] Russian shrapnel are being made at the rate of over 10,000 per day.

The equipment for hardening the shell forgings consists of three twin chamber, double end, overfired oil furnaces built by the Metals Production Equipment Co., of New York. The combustion chamber of each of these furnaces is above the working chamber and is separated from it by a perforated arch of refractory tile. The oil is delivered from overhead feed lines to five burners at each side of a two-unit battery of furnaces. The oil is atomized by steam and delivered to the burners at 80 lb. pressure. The flame of combustion is retained in the combustion chamber and the heated gases flow down through the checked refractory arch into the working chamber containing the shell forgings. After circulating in this chamber the gases pass out through an outlet in the side wall into a duct under the chamber and up through flues in the other side wall to vents in the top.

The roughly machined forgings are placed in metal trays providing convenient means of quickly placing four shells at the proper distance apart so that the heat of the furnace may circulate between them.

Hydraulically operated cylinders push three trays of shells into the furnace when water under 70 lb. pressure is admitted to the cylinders.

After the furnace has been filled with trays of forgings each succeeding group of three trays that is pushed in through the door at the front pushes all the others before it so that the last one emerges from the door at the back. As the shells leave the furnace an operator inserts the hooks of a two-pronged rake into holes in each tray and by a quick movement pulls it forward on smooth ways to a stop.

The forgings are subjected to a temperature of about 1500 deg. fahr. for a period of one hour and twenty minutes. The following device is used for regulating the movement of the shells through the furnace. It was determined that in order to subject each group of forgings to the heat of the furnace for exactly the required length of time, three trays must enter the furnace every five minutes. To insure the strict observation of this schedule an electric gong was installed to warn the operator when it was time to place another group of trays in the furnace. The ringing of the gong is timed by a revolving drum driven by a small direct-current motor.

From the furnace the shells go into the quenching oil. The oil reservoir contains 8000 gal. of oil which is maintained at the uniform temperature of 120 deg. fahr. by an extensive circulating and refrigerating system.

All the furnaces are equipped with automatic recording pyrometers which are arranged on shelves in a room adjoining the superintendent's office.

An important feature of shell making is the formation of the conical-shaped nose of the open end of the shrapnel forging, and the mechanical method of pressing the open end of the forging owes its success to the physical properties imparted to the metal in the annealing process.

The article describes the general features of the annealing furnaces.

Among other things the writer calls attention to the fact that the previous work done to satisfy the exacting demands of automobile, locomotive, and machine-tool construction has brought the art of heat treating previous to the beginning of the present war to the stage which alone made possible the wonderful strides made in the new art of shell making in this country during the last two years. (*The Iron Trade Review*, vol. 60, no. 6, February 8, 1917, pp. 365-368, 6 figs. *d*)

Railway Engineering

Water Conditions in the Locomotive Boiler, George L. Fowler

Data of a recent study of boiler feedwaters on a railroad where there was a variety of troubles from this source. An important feature brought out by the investigation is the impossibility of depending on the analysis of the raw water as drawn from wayside tanks.

As regards the formation of scale, cases have been observed where the scale formed was of medium hardness and brittleness, and was easily removed from the surface to which it adhered by tapping it with the hand. Where the sheets were bare or the scale thin, there was no corrosion; but where the scale formed, corrosion took place beneath it forming a large pit as shown in Fig 8. The thicker the scale the deeper was the pit (Fig. 8).

As the water appeared harmless and the corrosion occurred only beneath the scale, it was surmised that the scale might be corrosive. A sample of it was analyzed (complete data given in original article), but nothing was found of a corrosive nature, and it would seem therefore that after the deposition of a certain amount of scale the plates beneath it became locally overheated. This caused a decomposition of the organic matter, the calcium sulphate and magnesium hydroxide forming free sulphuric acid, which is partially protected from dilution with the boiler water and attacked the sheets. The cure then lies in preventing an accumulation and adhesion of scale.

In another case there was little or no trouble from scale, but there was an intense and rapid corrosion that would destroy tubes by pitting in nine or ten months. The water that was doing this did not even give an acid reaction, and there was apparently nothing to account for the intensity of the action which actually took place. A lime-and-soda treating plant had been erected at one place, but the result appeared unsatisfactory.

After a rather thorough examination of analyses of the water, it was decided that something was happening in the boilers of which nothing was known. Two boilers were selected, the water of each of which had been taken from a single tank, and samples analyzed after having been in service for about eight days. The variation in the composition was startling, as shown by Table 1.

The water taken from the boiler was extremely bad. The free sulphuric acid coupled with a large quantity of organic matter fully explained the rapid corrosion that takes place in the boiler using the raw water from which it is formed.

Because of the uncertainty as to the uniformity of the quality of the water delivered to the boiler, an experimental small boiler, of about two gallons' capacity, was built, in which definite samples of water were evaporated. The boiler was operated under a pressure of 200 lb. per sq. in. The method of operation was to draw a quantity of water from the tank to be examined and analyzed; then to take 75 gal. of the sample and evaporate it to 1 gal. in the small boiler. Table 2 gives a typical result which presents a good example of the change repeatedly found to take place in water that has been subjected to the high pressure and temperature obtaining in a locomotive boiler.

While some compounds disappeared, others were apparently formed. In this case the raw water contained neither calcium sulphate nor magnesium chloride, and yet both were found in the water taken from the boiler. On the other hand, the sodium sulphate and magnesium carbonate disappeared. The

decomposition of the magnesium chloride formed hydrochloric acid, which directly attacked the sheets.

As to the decomposition of sodium sulphate, which may appear incredible, the writer states that in seven cases where these evaporation tests were made, each showed an apparent disappearance of the salt and the formation of new compounds that did not exist in the raw water.

In fact, an attempt was made to regulate this phenomenon. One of the worst of the waters was selected and subjected to the boiling test, followed by an examination. The raw water was then treated with sufficient barium hydroxide to precipitate all of the sulphates as barium sulphate. Again, a concentration test was made of 75 gal. of water thus treated, with the results given in Table 3.

These results show that notwithstanding the practical elimination of the sulphates and presence of a certain amount of organic matter, all of the sodium was retained in solution and combined with a liberated carbonic acid. Some of the

TABLE 1 ANALYSES OF WATER FROM TANK AND BOILER (AFTER 8 DAYS' SERVICE)

	Grains per gallon.	
Impurities	From tank.	From boiler.
Calcium carbonate	0.29	....
Calcium sulphate	15.05	7.02
Magnesium sulphate	11.67	28.81
Magnesium sulphate (manganic)	....	10.61
Iron sulphate (ferric)	....	43.87
Alumina	...	45.15
Sodium sulphate	9.62	38.38
Sodium chloride	1.52	14.99
Sodium nitrate	....	0.12
Silica	1.51	21.93
Alumina and iron oxide	0.52	....
Organic matter	1.96	17.21
Free sulphuric acid	....	2.33
Total	42.16	230.42

TABLE 2 ANALYSES OF WATER FROM TANK AND EXPERIMENTAL BOILER

	Grains per gallon.	
Impurities	Raw water from tank.	Concentrated water from boiler.
Calcium carbonate	1.34	0.73
Calcium sulphate	....	1.91
Magnesium carbonate	0.70	....
Magnesium sulphate	0.17	2.76
Magnesium chloride	....	1.74
Sodium sulphate	0.52	....
Sodium chloride	0.70	2.11
Sodium nitrate	0.07	0.57
Silica	0.58	5.47
Alumina and iron oxide	0.29	2.64
Organic matter	0.81	2.29
Total	5.18	20.24

sulphuric acid and silicic acid were present, making the water strongly foaming.

For waters that did not lend themselves to successful tank treatment two methods were adopted to prevent the corrosive action, both of which appear to be working successfully. One is to make an examination of the water in the boiler each day and prescribe the amount of soda compound that is to be used. The examination requires only five to ten minutes' time and the application is made through a hose attached to the suction chamber of the injector. Enough of the compound is used to maintain the alkalinity of the water in the boiler at 0.3 per cent, which, while not entirely noncorrosive, is so nearly so as to avoid trouble.

The other and simpler method is to apply a corrosion inhibitive at each washout. If the boiler has been in service for some time and the corrosion has started, it has been found to require three or four applications to stop it. After that the water drawn from the boiler will be clear and free from oxides. Where this treatment is used and the water in addition to its corrosive qualities carries scale-forming matter in any quantity, it is necessary to add a scale preventive to the inhibitive. (*Railway Age Gazette*, vol. 62, no. 9, March 2, 1917, pp. 359-362, 1 fig. *cp*)

SOUTHERN RAILWAY DUPLEX LOCOMOTIVES

Description of the application of Mogul running gear and machinery to a Mikado locomotive.

By such an application the Southern Railway has materially increased the capacity of these locomotives without increasing the wheel load, and with a marked decrease in fuel consumption per ton-mile. This has been done with but little change to either the running gear of the retired engines or to the water tanks of the Mikados. The diameter of the cylinders of the tender engine has been reduced, which with the reduction of one inch in diameter of the Mikado-type cylinders, does not overtax the Mikado boiler to any extent. In addition to the reduction in cylinder diameter, the boiler capacity has been increased by the addition of brick arches

TABLE 3 ANALYSES OF SPECIALLY TREATED RAW WATER AND WATER FROM EXPERIMENTAL BOILER

	Grains per gallon.	
Impurities.	Treated raw water.	Concentrated water.
Calcium carbonate	1.11	0.70
Magnesium carbonate	0.11	0.05
Sodium carbonate	2.45	69.18
Sodium sulphate	0.58	57.87
Sodium chloride	0.76	9.91
Sodium silica	....	2.63
Silica	0.53	....
Alumina and iron oxide	0.06	0.53
Loss on ignition	0.40	4.14
Total	6.00	145.01

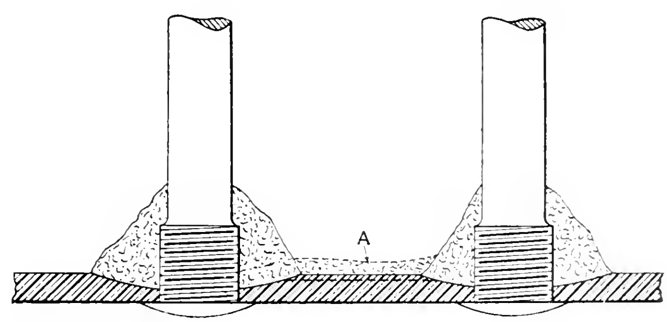

FIG. 8 SCALE FORMATION AND PITTING AROUND CROWN STAYS

and a feedwater heater which uses the exhaust steam from the air compressor.

Steam for the tender engine is taken directly from the superheater, through a well-lagged 3-in. pipe extending backward underneath the cap. A second pipe which permits the added use of saturated steam taken direct from the top of the boiler, is also connected with this pipe. This has been added in order to provide greater steam supply to the tender engine for peak loads on heavy grades.

With the application of the Consolidation running gear to the tender, the drawbar pull of the Duplex locomotives is made 39 per cent better than that of the original Mikados.

Several of these locomotives have been installed on the line between Asheville, N. C., and Hayne, S. C., a distance of 68 miles. On this line, eastbound, heavy-traffic direction, there are 1.5 and 1.7 per cent grades.

With the single Mikado locomotives the maximum tonnage handled over the first 22 miles of this line is 1100 tons. The Duplex locomotive will handle 1400 tons, or an increase of 27 per cent.

As regards the factor of adhesion in the Mogul, with the minimum weight of tender, it is much too low, viz., 2.25.

with the tender practically empty of water and coal. In the case of the Consolidation tender, the minimum factor of adhesion is about 3.25.

Fig. 9 shows the application of the Mogul running gear and machinery to the water tank of the Mikado type locomotive. The entire lower part of the locomotive remains practically unchanged, the cylinder casting is retained intact, and the front and rear draft castings are changed slightly, the front draft casting being shown in one of the illustrations. A pocket is formed in the tank at the front end to provide a proper clearance for the rear cylinders. (*Railway Mechanical Engineer*, vol. 91, no. 3, March 1917, pp. 121-123, 6 figs. *d*)

Superheat in Locomotives

At the Fifty Ninth Annual Convention of the American Railway Master Mechanics' Association held in June 1916 at Atlantic City, N. J., a report was presented by the committee on superheated locomotives. W. J. Tollerton of the C. R. I. & P. Ry., Chicago, Ill., Chairman.

This report provoked an interesting discussion.

D. R. MacBain (N. Y. Cent. R. R.) spoke of tests with locomotives equipped with Schmidt superheaters. An engine was taken of exactly the same type as those used without superheaters and an accurate account kept of every gallon of water and every pound of coal used, and also of every car that was moved about the station—as closely as was possible. An actual saving of fuel on superheated locomotives was found. No claim is made that any high degree of superheat was obtained on a switching locomotive, but this is what was found: On three different tests it was ascertained that even in the summer time, say for the month of September, there was a drop of approximately 25 per cent in the steam temperature from the time it left the boiler until it entered the cylinder. This was the result of the saturated tests. With the superheated switching locomotive this 25 per cent was taken up; or, in other words, it became possible to maintain on that slow-moving, short-work switching engine just about boiler temperature in the cylinder. The experience of that road so far indicated is that on short switching not much superheat is obtained, but that a vast saving is secured, due to cutting out the condensation, especially on a switching engine working with practically cold cylinders.

C. F. Giles (L. & N. R. R.) discussed the use of the drifting valve. It was found very difficult to get the engineers to use a cracked throttle in drifting down a long grade. An intercepting valve in the throttle was introduced with the expectation that it would be kept open when the main throttle was closed. This did not prove entirely satisfactory and, besides, the steam that is taken into the cylinder from the superheater units is naturally superheated and one cannot get as good results from superheated steam in drifting as with saturated steam.

In October 1915 an automatic drifting valve was applied with satisfactory results. In this case the pressure from the valve chamber keeps the valve closed when the engine is working steam. There is a spring on the opposite side that allows the valve to open when the pressure from the valve chamber is cut off. The valve is connected by a pipe direct to the dome which provides saturated steam continuously to the cylinders while drifting, with a branch pipe running from each side of this drifting valve to the valve chamber.

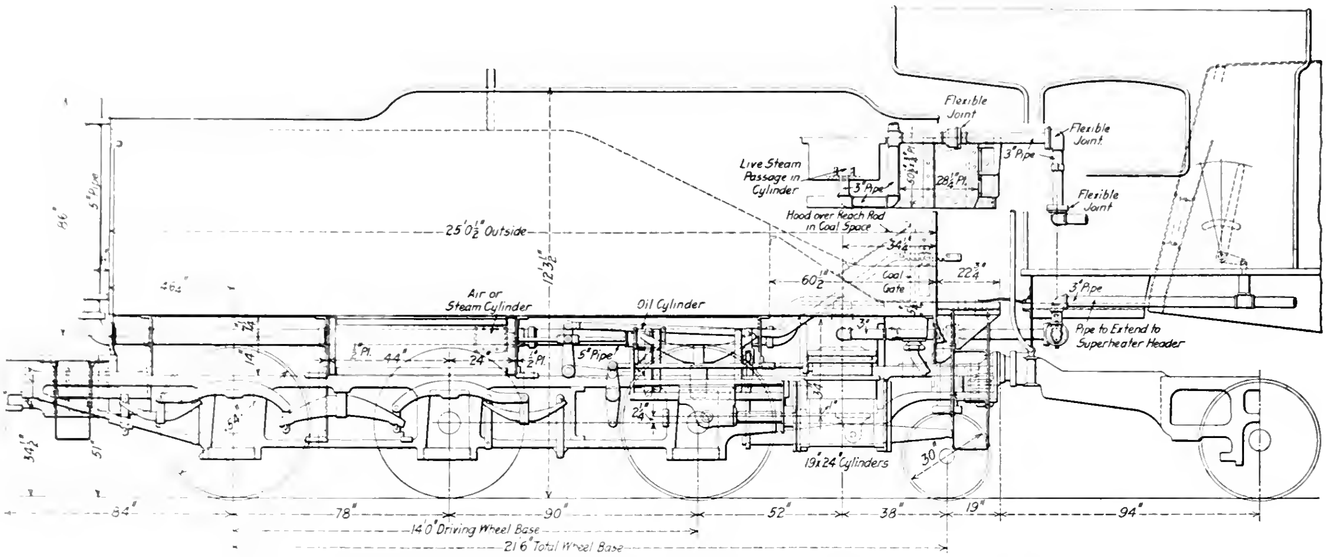

FIG. 9 APPLICATION OF MOGUL RUNNING GEAR AND MACHINERY TO WATER TANK OF MIKADO LOCOMOTIVE

The speaker had the valve chamber and cylinders on the first engine to which the valve has been applied opened up and found that they were lubricated as satisfactorily as any saturated engine he has examined.

H. C. Woodbridge (Assistant to Gen. Mgr., B. R. & P. Ry.) discussed the operation of slide-valve locomotives with high-degree superheat. About three years ago he tried a method by which the face of the valve and seat were bathed with lubricated saturated steam, and a circulation between the seat and the valve face established. He ran the engine using saturated steam for eleven months, testing it out as far as possible with a wide-open throttle and a short cut-off for long distances. A Schmidt superheater was then applied to that locomotive. Since the application the engine has made 35,000 miles, being handled during the past five or six months in pooled service, and in that pooled service the engine was allowed only 1¾ pt. oil for a 107-mile run. (The writer believes that this oil allowance should be increased to properly provide for irregular service.) The locomotive, a 40,000-lb.-tractive-effort consolidation engine, was then put in passenger service to see if the valves could be burned out. It performed

very satisfactorily on the fastest trains where it was necessary to run 53 to 54 miles per hour, which, with a small wheel, means 5 r.p.s. a good deal of the time. The same scheme was applied to an Atlantic-type passenger locomotive carrying 200 lb. of steam and is at present being applied on a Decapod pusher engine.

The writer expressed his belief that the distortion of a properly designed slide valve will not be sufficient to cause any trouble if it is properly lubricated. After the writer had found a slight distortion in the valves run with a superheater he was surprised to find just as much distortion in the same character of a valve with saturated steam.

R. P. Blake, speaking of his experience on the Northern Pacific, stated that observations of the performance of the engines led to the conclusion that there was little if any advantage in the five-feed lubricator. The same quantity of valve oil regularly and properly introduced into the cylinder through the valve would give better results than attempting to feed part of it into the cylinder direct. At present the results which are being secured in cylinder packing are probably averaging about 20,000 miles between renewals. (*Report of the Proceedings of the 59th Annual Convention of the American Railway Master Mechanics' Association*, Chicago, 1916, vol. 49, pp. 130-155, *g*)

Sieves

A Standard Screen Scale for Testing Sieves

Since the adoption by the Bureau of Standards several years ago of specifications for standard 100- and 200-mesh sieves, frequent requests have been received that this Bureau test and certify sieves of other sizes than these. With a view to the adoption of a series of standard testing sieves which might be of use to all industries making fineness tests, this Bureau for two years has been studying the question of such a standard screen scale. Various scales that have been proposed were considered, and information was sought of representative firms in the various industries interested as to their requirements. Manufacturers of sieves have also been consulted as to the desirability of different screen scales and the practicability of their manufacture. As a result of this study of the question, a conference was called at the Bureau of Standards April 20, 1916, of representatives of various committees of the American Society for Testing Materials. American Society of Civil Engineers, American Institute of Mining Engineers, American Foundrymen's Association, Mining and Metallurgical Society of America, American Water Works Association, American Institute of Metals, and the American Spice Trade Association; also representatives of the Committee of Revision of the U. S. Pharmacopœia, the U. S. Geological Survey, the U. S. Bureau of Mines, the U. S. Office of Public Roads and Rural Engineering, the U. S. Office of Grain Standardization, and the U. S. Bureau of Standards; also representatives of a number of private firms engaged in industries in which sieves are used, such as the glass, the drug-milling, the abrasive, the asphalt, the mining, the spice, the chemical, and the graphite industries; also representatives of the firms in this country manufacturing wire cloth and sieves.

This conference, after considering the various screen scales either proposed or now in use, adopted as a Standard Screen Scale that given in a table in the original paper, and recommends that it be adopted generally by scientific, technical, and engineering societies and committees, and by branches of national, state, and municipal governments as a part of their specifications for materials and methods of tests; also that it be used by private firms who have need of standard sieves.

This screen scale is essentially metric. The sieve having an opening of 1 mm. is the basic one, and the sieves above and below this in the series are related to it by using in general the square root of 2 (or 1.4142), or the fourth root of 2 (or 1.1892), as the ratio of the width of one opening to the next smaller opening. The first ratio is used for openings between 1 mm. and 8 mm., while the fourth root of 2 is used as the ratio for openings below 1 mm. to give more sieves in that part of the scale. The series has been made large enough, it is hoped, to meet the needs of all industries. Some industries may have occasion to use all the sieves in a certain section of the series and none of the others, while in other industries it may be desirable to use only certain sieves selected from the whole range of the series. In making such selections it is recommended that this be done on some systematic plan, as, for example, the selection of every other sieve or of every fourth one in the series below 1-mm. opening and every other sieve above 1-mm., in which case the ratio of each opening to the next smaller one would be as two to one.

Because of the wide range of openings in sieves now manufactured which are possible with a given number of meshes of wire per unit length by the use of wires of different diameters, and the consequent confusion and uncertainty which arises in designating sieves by the number of meshes per unit length, the sieves of this series have been designated by the width of the opening in millimeters, as, for example, a 1.41-mm. sieve, or a 0.36-mm. sieve. It is urgently recommended that all users of sieves in the future designate these standard sieves in this way and that the manufacturers mark and list the sieves in this manner rather than by the meshes per inch.

In the designation and certification of the sieves the metric units will be used by the Bureau of Standards. In the table (in the original paper), however, are also given the equivalents of these metric quantities in inches in order that the series may be more readily related to work previously done. It is, of course, immaterial whether units of the metric system, or of the customary system, or of any other system are used in the manufacture of the sieves provided they are within the tolerances.

To meet the need for sieves of this series at the present time a temporary provision has been made in the specifications for the acceptance of sieves of slightly different mesh and wire diameter than those called for in the screen scale, provided the resultant opening is the same as the nominal opening within a small range. This will make possible the use of a number of sieves now on the market in which the ratio of wire diameter to opening is only slightly different from that of the screen scale. This provision will be withdrawn when conditions are such that the manufacturers of sieves can furnish sieves made more exactly in accordance with the specifications.

The Bureau of Standards hereby announces that it will test sieves of this series to determine whether they conform to specifications given below. This test will consists of the examination of the mesh of both the warp and shoot wires of the cloth to ascertain whether it comes within the tolerances allowed; also measurements of the diameter of wires in each direction to determine the average diameter, and a measurement of any large openings to ascertain whether they exceed the limits given in these specifications; also an examination of the sieve to discover any imperfections of the sieve which

may seriously affect its sieving value. Sieves which pass the specifications will be stamped with the seal of this Bureau and will be given an identification number, and a certificate will be furnished for each sieve that passes the requirements.

For sieves which fail to meet the specifications, reports will be rendered showing wherein the sieve was not up to the standard.

A fee of \$2.00 per sieve will be charged for the test of the sieves when submitted singly. For from two to nine sieves submitted at one time the fee will be \$1.50 per sieve. For lots of ten or more the fee will be \$1.00 per sieve. Only half of the above fees will be charged for such sieves as may be rejected for exceeding the tolerances of mesh, in which case the wire diameter will not be measured. (*Abstract from an advance notice supplied by the Bureau of Standards,* Washington, D. C.)

Steam Engineering

Ford Boiler and Gas Plants, Thomas Wilson

In the Ford boiler plant seven of the largest boilers yet to be put in operation are in the course of erection. They are of the Badenhausen six-drum type, with six passes over the gases and with 25,000 sq. ft. of heating surface. While rated at 2500 hp., it is proposed to operate them continuously at 4000 hp. Steam will be generated at 180 lb. pressure and superheated to a temperature of 600 deg. fahr.

The article describes in detail the system of location of the boilers, which permits of an important economy of space.

Each boiler will be served by a 12-retort Taylor stoker of especially large size, driven by a variable-speed motor through a silent-chain drive. Clinker crushers are provided with a 5-hp. constant-speed motor at either side, with the drive by belt, gear box and ratchet, the throw of the latter being adjustable.

The water-back is of special design. It consists of two headers in the open space at the rear of the bridge wall, with $3\frac{1}{4}$-in. U-shaped tubes placed $6\frac{3}{4}$ in. apart passing through the bridge wall and projecting far enough to prevent clinkers coming in contact with the brickwork. Expansion is taken care of by arranging the brickwork to give a space of $\frac{1}{2}$ in. around the tubes, which space is packed with asbestos. By drawing them into the furnace the tubes can be removed without seriously interfering with the bridge wall. The headers are flexibly connected to the boiler by long bends and provided with handholes through which the tubes may be expanded or cleaned.

As the feedwater enters at the rear, the coldest water in the boiler goes to the water-back. The flow enters into and assists the regular circulation of the boiler. There are four blow-off connections to each boiler: two on the lower drum of the economizer section, and two on the lower drum of the boiler proper.

To obtain the high superheat anticipated, a Superno superheater is located between the first and second passes, or in the path of the gases just after the first bank of tubes. To obtain uniform heat transfer, a superheater is made up with an increasing number of tubes of decreasing diameter, the constant area approximately equal to the steam-outlet area from the boiler.

Between the third and sixth passes is located a damper hinged on to the boiler side and closing against an angle iron on the division wall between the two lower drums. Normally, this damper will be closed, and all of the gases will flow through the six passes of the boiler. Should the draft be lower than usual and it is desired to reduce the drop through the boiler, the damper will be raised so that a portion of the gases will enter directly from the third into the sixth pass.

When the plant is complete, the intention is to induce the draft by utilizing the exhaust from the gas engines. It is expected that the temperatures of both exhaust and stack gases will approximate 300 deg. fahr., so that the exhaust will be called upon to increase the draft.

In the small Wickes boilers, also, the steam is generated at 180 lb. pressure and superheated to 600 deg., with the boiler feedwater raised to a high temperature in the gas-engine cylinder jackets and the feedwater heaters.

The heat in the stack gases is utilized in an air preheater rather than in an economizer. The preheater consists of a rectangular sheet-iron box with tube sheets and 190 tubes of $3\frac{1}{2}$ in. outside diameter, placed on 6-in. centers both ways, set in the uptake from the boiler. The gases pass through the tubes. The air from the fan comes in at the side of the preheater, flowing across the tubes and back to the outlet, thence down through a duct to the wind box of the stoker. A series of sleeves with baffle flanges fit over the tubes to increase the area of contact, and to stratify the air so that all the surface will be used to advantage.

In the water heaters each unit is divided into four elements, receiving the exhaust and the jacket water from three engines. The gases pass through the four elements in series counter-current to the flow water. It is estimated that they will enter at the temperature of 550 deg. fahr. and leave at possibly 300 deg. The water leaves the gas-engine jackets at an average temperature of 195 deg., and it may reach a temperature of 275 deg. in the heater before being delivered to the economizer sections of the boilers.

The article describes in detail the ash- and coal-handling equipment and the gas-producer plant. In connection with the latter, it is stated that recently an experimental producer was built to make gas which would not require scrubbing apparatus. The outfit consists of a standard Hughes producer, fed with coal and discharging gas to another producer of special construction charged with coke, the tarry vapors in the gas from the first producer being fixed into permanent gases by passing through the bed of hot coke in the second machine. This unit is now in operation. (*Power,* vol. 45, no. 8, February 20, 1917, pp. 239-243, 5 figs. *d*)

Large Modern Steam Power Plant

Description of a large power plant of the Buffalo General Electric Company, the interest of which lies in its use of a pressure of 275 lb. and a superheat of 275 deg., together with a general discussion on the future of high steam pressures.

A consideration of the general state of the art of steam-power generation tends to indicate that except for the gain of 10 or 12 per cent that might be added by increasing the heat range by going to higher pressures or higher superheat, there appears to be at present no other source for bettering the economy of the steam plant.

The passage from the high pressures of today, 180 to 225 lb., to such as 600 lb., is not likely to come in a single jump, as it requires suitable materials of construction and a change in the whole steam side of the station. Further, because with pressures like 600 lb. the dew point is advanced much nearer to the comparatively inefficient high-pressure

stages of the turbine, there appeared to be serious obstacles in the way of an immediate increase to 600 lb., or thereabouts. It is, however, likely that in the near future, large turbines will be ordered so designed that a high-pressure wheel may be put on if it is desired to increase considerably the boiler pressure after installation, as has already been done at Boston.

The writer discusses in this connection the various features of high-pressure and high-superheat turbines, such as turbine materials and wheel friction. As to this latter the writer calls attention to the experiments of Konrad Anderssen, who found that the resistance to rotation in the wheel is approximately proportional to the density of the steam, and that it increases with the fifth power of the diameter of the wheel and the third power of the revolutions.

From this the writer passes to the description of the Buffalo plant. While much of the power required for the industries at Niagara Falls, and for some at Buffalo, has heretofore been exported from the Canadian side of the Niagara River, the Canadian authorities have curtailed the sale of this power to American industries, and for this reason to the other head. One connection from each header joins a receiver at each turbine, with which 15 in. diameter bends connect the turbine. The figure shows how well provided is the piping for the movement that 275 lb. pressure and 275 deg. fahr. superheat make inevitable.

All valves on the main steam piping except throttle valves are gate valves. The valves in the high-pressure steam lines are all steel. Although the steam velocities are not unusually high, the valves have been provided with seats designed to minimize the cutting and scoring effects of wire-drawing. The article illustrates various types of valves used, such as the boiler drumhead stop and check valves having the disk for seat screwed in instead of formed or pressed in, and seats, disks and stems of monel metal.

As regards boilers, the rate of coal feed by the plungers with the boilers operating at normal rating is 127 lb. per retort per hour. The stoker is capable of being operated to feed 1000 lb. of coal per retort per hour. When feeding 700 lb. per retort per hour, or 10.5 tons per boiler per hour, the boiler will evaporate about 160,300 lb. water per hour, from and at 212 deg. fahr., or 14.4 lb. per hour per sq. ft.

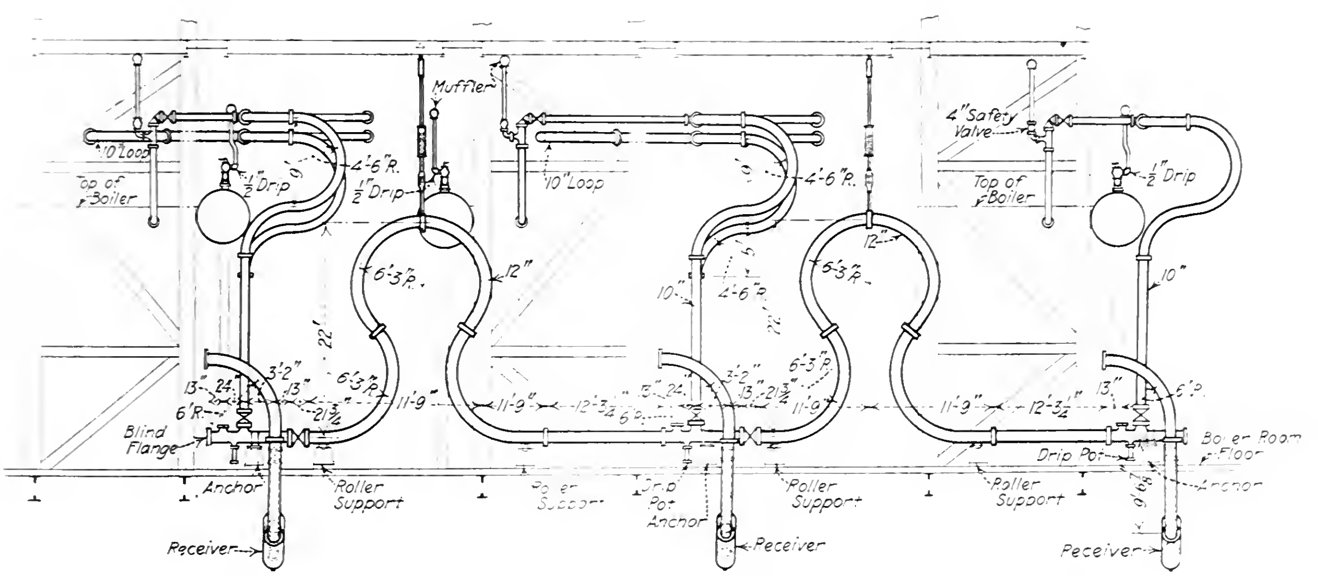

Fig. 10 Elevation of Steam Main and Leads from Three Boilers, Buffalo General Electric Company

the River Station of the Buffalo Electric Co. was built on Black Rock just outside the city limits of Buffalo, N. Y. The station was planned for 200,000 kw. capacity, 3 units each of 20,000 kw. at 90 per cent. power factor being installed initially; future units are to be 30,000 or 35,000 kw.

As regards time of construction a world's record has likely been made. The ground was broken for this work in January, 1916, and the station was put in commercial operation in November of the same year, a truly remarkable performance even in normal times, and especially when one realizes that the conditions of steam temperature and pressure require a considerable amount of special material.

An interesting feature is the high-pressure steam piping. As one stands facing the boiler-room wall, the bends in the 12-in. steam mains rise 23 ft. above the floor, as high as the boilers. Each bend, as shown in Fig. 10, consists of three parts, two 45-deg. bends from the horizontal, joined by a U-bend of 6ft. 3 in. radius, producing a double offset bend with four joints. There are two 12-in. headers, the 10-in. leads from the boilers at one side of the house going to one of these; the leads from the boilers on the other side going of heating surface. Hence, overload capacities can be obtained which would have been deemed impossible a few years ago. In fact, these boilers are heavily over-stokered as compared with usual practice.

The raw-water evaporator system for supplying distilled make-up feedwater is of interest. The purpose of it is to prevent formation of scale in the boilers or elsewhere in the system. This make-up water evaporator system has a capacity of 30,000 lb. of distilled water per hour, 24 hours per day. Distillate to have less than five grains of solid matter per U. S. gallon upon evaporation to dryness.

The diagrammatic layout of the evaporator plant is shown in Fig. 11. In the evaporator proper, the coils are of 1-in. outside-diameter seamless drawn-brass tubing wound in small coils so as to be quickly detachable. It is in the evaporator that most of the scale is formed and from which the sludge is blown to the waste pipe. The steam pressure is 275 lb. from the boilers, and the superheat 275 deg. As the heat transmission from superheated gas such as this steam is not as great as when saturated steam is used, a reducing valve and a de-superheater are used to reduce the steam to saturation at

[illegible] before it goes to the evaporator. One should, to facilitate the understanding of the system of Fig. 11, begin by tracing the lines from the raw water line, or start at the hot well and trace the course of the condensate from the hot well of the turbine condensers through the evaporator system condenser, and to the main open feedwater heaters, from which it goes to the economizer and then to the boiler. The raw water which is taken from the circulating water discharged from the main condensers, enters an open heater supplied with steam from the exhaust of the auxiliaries and then passes through a heated generator, the shell of which is supplied with vapor from the second effect evaporator, while the raw water passes through the opening of each evaporator.

The evaporator system is practically automatic in its operation, and the evaporators may follow very closely without personal attention the output as required by the load on the plant, or in accordance with the feedwater requirements.

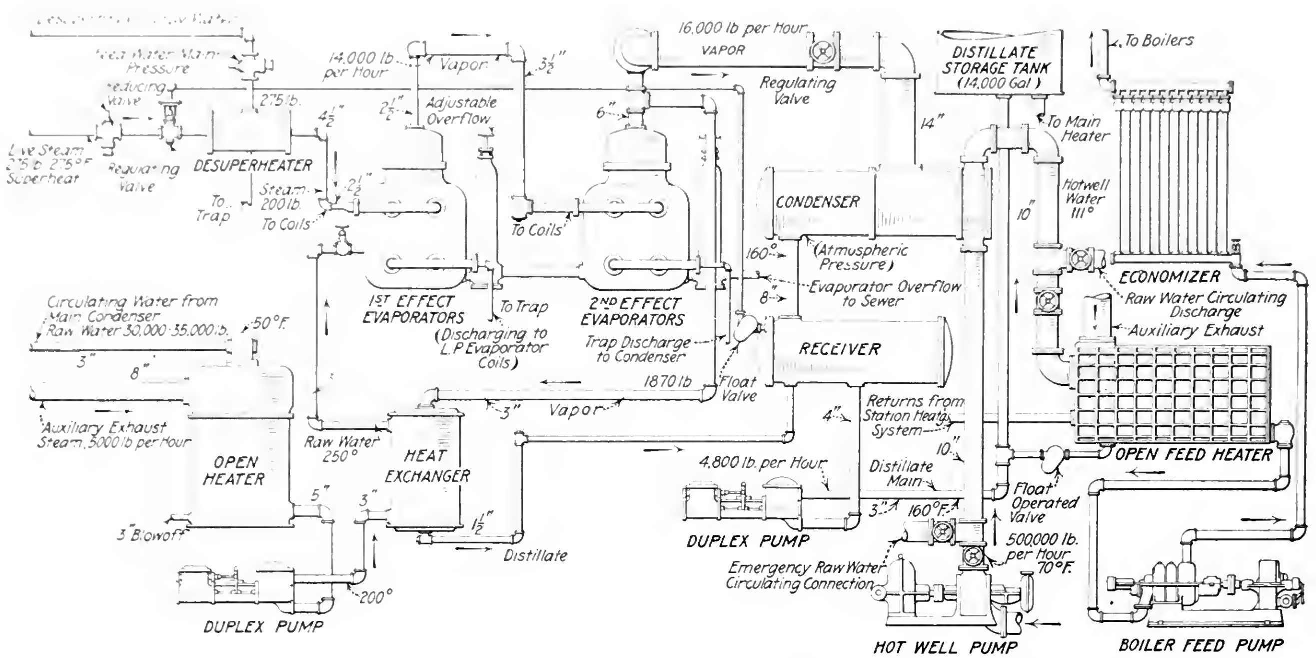

FIG. 11 DIAGRAMMATIC LAYOUT OF MAKE-UP WATER EVAPORATOR SYSTEM HANDLING 30,000 LB. DISTILLATE PER HOUR, BUFFALO GENERAL ELECTRIC COMPANY

(*Power*, vol. 45, no. 7, February 13, 1917, pp. 202-212, 11 figs. *dg*)

Varia

SCIENTIFIC PROBLEMS AWAITING SOLUTION

Henry le Chatelier, in a recent address to the French Academy of Sciences, indicated certain scientific problems with special reference to French engineering which still await solution.

The French industries are now actively interested in attempts to produce laboratory glass, which hitherto used to be imported from abroad. At present they are only melting experimental masses at a considerable cost in time and money. At the same time it is known that the main property of glass on which depends the entire success of production is the extension of the range of its fusibility. Preliminary measures of the variation of the viscosity of glass as a function of temperature and chemical composition would be of inestimable value, in that they would reduce the necessary number of experiments on a commercial scale, and while these latter experiments cost hundreds of francs each, laboratory experiments could be carried out in small platinum crucibles with a dozen grams of material, and would cost quite little.

The same methods could be used for the preparation of test pieces for the determination of expansion, which is of such great importance in ceramics, and for the determination of electrical resistance in insulators, and of chemical stability, valuable in chemical analysis.

Here, in the opinion of the speaker, lies a field of scientific work of the greatest value.

Metallurgy. Penetrating projectiles used in the navy must have a very hard tip in order to pierce surface-hardened armor plate. Hence, in order to control the production of these projectiles, it is necessary to have a method of measuring the hardness of heat-treated steel. As a matter of fact, we have not got it. The least unsatisfactory of all that we have at present is the Shore scleroscope, which uses the rebound of a small steel projectile having a diamond-pointed end. The results are, however, not comparable, since in addition to hardness they are affected by various elementary factors, especially the shape of the pieces tested.

The study of the behavior of elastic bodies under shock is a matter of great interest, but so far as this problem is concerned, knowledge has scarcely advanced beyond where it was left by Leonardo da Vinci. The rebound amounts, on the average, to three-quarters of the height of fall, varying from 60 to 90 per cent of this height. Calculus, together with experiments, would no doubt rapidly advance our knowledge and supply means for determining the conditions under which the rebound would depend only on the hardness of the surface of the body measured.

Pyrometry. The measurement of heat and temperatures acquires a constantly growing importance in the industries. Each one of our shops for heat-treating projectiles uses a good many pyrometers. Unfortunately, their indications are not as precise as would be desirable. One cannot use the standard

gas thermometer, which is too complicated for use outside of physical laboratories. The Siemens-Callendar platinum thermometer is very exact, but too fragile for everyday use in shops. The only three types of pyrometers exclusively used in shops are the thermo-electric, optical, and calorific radiation pyrometers. But their readings are not sufficiently exact.

Their defects are not due to the capricious action of natural laws. The laws are absolutely uniform in their action, but several elementary factors or several independent variables act simultaneously, and should we happen to neglect any of these factors, or even to fail to make sure that they remain absolutely invariable, we would obtain results necessarily lacking in precision, in accordance with the greater or lesser importance of the neglected factors.

The thermo-electric force of a couple depends, above all, on the temperature at the welded joint, but also, in a lesser degree, on the law of distribution of temperatures along the conductor between the hot weld and the cold weld. This is a phenomenon which we know qualitatively, but its quantitative investigation is still to be made.

The homogeneous wire heated in the middle under such conditions that the gradient of temperature differs from one part of the heated zone to the other, generates a parasitic thermo-electric force, and this phenomenon varies in intensity with the nature of the metal used.

The readings of the optical pyrometer depend on the emissivity of the bodies observed. Hitherto the emissivity of three bodies has been determined: platinum, oxide of iron, and oxide of nickel. A good many other common bodies are still to be studied.

The results obtained with a radiation pyrometer are affected by the variable distribution of temperatures in the metal box of the apparatus. This factor is yet to be studied, and it is also necessary to determine the conditions required to eliminate this disturbing cause.

Heating. The heat conductivity of materials used for walls of commercial furnaces, and also that of the masses of coal burned on the grates, are essential factors in the problem of proper utilization of combustibles. The conductivity of metals is known, but for refractory materials we have only empirical data which vary as much as 100 per cent in accordance with conditions of manufacture. There is no information at all, even empirical, as to the heat conductivity of the masses of coal; and still this conductivity is an essential factor in the important matter of the possibility of burning out the grate bars. To make these measurements really scientific, it would be necessary to carry out experiments on heaps of spherical balls of known constitution, systematically varied as to diameter and temperature. In this way it would be possible to determine the laws of transmission of heat through porous masses, of radiation, convection, and of conduction proper.

In the course of the same experiments one could determine the laws of flow of gases through masses of this character; and the results obtained would be used not only for heating but also for the selection of molding sands and in other problems.

The author discusses in a similar manner certain problems affecting agriculture. (*Quelques problèmes scientifiques à résoudre,* Henry Le Chatelier. *Le Génie Civil,* vol. 70, no. 6, February 10, 1917, pp. 95-96, *g*)

Detinning Apparatus

Prior to the war steel scrap in the form of cans, etc., was shipped from England to Germany for removing the tin, solder and zinc. The following apparatus has been recently patented in England to do the work at home.

The apparatus essentially consists of a slowly rotating inclined cylinder and a stationary hopper with a sleeve encircling the rotating cylinder. The latter has a feed aperture which once in every revolution registers with the aperture on the hopper and allows the cans to be fed into the internal heating chamber. To reduce the friction the latter is mounted upon roller bearings. The heating is effected by gas or oil burners.

The heating chamber is surrounded by a firebrick-lined cylinder with outlets for the products of combustion through the short flues at the top. Cans feed into the heating chamber, gravitate slowly through as the chamber rotates, and eventually find their way to the outlet where they pass down the chute. The temperature is gradually raised along the length of the chamber and is the highest at the outlet end. In the interior of the heated chamber channels are formed for collecting the molten tin and solder. *Aeronautics,* vol. 12, no. 170, January 17, 1917, p. 55, 1 fig., *d*)

American Institute of Mining Engineers

The 114th Meeting of the American Institute of Mining Engineers, which was held in New York City, Feb. 19 to 22, was one of public, technical and social interest. The general or public interest of the meeting was more than is usually the case, due to the activities of the Institute in connection with public affairs as well as to papers of general interest, as for example: a new source of potash supply (the isolation of Germany has cut off the chief source of this material); a study of the world's reserves of manganese ores and of petroleum; and finally a research on the subject of erosion of guns. This latter paper attracted the interest of members of the Naval Consulting Board, of experts of the United States Army and Navy and of the Spanish Military Commission, many of whom attended the meeting and discussed the paper. General interest also centered around the personality of Herbert C. Hoover, Chairman of the Commission for Relief in Belgium, who, since before the war, has been a Vice-President of the American Institute of Mining Engineers and who was guest of honor at the Reunion Smoker and at the Annual Dinner, where announcement was made that he had been elected an Honorary Member. Finally, ladies of the families of members of the Institute gathered to the number of about one hundred, and formed a Women's Auxiliary of the A.I.M.E., "for service along any lines which may prove useful now or in the future to the country or community or to humanity at large." The activities of the Auxiliary are being extended to every part of the globe where mining engineers and their families reside.

The technical interest of the meeting is indicated by the fact that eighty-five per cent of the papers presented were discussed. In some cases the discussion was more important, and in some cases more voluminous, than the paper which brought it forth.

The social features of the meeting included a Reunion Smoker, on Monday evening; the Annual Dinner, on Tuesday evening; an Exhibition of Moving Pictures in colors, on Wednesday evening; Luncheon for all members and guests, including the ladies, on each day; and finally, an All-Day Excursion to the West Point Military Academy, by special train, on Thursday, Washington's Birthday, where the members and guests were royally entertained by the Superintendent and his staff, and where they had the opportunity in

[illegible] entertaining [illegible] at luncheon. Other most enjoyable occasions in connection with the meeting consisted of a visit to the magnificent Art Galleries of Senator William A. Clark and Henry C. Frick, Esq., Tea and Exhibition Ice-Skating on the roof of the Waldorf Astoria, a theatre matinee for the ladies, and a visit to a moving picture studio.

Bradley Stoughton,
Secretary.

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

A new society under the name of the American Institute of Weights and Measures has been organized, with the purpose of opposing the introduction of the metric system in the United States.

The following officers were elected: President, W. R. Ingalls; Vice-Presidents, Henry D. Sharpe and D. H. Kelly; Treasurer, Walter M. McFarland; Secretary, F. A. Halsey.

According to a statement given to the press by State Engineer (New York State) Williams, daily service on the new Barge Canal between Buffalo and Albany will be begun in May. This will mean direct barge connection between the Great Lakes and the Port of New York, although facilities for the reception of all classes of freight will not be provided until next year. Freight rates will be approximately two-thirds of the railroad carrying charges.

In anticipation of the early need of cars of higher average capacity than those now in common use, the Pennsylvania Railroad, according to the *Railway Review*, has constructed a hopper gondola car of eighty-five tons capacity. This particular car has been constructed as an experiment, but if should prove successful, will serve as a model for future coal-carrying equipment. The design involves the use of four-wheel trucks and imposes loads thereon in excess of 60,000 lb. per axle, which approaches very nearly the limits recognized in locomotive construction.

When a modern large gun is fired with nitrocellulose smokeless powder, the temperature of combustion reaches from 4,000 to 5,000 deg. fahr.; and if the powder contains 25 per cent of nitroglycerine, it may rise to 5,000 to 6,500 deg. Steel melts at 2,650 deg. fahr., and a thin film of steel is fused in about one-sixtieth of a second. As soon as the projectile has left the gun, the big outflow of gas washes away a portion of this thin film of fused steel, and the bore is thus enlarged 0.001-in. in a 14- or 16-in. gun at each shot. With 58 per cent nitroglycerine, as in some English powders, the erosion is much greater.—Hudson Maxim, at the A.I.M.E. Annual Meeting, New York, Feb. 21, 1917.

The Pennsylvania Railroad has recently installed at Pitcairn, Pa., a novel type of plate-fulcrum track scales. This form of construction eliminates the knife edges which have been practically universally employed in scales of all kinds. In consequence of this change, the need of regrinding and renewing knife edges and bearings is done away with.

The place of the knife edge is taken by a thin plate continuous from lever to bearing. These novel plate fulcrums consist of relatively thin central portions connected to heavier portions or heads. The thin portion gives the desired flexibility, while the large heads distribute the load on the supported members and decrease the unit stresses. The design is such that the necessary vibration is taken care of without need of such wear as takes place in a knife-edge scale.

As a result of experiments recently carried out at the Consolidated Gold Fields Laboratory, an easy, cheap, and effective method of removing iron oxide from corroded and pitted iron plates has been evolved. Previous practice on the Rand has been to remove this mechanically, either with hammers, chisels, or a sand blast. While largely efficient, each of these methods is liable to leave traces or nodules of rust, especially at the bottom of the pitting, and these nodules prevent the covering of paint adhering to the iron and form nuclei for further corrosion.

The method evolved consists in applying to the surface of the iron a mixture of finely crushed sodium bisulphate and common salt, in the proportion of two parts of the former to one of the latter. This mixture is prepared, then wetted (just sufficiently to be cohesive) and applied to the iron plate. If time be no object, the moist mixture can be left until the plate is clean, but the action is much more rapid if the mixture is scraped off every two or three hours and the iron scrubbed thoroughly with a wire brush, applying water at the same time. The treatment is repeated until the plate is clean. Usually 24 hours is sufficient for a badly corroded plate.

The liberation of hydrochloric acid takes place slowly, and its action on the metallic iron appears to be slight.

When the plate is thoroughly clean it is washed well, finally with an alkaline solution, and dried quickly. A coating of paraffin oil is at once applied to protect the surface against atmospheric action. The metal is then ready for application of paint or other protective covering.

At the College of Engineering of the University of Minnesota a new educational experiment is being tried in the application of the task-and-bonus plan to the departments of shop work and design. Every job given to a student carries with it the time allowed, which is estimated on a fair basis. Any time saved by the student is given to him as a credit by means of which his time in college may be shortened if he accumulates a sufficient amount. It is assumed that the best men can save one-third of the time; and on the other hand if they prefer to do more work and not use the credit in reducing the time spent on the subject they can get one-third more value out of the course.

Prof. J. J. Flather reports that the system is working well both in the shop and drawing room and that all the instructors are enthusiastic in its application. The output per individual is at least 25 per cent and in some cases 50 or 60 per cent more than was the average before the scheme went into effect. There is an increased enthusiasm on the part of the men; their ambition is stimulated, and no drop in the quality of the work has been apparent. In fact, there is a strong tendency to maintain a high standard because additional credit is given for superior work and an extraordinarily good man may earn one-third bonus for quality in addition to the bonus he may earn for quantity.

SELECTED TITLES OF ENGINEERING ARTICLES

AERONAUTICS

The Case for the Large Aeroplane. F. Handley Page. Flight, no. 425 (no. 7, vol. 9), February 15, 1917, pp. 161-164.

Enemy Aircraft Engines. The Automobile Engineer, vol. 7, no. 99, February 1917, pp. 32-34, 5 figs.

Les Albatros. L'Aerophile, vol. 25, nos. 1-2, January 1-15, 1917, pp. 6-10.
The Albatros aeroplanes.

Le Biplan allemand Rumpler. Jean Lagorgette. L'Aérophile, vol. 24, nos. 23-24, December 1-15, 1916, pp. 365-379, 39 figs.
The German Rumpler biplane.

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LIBRARY NOTES

From the Libraries of the Four Founder Societies and the United Engineering Society, in the Engineering Societies Building, New York City

Our New Librarian

W[illegible] the appointment of Dr. Harrison W. Craver, until recently librarian of the Carnegie Library of Pittsburgh, to be Director of the combined [illegible] of the American Society of Civil Engineers, the American Institute of Electrical Engineers, the American Institute of Mining Engineers, The American Society of Mechanical Engineers, and the United Engineering Society.

Dr. Craver was born in Owaneco, Illinois, August 30, 1875. He was educated in the public schools of Carmi, Illinois, and Terre Haute, Indiana, and the Rose Polytechnic Institute, from which he was graduated in 1895, having specialized in industrial chemistry. The following year was spent in post-graduate chemical study with Dr. W. A. Noyes. In 1896 he became chemist to Kirkpatrick & Co., Limited, of Pittsburgh, and later to the Shoenberger Steel Co., the Virginia Iron, Coal & Coke Co., and the Duquesne Reduction Co. During this period he acquired a practical knowledge of iron metallurgy, particularly of open-hearth steel manufacture.

Dr. Harrison W. Craver

In 1900 Dr. Craver first became associated with the Carnegie Library of Pittsburgh, being asked by the librarian, Dr. Edwin H. Anderson, now director of the New York Public Library, to undertake the organization of a technological department. To this work his attention was given until 1908, although interrupted by some returns to metallurgical work. Among these the most important was in 1902, when he became assistant superintendent of the Allegheny Steel Co., then in process of organization, and was placed in charge of their rolling mills. In 1908 he was elected librarian of the Carnegie Library of Pittsburgh, which position he has held since.

Dr. Craver's library experience has been unusually varied. The Technology Department, his first task, was a venture in a field hitherto untried, as no municipal library had attempted to meet the special wants of engineers and manufacturers. The methods of organization and the plan of service adopted have proved the model for the technology departments since inaugurated in most similar institutions in America. He has developed an unusual system of coöperation with the public schools and has been able, through the constant succession of bibliographic publications issued by the Library under his direction, to be of service to libraries and students throughout the world. The bibliographies on engineering subjects have been especially appreciated.

Among librarians his services to the profession have long been recognized. He has been since 1909 a member of the Council of the American Library Association, a member of the Executive Board since 1913, and Chairman of the Finance Committee since 1914. At present he is also First Vice-President of the Association.

Dr. Craver has been a member of the Engineers' Society of Western Pennsylvania since 1900. He was for several years a director of the society and chairman of the publication committee. He is also a member of the American Chemical Society and of the American Association for the Advancement of Science.

Now that the libraries of the four Founder Societies are grouped under one roof, an opportunity occurs to mold them into one all-embracing Engineering Library and to render this of service to the greatest degree to the members of the Societies and the profession generally.

Dr. Craver will be given most cordial support by the Library Board to develop his ideas and bring this all-important problem to a successful issue.

Library Service Bureau

THE Library Service Bureau, conducted by the United Engineering Society, has greatly increased its clientele since its foundation in April 1915. Service has been rendered to correspondents in 239 localities in 45 States in the United States, as is shown on the map here reproduced, and to foreign correspondents in 70 localities in 23 foreign countries. Photostat copies of articles in engineering periodicals have been sent to far-distant Australia, Korea and South Africa. Bibliographical assistance has been given in connection with the unification of railways in Australia, and the revision of the mining laws in that country; the development

of mining in China, Korea and South Africa; the raising of a sunken vessel in Chile; the construction of oil storage tanks in India, and the electrification of railways in Austria. The service is therefore nation-wide and world-wide.

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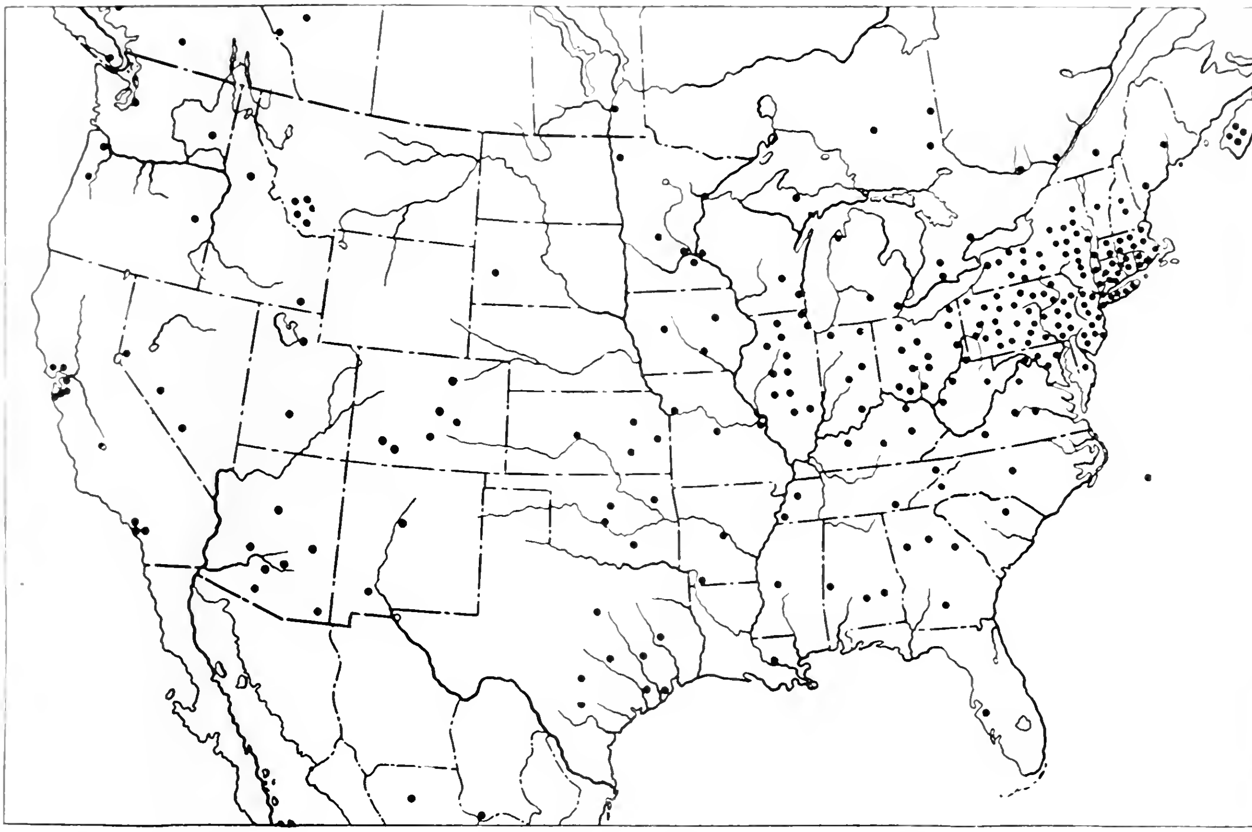
The Development of the Steam Engine. By Max Toltz. Gift of W. P. Cutter.

District of Lake St. John, Quebec, Part of. Canada Geological Survey: Memoir 92. *Ottawa, 1916.* Purchase.



Geographical Distribution of Library Service Bureau Correspondents

American Iron & Steel Institute. Year Book. 1910, 1912-1915. *New York, 1910, 1912-15.* Gift of American Iron & Steel Institute.

American Library Annual, 1915-16. *New York, 1916.* Purchase.

American Railway Engineering Association. Proceedings, vols. 15-17. *Chicago, 1914-16.* Purchase.

American Railway Master Mechanics' Association. Proceedings, vol. XLIX. *Chicago, 1916.* Purchase.

The Ash in North Carolina. Press Bulletin no. 156, N. C. Geological & Economic Survey. *Chapel Hill, 1917.* Purchase.

Bibliography of Fishes. Volume I. Authors' Titles A-K. *New York, 1916.* Purchase.

Bibliography of Recent Literature on Flotation of Ores. January to June 1916. U. S. Bureau of Mines. Technical Paper 135. *Washington, 1917.* Purchase.

A Brief Description of the Physical and Operating Properties of the Subsidiary and Affiliated Companies of the General Gas and Electric Company, May 1915. *New York,* n.d. Gift of Chas. H. Armstrong.

Buyers' Guide for Textile Mills. A handy reference book for buyers of textile mill supplies and equipment. New York, n.d. Gift of Textile World Journal.

By-Product Coke and Gas Ovens for the Recovery of Ammonia, Tar and Benzols. Designed and built by H. Kopers Company. *Pittsburgh,* n.d. Gift of H. W. Nicolson.

Calculus. By H. W. March and H. C. Wolff. *New York, 1917.* Purchase.

Dutch East Indies. Jaarverslag van de Winning, het Vervoer en den Verkoop van Banka-Tin over het Exploitatiejaar 1914. *Batavia, 1916.* Purchase.

Electric Central Station Distribution Systems; their design and construction. Ed. 2. By H. B. Gear and P. F. Williams. *New York, D. Van Nostrand Co., 1916.* Price $3.50. Gift of Publishers.
The first edition of this work was published in 1910, and was based on articles in the Electrical Age. This new edition is due to the rapid progress in the last few years and has been largely rewritten.
W. P. C.

English and Engineering. A volume of essays for English classes in engineering schools. By Frank Aydelotte. *New York, 1917.* Purchase.

Federal Valuation of the Railroads in the United States. Statement prepared by H. C. Phillips, of the developments in connection with Federal valuation as of February 10, 1917. Gift of Clemens Herschell.

Feldspar in Canada. Canada. Mines Department, pub. no. 401. *Ottawa, 1916.* Purchase.

Gas Industry. vols. 11-21. *Buffalo, 1911-12.* Purchase.

Geology of the Country to the South of Kalgoorlie, including the mining centers of Golden Ridge and Feysville, Western Australia. Geological Survey, Bulletin no. 66. *Perth, 1916.* Purchase.

Grandes Voûtes. vol. 6. By Paul Séjourné. *Bourges, 1916.* Purchase.

Graphite, 1916. Gift of Joseph Dixon Crucible Co.

[illegible] State Geological Survey. Year Book for 1915. Administrative Report and [illegible] papers. Bulletin no. [illegible] [illegible], 1916. Purchase.

India Rubber, Gutta Percha and Electrical Trades Diary and Year Book, 1917. London, 1917. Purchase.

Institution of Civil Engineers. List of Members. 1917. *London, 1917.* Purchase.

Institution of Gas Engineers. Transactions, 1916. *London, 1916.* Purchase.

Manchester Association of Engineers. Transactions. 1915-16. *Manchester, 1916.* Purchase.

Manufacturing Costs and Accounts. By A. H. Church. *New York, 1917.* Purchase.

Marine Steam Engine. Ed. 13. By Richard Sennett and H. J. Oram. *London N. Y., 1916.* Purchase.

Master Car Builders' Association. Proceedings. vol. 50, pt. 1-2. *Chicago, 1916.* Purchase.

Metal Mine Accidents in the United States during calendar year 1915. U. S. Bureau of Mines. Technical Paper 168. *Washington, 1917.* Purchase.

Metropolitan Water Board. Twelfth Report on Research Work by A. C. Houston. *London, 1916.* Purchase.

Motor Cycling Manual. Ed. 3. *London,* n.d. Gift of Frank Gilliland.

National Association of Cotton Manufacturers. Transactions. No. 101. *Boston, 1917.* Purchase.

National Committee for the Prevention of Blindness. Annual Report, 2d, Nov. 1916. *New York, 1916.* Gift of L. Cammen.

National Lamp Works of General Electric Company. Abstract. Bulletin of Nela Research Laboratory Works. *Cleveland, 1917.* Gift of National Lamp. v. 1, no. 2.

New York (City) Department of Water Supply, Gas and Electricity. Communication from Commissioner William Williams to the Board of Estimate and Apportionment, transmitting report of Deputy Commissioner Wilcox upon the Citizens Water Supply Company of Newton, Borough of Queens, Feb. 5, 1917.

—— Report of Delos F. Wilcox, in relation to the Citizens Water Supply Company of Newton, Oct. 7, 1916. Gift of City of New York Department of Water Supply, Gas and Electricity.

New Zealand. Mines Statements for 1915. *Wellington, 1916.* Purchase.

North Carolina and her Natural Resources, some Facts and Figures. Ed. 2. *Raleigh, 1917.* Purchase.

North East Coast Institution of Engineers and Shipbuilders. List of Members. Feb. 1917. *Newcastle-upon-Tyne, 1917.* Purchase.

Oil Investigations in Illinois in 1916. Illinois. State Geological Survey. Bulletin 35. *Urbana, 1917.* Purchase.

Operation of Gas Works. By W. M. Russell. *New York, 1917.* Purchase.

Pennsylvania. Department of Agriculture. Proceedings of the Farmers' Annual Normal Institute. Bulletin 283. *Harrisburg, 1916.* Purchase.

—— Annual Report, 21st. 1915. *Harrisburg, 1916.* Purchase.

Pennsylvania. Department of Mines. Report. Part I—Anthracite, 1915. *Harrisburg, 1916.* Purchase.

Physical Experiments for Engineering Students. By Samuel Sheldon and Erich Hausmann. Part I. Mechanics, Sound, Heat and Light. *New York, D. Van Nostrand Co., 1917.* Price $1.25. Gift of Publishers.

Prepared for sophomore students in the Polytechnic Institute of Brooklyn. There are thirty exercises, covering a course of ninety hours. W. P. C.

Pilot Butte Oil Field. Wyoming State Geologist. Bulletin no. 13. *Cheyenne, 1916.* Purchase.

Preliminary report on the Crystalline and other marbles of Alabama. Alabama Geological Survey. Bulletin no. 18. *University, 1916.* Purchase.

Quarry Accidents in the United States during the calendar year 1915. U. S. Bureau of Mines. Technical Paper 165. *Washington, 1917.* Purchase.

Railway Business Association. A Glimpse at the Works by Frank W. Noxon, Jan. 16, 1917. Purchase.

Railway Problem. Address by Frederick A. Delano, at the annual dinner of the Railway Business Association, Jan. 16, 1917. Purchase.

Refining and Utilization of Georgia Kaolins. U. S. Bureau of Mines. Bulletin 128. *Washington, 1916.* Purchase.

Russian Electrotechnical Commission. Standardization Rules of the American Institute of Electrical Engineers. In Russian. n.p. 1916. Gift of Commission.

Russian Electrotechnical Terminology. By L. D. Tsaxoff. Russian. n.p. 1916. Gift of International Electrotechnical Commission.

Russia. Scientific Committee of the Ministry of Agriculture. Bulletin of Bureau of Agricultural Mechanics. vol. 8, nos. 1-3. n.p. 1916. Gift of Committee.

Seaboard Air Line Railway Company. Annual Statement, 1909-1916. *Portsmouth, Va., 1909-16.* Gift of Company.

The Solution. Address by Alfred P. Thom, at the Annual dinner of the Railway Business Association, Jan. 16, 1917. Purchase.

Some Business Aspects of the Railroad Problem. Address by Walker D. Hines. Annual meeting of the Chamber of Commerce of the U. S. *Washington, D. C., January 31, 1917.* Purchase.

Springfield (Ill.) Insurance Department. Addresses and Papers on Insurance. By R. M. Potts. *Springfield, 1917.* Gift of Insurance Department.

Staffordshire Iron and Steel Institute. Proceedings. vol. 31. *Stourbridge, 1917.* Purchase.

Strength of Ships. By A. J. Murray. *New York, Longmans, Green & Co., 1916.* Price $5.00. Gift of Publisher.

An extensive treatise, largely mathematical, of the strength of beams, columns, shafts, bulkheads, plating, fastenings, rigging, and outboard fittings, plate brackets and rudders, as well as discussions of longitudinal and transverse strength. W. P. C.

System. vols. 11-28. *New York, 1907-1915.* Purchase.

Tables giving the Times of Rising and Setting of the Sun and Moon, 1917 and 1918. Supplement to the American Ephemeris, 1917. *Washington, 1917.* Purchase.

Tentative Valuation by Interstate Commerce Commission, Feb. 14, 1917. Elgin, Joliet & Eastern Railway. Gift of Clemens Herschel.

Thermodynamics of the Steam Engine and Other Heat-engines. Ed. 6. By C. H. Peabody. *New York, 1914.* Purchase.

The Toltz-Lipschutz Acetylene Car Lighting System. By Max Toltz. Gift of W. P. Cutter.

U. S. Bureau of Standards. Circular nos. 14, ed. 5; 16, ed. 4; 30, 35, ed. 2; 38, 3d. 2; 48-49, ed. 2; 51, 52, ed. 2; 53, 54, ed. 2; 55; 57, ed. 2; 59, 60.

—— Scientific Papers. nos. 267-8, 271-6, 278-9; 282-91, 293-5.

—— Technologic papers. nos. 25, 41, 70, 73, 76, 77, 79, 82. Purchase.

U. S. Bureau of Standards. Weights and Measures. 11th Annual Conference. *Washington, 1917.* Gift of Bureau of Standards.

U. S. Interstate Commerce Commission. Valuation in the matter of the property of the Atlanta, Birmingham & Atlantic Railroad Company, Georgia Terminal Company and Alabama Terminal Railroad Company. Hearing, Washington, Jan. 29-Feb. 3, 1917. Gift of Clemens Herschel.

Water Powers of Alabama, Second Report on. Alabama Geological Survey. Bulletin no. 17. *University, 1916.* Purchase.

Western Reserve University. Catalogue, 1916-17. *Cleveland, 1917.* Gift of University.

Who's Who in America. 1903-05. *Chicago, 1905.* Gift of Clemens Herschel.

A.S.M.E. Accessions

Atlantic Deeper Waterway Association. Report of Proceedings of 9th Annual Convention. *Philadelphia, 1917.* Gift of Association.

Detroit (Mich.) Board of Water Commissioners. Annual Report 64th, 1916. *Detroit, 1917.* Gift of Board of Water Commissioners.

Hawaiian Volcano Observatory. Weekly Bulletin. vol. IV, no. 11, 12. *Honolulu, 1916.* Gift of A.S.M.E.

Huddersfield Engineering Society. Journal of Proceedings. 17th session, 1915-16. *Huddersfield, 1916.* Gift of Society.

Inferences Concerning Auroras. By Elihu Thomson. Reprinted from the Proceedings of the National Academy of Sciences, vol. 3, Jan. 1917. Gift of A.S.M.E.

Johnson's Steam Vessels of the Atlantic Coast, 1917. New York, Eads Johnson Publishing Co., 1917. Price $5.00. Gift of Eads Johnson.

This handy volume contains a list of the steam vessels of American registry on the Atlantic Coast. The main facts are given in the list by companies or owners, an alphabetical index being furnished. W. P. C.

Mayor's Committee on Unemployment. Planning Public expenditures to compensate for decreased private employment during business depressions. Extension of an address by John R. Shillady. *New York City, 1916.* Gift to Mayor's Committee on Unemployment.

National Association of State Universities in the United States of America. Transactions and Proceedings. vol. 14, 1916. *Burlington, 1916.* Gift of A.S.M.E.

National Marine Engineers' Beneficial Association, Journal of Proceedings. vol. 14, no. 2. *Chicago, 1917.* Gift of Association.

National Rivers and Harbors Congress. Declaration of Principles adopted Dec 8, 1916. Gift of A.S.M.E.

New Garbage Reduction Plant for the City of New York. By Gustave R. Tuska. Paper read before the 23d Annual Convention of American Society of Municipal Improvements at Newark, N. J., Oct. 9-13, 1916. Gift of author.

The Potentiality of Waterways. Address by Joy Morton before the National Rivers and Harbors Congress, 13th Annual Convention, Dec. 1916. Gift of A.S.M.E.

Propriety of River and Harbor Appropriations. Remarks of Gen. Wm. H. Bixby. Before the National Rivers and Harbors Congress, 13th Annual Convention, Dec. 1916. Gift of A.S.M.E.

Relation of Inland Waterways to Naval Efficiency. An Address by Admiral Wm. S. Benson. Before the National Rivers and Harbors Congress, 13th Annual Convention, 1916. Gift of A.S.M.E.

Some Observations on Water Transportation. An address by Gen. Wm. B. Black. Before National Rivers and Harbors Congress, 13th Annual Convention, Dec. 1916. Gift of A.S.M.E.

Story of the Aeroplane. 1917. Gift of the Wright Flying Field, Inc.

TRADE CATALOGUES

Builders Iron Foundry. Providence, R. I.
Bulletin No. 165. The charge for water actually exists whether it is specifically entered on the accounts or not.

Dielectric Mfg. Co. St. Louis, Mo.
Data on dependable insulation.

Fire Detecting Wire Co. New York, N. Y.
Fire Detection. 1916.

Flannery Bolt Co. Pittsburgh, Pa.
Staybolts. February 1917.

Goodrich, B. F. Company. Akron, Ohio.
Motor Trucks of America. vol. 5, 1917.

Hutchison Vapor Heating Corporation. Washington, D. C. System of vapor heating. 1915.

Kitts Manufacturing Co. Oswego, N. Y.
Catalogue No. 12. Steam specialties. 1917.

Monarch Engineering & Manufacturing Co. Baltimore, Md.
Crucible problem solved.

Under-Feed Stoker Company. Chicago, Ill.
Publicity Magazine. February 1917.

Walworth Mfg. Co. New York, N. Y.
Walworth Log. February 1917.

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary and items should be received by April 16 in order to appear in the May issue.

CHANGES OF POSITION

Lieut. Philip B. Eaton of the U. S. Coast Guard Cutter "Bear," San Francisco, Cal., is now stationed at the Naval Aeronautic Station, Pensacola, Fla.

Mark E. Smith, until recently affiliated with the Erie City Iron Works, Erie, Pa., as draftsman, has become associated with the Union Iron Works of the same city.

Frederick W. Starr, formerly connected with the Toledo Scale Company, Hartford, Conn., has become identified with the Fisk Rubber Company, Chicopee Falls, Mass.

T. E. Buck, formerly draftsman with the Donora Steel Company, Donora, Pa., has entered the employ of the United Engineering and Foundry Company, Springfield, Ill.

C. W. Hunting, recently vice-president and general manager of the Minneapolis and St. Louis Railroad, Minneapolis, Minn., has been elected president of the Virginian Railway.

James McNaughton, formerly vice-president of the American Locomotive Company, has been made assistant to the president of the Eddystone Munition Corporation, Eddystone, Pa.

Paul A. Fusselman, formerly general shop foreman of the Kansas City Gas Company, Kansas City, Mo., has become associated with the Counties Gas and Electric Company, Ardmore, Pa.

Waldo H. Blackmer has severed his connection with the American Ammunition Company, Worcester, Mass., and has become affiliated with The Harrison Radiator Corporation, Lockport, N. Y.

John R. LeVally, formerly engineer with the Burrell Belting Company, Chicago, Ill., has become affiliated with Armour and Company, Chicago, Ill., in the capacity of assistant chief engineer.

Harold B. Bernard has resigned his position with The Foxboro Company, Foxboro, Mass., to accept the position of mechanical engineer with the Oklahoma Petroleum and Gasoline Company, Tulsa, Okla.

Arthur Driver, formerly chief tool designer, Gray and Davis, Inc., Boston, Mass., has accepted a position with the Canadian Cartridge Company, Ltd., Hamilton, Ont., Canada, in the capacity of mechanical engineer.

C. J. Bacon has resigned his position as assistant engineer of construction with the Illinois Steel Company, South Chicago, Ill., to enter the engineering department of E. I. du Pont de Nemours Company, Wilmington, Del.

Norman L. Baker has become connected with the American Steel Foundries, East St. Louis, Ill., in the capacity of works engineer. He was formerly mechanical engineer with the By-Products Coke Corporation, Chicago, Ill.

George C. Vennum, until recently assistant chief engineer of the Union Electric Light and Power Company, St. Louis, Mo., has assumed the duties of mechanical superintendent of The Douglas Company, Cedar Rapids, Ia.

Harry D. Carter, until recently fuel engineer with Samuel M. Green Company, Springfield, Mass., has become affiliated with the Warner-Klipstein Chemical Company, Inc., South Charleston, W. Va., in the capacity of superintendent.

Robert B. Adams has resigned his position as assistant superintendent of the New England Westinghouse Company, Meriden, Conn., and has accepted a similar position with the King Sewing Machine Company, of Buffalo, N. Y.

Virgil A. Root has accepted a position in the engineering department of Warner and Swasey Company, Cleveland, O. He was formerly connected with the engineering department of the Subers Fabric and Rubber Company, Cleveland, O.

Kenneth I. Tredwell, until recently purchasing agent with The Sentinel Manufacturing Company, New Haven, Conn., has accepted a position on the production engineer's staff of the Winchester Repeating Arms Company of the same city.

Newman Comfort, manager of the Nebraska Division of the Universal Inspection Company of Iowa, Omaha, Neb., has assumed the duties of manager of the Ohio Branch of the National Workmen's Compensation Service Bureau, Cleveland, O.

John C. Hoar has resigned as master mechanic of the Chateaugay Ore and Iron Company, Lyon Mountain, N. Y., and has assumed the duties of general foreman of repair departments of the American Locomotive Company, Schenectady, N. Y.

Wallace H. Martin, until recently instructor of mechanical engineering at the University of Minnesota, Minneapolis, Minn., has become associated with the mechanical engineering department of The Pennsylvania State College, State College, Pa.

Theodore H. Hermanson, formerly superintendent of the Blake and Knowles Works of the Worthington Pump and Machinery Corporation,

[illegible] Cambridge, Mass., has assumed the duties of superintendent of [illegible] plant of Henry R. Worthington, Harrison, N. J.

George W. Rich, formerly works manager of The Aultman and Taylor Machine Company, Inc., Mansfield, O., has resigned his position and has accepted the position of assistant general factory manager for the Curtiss Aeroplane and Motor Corporation of Buffalo, N. Y.

H. J. Markey has left the hydraulic turbine department of The Wellman-Seaver-Morgan Company of Cleveland, O., and is now connected with the Firestone Tire and Rubber Company, Akron, O., in the special engineering department handling new plant construction.

Monroe R. Hull has resigned his position as chief engineer of the Arizona Copper Company, Ltd., Clifton, Ariz., to accept the position of mechanical engineer for the Sissert Mining Company, Ltd., with general office at London, and will be located at their properties in Russia.

M. William Ehrlich has become associated with the sales force of the Kewanee Boiler Company, with headquarters in New York. He was formerly connected with Hersh and Brother, heating and ventilating contracting engineers of Allentown, Pa., in the capacity of chief engineer.

Wallace J. Newell, formerly with the Westerman Iron Works, Seattle, Wash., is in the employ of the British Columbia Salvage Company, Vancouver, B. C., as engineer in the salvaging of the German S.S. "Sesostris" which went ashore off the west coast of Guatemala some years ago.

ANNOUNCEMENTS

Carl Eihrmann has become associated with the T B Gasoline Company, Chelsea, Okla.

James Stokoe has accepted a position with the Sinclair Refining Company, Chicago, Ill.

George W. Dunham has been elected a member of the board of governors of the Aero Club of Detroit.

Walter W. Hagerty has accepted a position with The Roessler and Hasslacher Chemical Company, Perth Amboy, N. J.

John J. Swan has been commissioned by the President as a captain of Engineers, in the Engineer Officers' Reserve Corps of the United States Army.

Palmer Collins, assistant superintendent of the South Works of the American Steel and Wire Company, Worcester, Mass., has severed his connection with the company.

Lieutenant Martin A. Doyle, formerly identified with the U. S. Coast Guard Cutter Mohawk, New York, is now stationed at Pensacola, Fla., Coast Guard Cutter Penrose.

Henry D. Sharpe, president of the Brown and Sharpe Manufacturing Company, Providence, R. I., has been elected a director of the New England Telephone and Telegraph Company.

R. B. Sheridan, president of the Allied Machinery Company of America, New York, left on March 2 for a business trip to Spain and France. He will be away for two months or more.

Cass L. Kennicutt, who for many years has been known as one of the foremost experts in water softening, has become associated with The Permutit Company, in charge of the Chicago office.

Clyde C. Elmes, superintendent of the Eddystone Ammunition Corporation, Eddystone, Pa., has been commissioned a captain in the Engineer Officers' Reserve Corps of the United States Army.

William H. Smead, manager of the heating and equipment department of the Austin Company, Bridgeport, Conn., has been transferred to the home office of the company, Cleveland, O., in a similar capacity.

H. Ralph Hadlow, formerly consulting mechanical engineer, Cleveland, O., has become mechanical engineer with The Watson Engineering Company, Cleveland, O., which has been incorporated to carry on the business of Wilbur J. Watson and Company.

George H. Woodroffe has accepted the position of mechanical and metallurgical engineer with The Parkesburg Iron Company, Parkesburg, Pa. He was formerly in the employ of the Philadelphia Steel and Forge Company, Philadelphia, Pa., as superintendent of the forge department.

Rolla C. Carpenter reaches the retiring age at the end of the present college year and will sever his active connection with Cornell University at that time. Professor Carpenter expects to maintain his activities in the fields of engineering investigation and research for several years to come.

Edwin G. Hatch, consulting engineer, of New York, is arranging to have manufactured in this country a large quantity of 5 per cent nickel steel turbine blades for the Victoria Falls and Transvaal Power Company, Ltd., of South Africa, whose plant serves the Rand Gold Mines. These buckets were, previous to the war, manufactured in Germany.

Stewart M. Marshall, formerly chief engineer of the Cambria Steel Company, Johnstown, Pa., and latterly chief engineer for the Southwark Foundry and Machine Company, Philadelphia, Pa., has formed a partnership with Charles Page Perin, to undertake consulting work connected with the iron and steel industry, with offices at 2 Rector Street, New York.

Benjamin F. Wood, for 16 years electrical engineer, Pennsylvania Railroad, and for the past three years vice-president and chief engineer of the United Gas and Electric Engineering Corporation, announces the organization of B. F. Wood, Engineers, Inc., New York. The new firm will investigate, design, construct and supervise engineering works in power development, transmission, railroad electrification, electric railway and lighting systems and industrial plants.

Gustaf Akerlund and George W. Semmes, formerly chief engineer and assistant chief engineer, respectively, of the Standard Gas Power Company, have established a consulting and contracting engineering business under the name of Akerlund and Semmes, with headquarters at 17 Battery Place, New York. The firm will specialize in gas producer equipment for power as well as for metallurgical and ceramic ware furnaces.

E. Howard Reed, vice-president of the Reed and Prince Manufacturing Company, Worcester, Mass., has enlisted for three months' service as an executive at the United States torpedo station, Newport, R. I., with the rank of a lieutenant commander in the United States naval reserve, thereby releasing one or more officers for active sea duty. Mr. Reed, who is rated in class 4, composed of experienced manufacturers, will be attached to the torpedo-making branch of the station.

APPOINTMENTS

Harold L. Green has been appointed resident manager of the Cleveland office of Scovell, Wellington and Company.

John A. Leach has recently been appointed mechanical engineer of the Minneapolis Steel and Machinery Company, Minneapolis, Minn.

William L. Batt, formerly sales engineer with the Hess-Bright Manufacturing Company, Philadelphia, Pa., has been appointed sales manager.

William L. Saunders of New York, chairman of the Ingersoll-Rand Company, has been appointed as Class C director of the New York Federal Reserve Bank.

Edward J. Kearney, secretary and treasurer of the Kearney and Trecker Company, has been appointed a member of the Wisconsin State Board of Industrial Education, by Governor E. L. Philipp.

AUTHORS

J. E. Johnson, Jr., is the author of a book entitled Blast-Furnace Construction in America.

Richard Moldenke has contributed an article entitled The Seasoning of Castings to the March issue of *The Foundry*.

Fred. M. Heidelberg is the author of An Ideal Changehouse, which appears in the March 3 issue of the *Engineering and Mining Journal*.

Percy H. Wilson, consulting engineer, of Philadelphia, has contributed an article entitled, Edison Portland Cement Plant Remodeled, to the March 3 issue of *Engineering Record*.

N. W. Akimoff is now completing a text book on Applied Hydrodynamics, which will be of the same general character and for the same grade of engineers as his recent book on Lagrange's Equations.

THE NEW BOOKS

ALL books received by The Journal will be listed under this heading, generally accompanied by brief descriptive notes. Works of special importance to mechanical engineers will be commented on at length by members and others peculiarly qualified by reason of their experience and training. In this issue are included two comprehensive reviews of recent works in cost accounting.

Cost Accounting and Burden Application

Cost Accounting and Burden Application. By Clinton H. Scovell, A. M. Harvard University; C. P. A. New York and Massachusetts, Assoc. Am.Soc.M.E., etc. Cloth, $5\frac{1}{4}$ x $7\frac{3}{4}$ in., xiv + 328 pp. D. Appleton & Co., New York, 1916. $2 net.

The author of this little book is a specialist in industrial accounting. He is of the modern school, recognizing the fact that cost accounts are of no value unless they are properly interpreted and made use of as one of the elements of scientific management. The book is not a systematic treatise, suitable for students, but is a logical discussion of general principles, criticizing the errors in belief of many of the old school of accountants. It should be read by practical accountants who wish to be informed as to the latest and best theory of their profession. Two of the controversial subjects in accounting theory are treated at great length: Interest Charged to Cost, and Methods of Applying Burden. As to the first the author gives a most convincing argument that interest on investment should be considered as a part of factory cost, taking issue with A. Lowes Dickinson, who presents the opposite view in his book Accounting Practice and Procedure. As to burden application, he condemns the percentage on wages, the percentage on labor and material, and the man-hour rate methods, and approves what he calls the "new machine-rate," which is called by most writers the "machine-hour rate." He shows the necessity of checking the burden charged to cost through the machine rate with the actual burden during corresponding periods, and exposes the unsoundness of the theory proposed by A. Hamilton Church in his book on The Proper Distribution of Expense Burden, and his "supplementary rate" by which the total burden during a period is charged to the cost of the goods produced during that period. The author states the correct principle as follows: "Only a part of the total burden is chargeable to the manufacturing cost of the product made during periods of curtailed production, the part chargeable being the same percentage of total burden as the curtailed production is of the total production."

In a footnote Mr. Scovell seems to claim that he was the discoverer of this principle, and states that he made practical application of it in 1911. The present reviewer, however, used it in 1909 in a works with which he was then connected, not suspecting that it was anything new, and in reviewing Mr. Church's book in *The Iron Trade Review* of Feb. 4, 1909, condemned the supplementary rate and advocated charging a machine with the same burden throughout the year, irrespective of the fluctuations of business conditions outside of the shop.

In a chapter on Unearned Burden the author describes the correct method of treating it in these words: "Monthly cost reports show comparatively the amount of unearned burden, indicating the tendency of business conditions. [It may, however, indicate bad shop management, by which some of the machines are unnecessarily idle.] This unearned burden may either be charged off each period to Loss and Gain or a reserve may be accumulated out of profits during busy times to which the unearned burden may be charged during time of business depression." Special chapters are devoted to discussions of Foundry Costs, Textile Costs, Candy Costs and Paper Manufacturing Costs.

In the interest of good English it would be well for the author in his next edition to avoid the use of the word "inventory" (p. 91) in the sense of "materials" or "stores" and confine it to the dictionary meaning, and on page 50 to change "data" to "datum."

William Kent.

Manufacturing Costs and Accounts

Manufacturing Costs and Accounts. By A. Hamilton Church. Cloth, $5\frac{3}{4}$ x 9in., 452 pp., 139 illustrations and 4 folding plates. McGraw Hill Book Co., Inc., New York, 1917. $5.

Mr. Church's immediate purpose is to define the "why and wherefore," the mechanism, and the operations of cost accounting, and to make clear the relations of cost accounting to general accounting. His further intent is to enable the cost accountant on the one hand and the general accountant on the other each to understand and appreciate better the importance of the other's work.

He is therefore concerned wholly with the principles of costing, their application under the three methods of expense distribution later defined, and the nature and proper use of factory cost reports. He does not attempt to describe any specific cost-keeping system, and indeed expressly disclaims any intention or desire of so doing.

The province of factory operations in which the cost accountant works, Mr. Church discerns as an intermediate term in the series by which business generally transforms money into goods, goods into sales, sales into cash again. That is, in a merchandizing enterprise we have the cycle

Cash—purchases—sales—accounts receivable—cash.

The function of the general accountant is to record, separate, classify, and summarize all the details of these transformations, using therefor the standard media—the journal and ledger—conveniently subdivided when a large business is to be handled.

In a manufacturing proposition the cycle becomes

Cash—purchases—*factory operations*—sales—accounts receivable—cash.

The cost-accountant's province includes the whole region of these intermediate changes. He must keep with each item of material, labor, and expense therein an account similar to that which the bookkeeper maintains with each customer and item of cash. He should assume control where the general accountant leaves it at the factory gate, maintain it until the finished product is ready for delivery, and connect his records with the main accounts, of which they form a specialized and detailed subdivision.

His peculiar problems arise from the fact that different items of the purchases (i. e., material) may be justly charge-

[illegible] different fractions of the collateral outlay for overhead and expense, and may be in very various stages of completion when a balance is to be struck, and the difficulties thus created increase enormously with the diversity of manufactures carried on in the plant.

Mr. Church sets himself the task of describing the art by which these problems are solved, and of outlining approved practice in dealing with the subjects, situations, and transactions met in actual cost keeping work.

He begins with a survey of the mechanism of accounting and of cost accounting, the elements of cost, and the means for connecting cost with product. He defines three methods of charging direct labor and expense: *A*, by departmental hour cost; *B*, by hourly burden or percentage of wages; *C*, by scientific machine rates. He distinguishes further three degrees of subdivision of the unit quantity to which cost may be applied—entire departmental output, definite lots, and individual pieces or parts. He recognizes finally two degrees of detail practicable in determining the departmental cost of any unit—i. e., all departmental processes may be lumped as a total, or each process costed separately. He then outlines the processes of costing by each of the three primary methods *A*, *B*, and *C*, and concludes Part I by a discussion of the common problems of waste, scrap, by-products, depreciation of small tools and equipment, and selling expense.

Part II takes up the actual operations of purchase and production, the departmental activities involved, the standard system of accounts as usually necessary and common to all cost work, and the books, forms, blanks, etc., used for records common to all systems. Four chapters out of the twenty-four in this part are devoted to special forms peculiar to the three primary methods of allocating expense already referred to as *A*, *B*, and *C*, and the last three chapters deal with the collecting of departmental costs and general considerations affecting cost keeping. Part III discusses the nature, scope, and preparation of factory reports and returns.

Of the 140 illustrations in the book, about one-fourth are diagrams tracing the relations between accounts, and the course of items of cost in their passage from original entry to the final controlling account. The remainder are typical rulings and printings for the various books, sheets, cards, schedules, and other forms requisite in standard cost-accounting practice as defined by the author.

Mr. Church appears to have achieved his declared purpose to approach his subject from an angle and by a method different from any foregoing attempt, and to present a survey of the general structure of cost accounts free from detailed description of any specific system of cost keeping. It is open to question whether the view he gives is "comparatively simple," or indeed whether any simplicity, even comparative, can be given to such a conspectus. Ready comprehension of his subject matter, and even of his diagrams, seems to presuppose a familiarity with the processes of general accounting and the phenomena of manufacturing that comes only after long experience with more elementary aspects. The book is hardly one for student beginners. On the other hand, no degree of proficiency is likely to be so great as to put a practitioner beyond the capacity for finding interest and profit in the volume. Certainly, mature minds exercised in the problems appearing along the field of contact between factory production and commercial accounting will find in it suggestion, explanation, and direction obtainable, so far as the reviewer knows, nowhere else.

CHARLES BUXTON GOING.

Strength of Ships. By Athole J. Murray. 5½ x 8¾ in., 400 pp., 218 diagrams, 3 folding plates and many tables. Longmans, Green & Co., New York, 1916. $5 net.

In this book, which is said to be the first in the English language to be exclusively devoted to the subject, the author has aimed to include all available information in the field of the strength of materials which has a special application to the design of the structure and fittings of vessels, as well as some of the recently published research work of shipbuilders. The thirteen chapters following an introductory section deal respectively with stress, strain, and elasticity; materials of ship construction; beams; columns; shafts; longitudinal strength; transverse strength; watertight bulkheads; strength of plating; fastenings; rigging and outboard fittings; plate brackets; rudders.

The Marine Steam Engine. By the late Richard Sennett, Engineer-in-Chief of the Navy; Fellow of the Royal School of Naval Architecture and Marine Engineering, etc., and Sir Henry J. Oram, K. C. B., F. R. S., Engineer-in-Chief of the Fleet; Engineer Vice-Admiral, etc. Longmans, Green & Co., New York. Thirteenth edition, 1916, 6 x 9 in., ix + 502 pp., 414 illustrations. $6 net.

In the last two editions of this well-known work—first issued in 1882, much matter has been added to the chapters dealing with the steam turbine, the torsion meter, and the internal-combustion engine, to take account of their rapid development and increasing importance in marine engineering.

Electric and Magnetic Measurements. By Charles M. Smith. 5 x 7¾ in., 373 pp., 171 illustrations. The Macmillan Co., New York, 1917. $2.40.

This course, which has been developed from the author's lecture and laboratory notes, presupposes on the part of the student a year's study of general physics and some knowledge of the calculus. The 56 laboratory exercises which are given are so described that particular types of apparatus are not called for unless they happen to be well known and generally available.

Pipe and the Public Welfare. By R. C. McWane. 5 x 7½ in., 165 pp., 77 illustrations. The Stirling Press, New York, 1917. $1.

After a brief historical sketch of the use of pipe from the earliest days, the author describes the methods used in manufacturing cast-iron, wrought-iron, and steel pipe. A third chapter gives much technical and historical information on the deterioration of metal pipe and canvasses the relative merits of the wrought and cast forms. The final chapter, of 21 pages, is devoted to wood-stave pipe.

The John Fritz Medal. Embossed boards, 6 x 9 in., 98 pp., 14 illustrations. Obtainable from the Secretary, John Fritz Medal Board of Award, Engineering Societies Building, New York City. $4.

The John Fritz Medal is a gold medal presented for achievement in applied science as a memorial to the great engineer whose name it bears. The John Fritz Medal Board of Award, appointed by the four great national engineering societies, has published this handsome volume—from the Bartlett Orr Press, giving a history of the medal, the rules governing its award, biographical sketches and portraits of the thirteen medallists, and the names of those who have served on the Board of Directors and the Board of Award from the establishment of the medal, in 1903, to the present.

The Taylor Society announces that its next meeting will be held in Syracuse, N. Y., May 18 and 19.

SPRING MEETING PAPERS

THIS country is now in a war of great magnitude and far-reaching results. It is a war of brains and has resolved itself into a contest putting the utmost demand on the ability of engineers to organize and direct the industries which constitute the vital forces of the nations involved. Two and one-half years of the war have emphasized this truth. One of the most potent requirements for a successful issue is an ample and sufficient output of war material from engineering workshops. To bring out the results of valuable experience in munitions manufacture, which has been obtained by many engineers through the period of war, and to make these results available to all, professional sessions of the Spring Meeting of The American Society of Mechanical Engineers will be devoted to the various phases of the subject. Papers to be presented at these sessions are printed in comprehensive abstract below.

Other important professional features of the Spring Meeting, to be held in Cincinnati, May 21 to 24, are sessions on Machine Shop Practice, Gas and Steam Power Subjects, and Protection of Industrial Workers and also a Joint Session with the National Machine Tool Builders' Association for the consideration of papers on Employees' Service Work and Industrial Education. Abstracts of papers to be presented at the first three of these sessions are also published in this issue. The topics at the Joint Session will be introduced in the form of addresses without previous publication.

MUNITIONS PAPERS

THE Committee on Meetings, in arranging for sessions at the Spring Meeting on the subject of the Manufacture of Munitions, desired to obtain a general discussion of the basic problems involved, which have to be met and solved to ensure success in the quantity production of arms and ammuition. The brief papers which follow are in the nature of introductory discussions, designed to draw out further discussions on such fundamental questions as Financing, Organization, Manufacturing Principles, Special Machines, Essentials for Quantity Manufacturing, Procuring Materials, Specifications, Limits and Tolerances, Gages and Inspection. The sessions will be entirely informal, and all members who have had experience in munitions manufacture are urged to attend and contribute to the common cause.

Following the papers is a bibliography of current articles on munitions production which have appeared during the past eighteen months.

MUNITIONS CONTRACTS AND THEIR FINANCING

By FREDERICK A. WALDRON, NEW YORK, N. Y.

Member of the Society

THE manufacture of munitions is a strictly engineering proposition in which the functions of the engineer dominate. Had engineering methods been employed in the initial stages of the work in the past two years, instead of "corner grocery" methods of beating down in price for the sake of letting the contract at an advantageous figure, the profits in many cases would have been far in excess of what they are today.

Few people realize the penetration of financing into the bone and sinew of our national existence. In the daily routine of life, with the majority of people receiving a stipulated income by the day, week, month or year, the intricacies and risks involved by those providing the money to pay this income are seldom if ever thought of.

The forces set in motion by signing a contract, large or small, penetrate and accelerate industrial and natural resources.

In the last two years wonderful progress has been made in the development of resources hitherto thought to be remote or inaccessible, and the education and training of men in the allied industries has developed at a rate heretofore unknown. Why this sudden development? Why such an exhibition of human energy, both mental and physical? It was dire necessity, and necessity knew no master.

Money or currency is the visible medium of exchange, and if there is no money or other recognized medium of exchange, man resorts to primitive methods and fights for existence.

With the advent of contracts amounting to millions, few manufacturers, if any, at the beginning of the war, fully realized the time that would be required to deliver the materials. Not only this, the amounts involved were staggering. It has now become customary to converse in terms of millions of dollars instead of dollars and cents. Further, the difficulties of the problems, such as sub-contractors failing to perform, the increased cost and difficulty of transportation, the obtaining of tools, equipment, materials, and labor, for the fulfillment of these contracts, were not anticipated.

With these conditions, which are now in retrospect, many industries are charging off deficits of considerable size to experience in the manufacture of munitions. Few have made fair profits. Some have made abnormal profits.

With the foregoing as a matter of history, the question as to how the Allied Nations obtained their credit would be extraneous to the subject. This brings the question before us for discussion as to how the contractor is to receive his money promptly and regularly for his work.

It is sufficient for the manufacturer to know that the work which he is to do will be regularly and promptly paid for, and any risks taken by him to produce in quantity within the time specified are to be amply protected by an advance of money sufficient to cover the expense of preparation.

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Undoubtedly the cause of failures in the delivery of munitions of sufficient quantity within the time specified, is directly traceable to the lack of judgment in the amount of money demanded as advance payment, combined with a lack of business and financial management.

If we review carefully the ratio of the amounts advanced to the total amount of the contract and its time of completion, it will be found that in no case has a sufficient advance been made to enable the contractor to finance this work on the same basis as he would adopt in the conduct of his regular business.

WHAT IS FINANCING?

Financing is providing the coin of the realm in adequate and opportune quantities for the purpose of obtaining an object desired. Where ready cash is not available, the usual way of providing the coin of the realm is by the issue of mortgages, bonds or notes, which are papers promising to pay at maturity the amounts advanced, with interest of course for the use of the money, payable at specified periods during the time for which the loan is made.

All mortgages, bonds or notes must have tangible and preferential security, rights, etc. These principles cover the salient points necessary for a government, corporation or individual to obtain the necessary amount of money to pay for the object to be obtained.

Documents given by the party wishing to obtain the object (called the Owner or Purchaser) to the party who is to provide the object (called the Contractor or Vendor) are in the form of leases, contracts, or purchase orders, supplemented by specifications and drawings, or samples of the object desired.

Prior to the signing and exchange of these documents, the money which the purchaser wishes to use to attain his object has been provided. Upon the signing and exchange of these documents, the details are planned for distributing this money in adequate and opportune quantities in order that the object to be attained may be completed as rapidly as possible and the contractor provided with sufficient funds to promptly and efficiently complete his work.

If a purchase order or contract exceeds a certain amount and covers a definite period of time, a bond is required in order to protect the purchaser.

On large munitions contracts, the bonds of sub-contractors are marshalled by the general contractor and deposited as security. This is to indemnify the purchaser against loss. In fact, the bond is the purchaser's insurance to secure him against failure to complete the work, or the dissipation of moneys paid by the purchaser to the contractor as an advance payment. A bond is also required by those financing the work.

ADVANCE PAYMENTS

1 When and how met
2 Amount in percentage of the total amount of the contract
3 Rate of liquidation
4 Interest charges.

PAYMENTS ON ACCOUNT

1 When to be met. Depends on:
  - *a* Resources of contractor
  - *b* Volume and rate of delivery of material
  - *c* General progress of work
  - *d* Complete information.

2 Amount of payments:
  - *a* Purchase value less a certain percentage for reserve or adjustment at end of contract
  - *b* A purchase value or agreed amount to liquidate advanced payments.

3 Type of payments:
  - *a* Sight draft, check, notes or bonds.

FINAL PAYMENTS AND ADJUSTMENTS

1 Adjustment of percentage held back on part payments
2 Adjustment of debits and credits during the progress of the contract
3 Type of funds:
  - *a* Notes, bonds, sight drafts, checks.

DISCUSSION OF ADVANCE PAYMENTS

In manufacturing and contracting requirements, it is a well-known fact that from three to five turnovers of inventory per year are essential to a reasonable profit.

The general contractor, on a large munitions contract, has to provide in turn advances not only to the sub-contractor, but he must also be able to take advantage of the market, and oftentimes buy materials long before they are required. He has also to meet the payments for materials of sub-contractors furnished long in advance of the time they are to be used. Then, again, contracts have been let to some small concerns who have failed to fulfill the requirements of the contract. This also applies to the larger sub-contractors and, as has been the case, it is necessary for the general contractor, in order to protect himself, to take control of the entire properties of the sub-contractor on an entirely different basis and under entirely different conditions. This involves delays not ordinarily estimated in the contemplation of the work to be done.

A further necessity for ample and proper financing during the progress of the contract, is that assembling contractors be supplied with a sufficient number of component parts of proper quality in order to complete the work.

It is quite possible (in fact, it has happened) that manufacturers of component parts have held up shipments awaiting payments on their materials. To my knowledge, this has involved at different times delays in the completion of work valued at from one to three million dollars over a period of time of from two to five weeks, which, if figured on the basis of six per cent, would mean a loss to the general contractor of from $4,000 to $12,000 on interest charges alone.

But, beyond all of this is the demoralizing effect on a sub-contractor and the discouragement which he experiences. This reacts upon the organization, and in a very short time the enthusiasm and efficiency of the personnel of the plant have rapidly deteriorated.

Then, again, the question of financing depends to a large extent upon the government with which the general contractor is dealing. With some there is no trouble, and businesslike methods are used in the handling of all financial transactions. There are others, however, that are exceedingly troublesome and irregular in meeting their financial obligations and, while they are good for the money obligated, the irregularity and slowness of payments oftentimes creates suspicion and distrust on the part of the manufacturer, with a corresponding demoralization.

After an observation and experience of two years in this work, the writer feels safe in assuming that an advance of at least 25 per cent is necessary and 33 1-3 per cent would

leave a sufficient margin of safety, with good management.

It is not necessary that all of this amount be paid upon the signing of the contract, but it should be available for drawing upon as occasion might require.

The rate at which advance payments should be liquidated is a matter which can only be adjusted to the requirements of the case in hand. A good rule to follow is to deduct from each invoice the same percentage of this invoice as would liquidate the advance payment upon the completion of the contract. It is customary, in some contracts, to deduct an additional ten per cent as an adjustment fund to protect the purchaser at the completion of the contract.

Interest charges are sometimes demanded on advance payments, but the usual practice is to dispense with this charge.

PAYMENTS ON ACCOUNT

Payments on account depend on the resources of the contractor, volume of business, rate and quality of materials delivered, general progress of the work, and complete audit information as to the financial condition of the contractor.

The amounts of these payments are generally made on the invoice value of the materials shipped, less deductions for the liquidations of the advance payments and insurance to the purchaser.

The types of payments usually made are either cash on receipt of the bill of lading or sight draft; or settlements at certain defined periods, either by the week, semi-monthly or monthly; sometimes, thirty days from the receipt of the invoice, bills of lading or inspectors' certificates.

Where the financial standing of the company is such as enables it to have cash on hand or available to conduct its business, payments are taken in bonds or short-term notes of the government for which the work is being done.

FINAL PAYMENTS

Final payments should be made as promptly as possible upon the completion of the contract. It is hardly possible, in the majority of contracts, to make these final payments promptly, as it oftentimes involves the adjustment of debits and credits for expenses on the part of the contractor and rejected work or spoiled materials on account of the purchaser. It is essential, therefore, in order to have a prompt adjustment, that a close check be kept on the progress of the work at all stages and a clear and definite method of maintaining records be kept by both the purchaser and the contractor.

The types of funds used in final payments are the same as those used for payments on account.

ORGANIZING FOR MUNITIONS MANUFACTURE

By ARTHUR L. HUMPHREY, WILMERDING, PA.

Member of the Society

THE task of organizing a plant to undertake the manufacture of munitions is one of many factors. In fact, organizing involves all of the items in the general list: specifications, materials, designing, limits, gages, inspecting, etc.

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The general success of the undertaking is dependent upon the perfection of the working organization, upon the selection and installation of adequate machines and other tools, and upon the careful planning of the work, which is not limited to that within the shop alone, but involves a consideration of the market, the purchase and delivery of supplies.

The financing accomplished, the task of organizing comes next in order. Their work done, the financial backers of the undertaking become impatient to see deliveries made because of their failure to understand the mechanical and human problems in the task of organizing, and a net loss is the result of insufficient time being allowed for perfecting the working organization, equipping for and planning the work. Haste makes waste in most affairs and it is not the exception here. A premature beginning may result in an encounter with conditions which will mean an entire revamping of the whole scheme—conditions which would have been determined and provided for had sufficient time been given for careful planning and making schedules complete in every detail from start to finish.

It is quite essential that an organization for the manufacture of munitions be built around a nucleus of men who have had experience either in munition making or in work of an allied character. With such a group as a basis, it is comparatively easy to place new men and ramify the organization into the various departments and divisions, each properly correlated with the other. It should be so arranged that each department acts as a unit within itself and attends to but one thing, such for instance as manufacturing the shrapnel time fuse and that alone.

Many operations in the manufacture of munitions cannot only be as well done by women as by men, but are better done by female help. These operations are such as involve light, delicate work, requiring deftness and dexterity in the use of the fingers. Therefore, such work should be segregated at every opportunity and the organization be made to include the requisite number of women.

The work to be accomplished is first revealed by the specifications submitted. Conferences between the engineers and shop foremen should be held at frequent intervals as the planning and scheduling progress in accordance with the results demanded by the specifications, and the whole problem should in this way be thoroughly "threshed over."

This problem of organizing is closely bound up with that of equipment. The condition of the machinery market and the urgency of the contract will determine largely the type of machines installed. In every case, where possible, automatic or semi-automatic machines should be given preference in order to get maximum accuracy with a minimum skill requirement on the part of the operators. This reduces materially the losses due to error of the individual. Careful consideration should be given to every detail of the manufacture, a thorough time study made, and the most logical sequence of operations worked up and scheduled before decisions are made as to the types of machines to be installed. Too much stress cannot be placed upon this feature, for any changes it may be necessary to effect after the machines have been ordered will result either in considerable loss or inefficient manufacture. Grouping of the machines should also be gone into very carefully to avoid unnecessary handling between successive operations.

Great emphasis must be placed on the necessity for a well-organized and well-equipped tool room. It is of paramount importance to have an unstinted supply of gages, jigs, machine fixtures and other special tools, for these are needed in great number in the manufacture of munitions. They are, in

fact, indispensable to the successful quantity production of accurate work.

Also, upon the inspection department will depend the proper utilization of the gages supplied by the toolroom—in other words, the inspection department and the toolroom are links in the same highly important chain of accuracy. A carefully organized inspection force must check the product not only at the end, but at each successive stage of manufacture. The product must be checked not only for variations in dimensions but for chemical and physical properties as well. The personnel of the inspection force is of the utmost importance, for it is quite unwise to give the power of rejection to a group of uninformed inspectors who are lacking in judgment. And if power to reject be withheld, the inspection force might well be entirely dispensed with.

Other points of interest in this general connection may be found in the writer's paper on The Mobilization of Material and Industrial Resources, read before the Engineers' Society of Western Pennsylvania on May 31, 1916.

ORGANIZATION FOR MUNITIONS MANUFACTURE

By HARRY L. COE, BOSTON, MASS.

Member of the Society

I HAVE approached the subject from the viewpoint of a manufacturer already engaged in a metal-working business, and have tried to suggest some of the factors which he should consider if he expects to produce projectiles. Assuming that the manufacturer has ample financial resources, adequate equipment, a satisfactory source of raw materials, etc., what type of an organization is essential to the successful production of munitions: and among the various kinds of munitions, what articles can the particular plant produce economically?

Much time and effort will be wasted if this double process of selection is not given attention. The characteristic optimism and confidence of the American manufacturer, coupled with the strong desire to be of service to his country, or to make money, lead many firms into making persistent efforts to get munitions contracts which should, logically, go to firms of an entirely different character and facilities.

Before looking for a munition contract, there should be an honest self-analysis. It isn't a question of "can my shop produce this piece?" but "can it make this piece as well and as economically as anyone else?"

Many firms having a good manufacturing organization will feel that they require only a little additional equipment. To these people I say, "Beware!" Three years ago they might have had as good a chance of success as anyone, but today they will have to compete with the firms which have not only the organization but the proper equipment as well.

On the other hand, they may have a general equipment which can be adapted to munitions, but their shop and executive organization may not be trained to think and act along the lines of specialized mass production. And here again I say, "Beware!" Difficult, slow and expensive though it may seem to start from nothing and equip a complete munitions plant, it is much more difficult, slow, and expensive to develop and get into effective operation the organization which will make this kind of a business successful.

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CHARACTERISTICS WHICH MUNITIONS PLANTS LACK

We turn with pride to our great industries,—the steel corporation, our railroads, etc.—and feel that certainly the American genius and ability which has made them possible can turn out unlimited quantities of shells. And so they can, *if they have time.* Unfortunately for the manufacturer, this element of time is of the greatest importance to the fighting units. The advantage lies with the side which first gets the necessary supplies.

The big, centralized organizations are the result of a slow process of evolution, and while their working force may be constantly changing, one finds that the habits and traditions of the work are maintained, and it is this force—habit and tradition—which is entirely lacking in the munitions business. To produce shells economically, this force must be generated in and by the organization, which means embodying in that organization a certain proportion of picked men, chosen because they possess these habits, or who, because of their versatility and training, can quickly acquire them. Such men are not easy to find and the time it would take to get *enough* of them together in one place to make a large organization successful is almost a fatal handicap.

It would seem, therefore, that the greatest success would be obtained by comparatively small units specializing in one type of munitions. One may say, "Why not have a big shop departmentalized, with a case shop here, a shell shop there, time fuses or primers in another section, etc.?" Theoretically, this would be all right, but if one studies the organizations which have tried this in the past few years, he will find a tremendous amount of lost time, effort and money. In other industries where this principle has been successfully developed, I believe there will be found quite a percentage of men in each division who have grown gray-haired with years of service along that particular line.

This condition does not obtain today with respect to the munitions business. Before the present year the firms manufacturing projectiles in the United States were very few. The orders placed by our Government outside of its own arsenals were so small that even at the high figures paid they offered no attractions to anyone to develop a business along these lines. As a rule, the training in the arsenals has not fitted men to produce the best results under our existing industrial conditions. At the present time the arsenals are not letting any of these good men get away. In general, the attitude of the War Department has not encouraged the development of this industry except in the cases of a few manufacturers, as mentioned above. The result is that there is a very limited field from which to draw either workmen or executives "skilled in the art."

It would seem, therefore, that the manufacturer must build an organization around such of his men as possess the proper habits and training, and they in turn will have to see to the development of the manufacturing units. Here, again, large and complicated units do not develop rapidly, and in them mistakes are tremendously expensive and slow to correct.

The manufacturer should therefore take stock of his organization carefully. If it does not contain men whose habits of thought and training are consistent with specialization of processes and mass production, it lacks one of the prime factors in successful munition manufacture.

ADAPTABILITY OF PLANT TO PRODUCT

If, on the other hand, the organization *is* of this type, he should look carefully over the wide range of articles classified

as munitions and select something which is as similar as possible to his regular product in size, material, and general nature.

We hear of gray-iron foundries making strenuous efforts to get contracts for producing cartridge cases, when the nearest thing they have to a press is a plate-molding machine and they never had an opportunity of running to capacity on a single pattern for more than a few days at a time. Needless to say, if such people are so unfortunate as to get a contract, it is almost certain to prove an expensive failure for them and may result in a serious shortage of supplies for the fighting line.

Assuming now that there is an organization which is accustomed to specialization and that a type of munitions adapted to the available equipment has been selected, what subdivision should be made in the organization and what functions should be performed by each?

In the first place, it is futile to try to handle a projectile department as an appendage to some other part of the business. It is a business in itself and its success or failure will probably depend on the completeness with which every detail is worked out and checked.

This is a product in which duplication inside exceedingly small limits is essential. Moreover, if one agrees with the theory of specialization mentioned above, the type of munitions manufactured will be limited to a few pieces, or even to a single piece, of the same nature. The size of the order should be large enough so that even the smallest working unit —man or machine—can be employed constantly on the same operation. Under such conditions no detail is so small but that it pays to give it careful attention. Every motion will be repeated many times an hour, and the expense due to trivial losses will soon reach large proportions. Realizing this and knowing that this is a temporary business, many firms have gone outside of their regular force and employed special managers to look after their projectile manufacture. This has been their sole function and the arrangement was terminated when the order was completed.

The internal mechanism of the organization, then, might be classified somewhat as follows:

1 General Service Department
2 Diplomatic Staff
3 Production Department
4 Inspection Department

1 General Service Department

Under the General Service Department, we find

a Records and accounting (with special prominence given to control of manufacture rather than to details of cost finding)
b Purchasing and stores organization
c Designing, drafting and experimental development
d Protection and safety (with special reference to destruction by representatives of the enemy's government and to the safeguarding of unskilled workers).

With reference to these general departments, it may be safe to modify our general principle of entirely separate organizations. Whether or not these departments are combined with the existing departments employed in similar work will depend somewhat on the volume of the work both in the normal business and in the munition contract, as well as on the physical layout of the plant. In most cases it is possible so to plan that this work will follow the practice developed for the regular business and can be absorbed by the department already doing this kind of work.

With reference to the purchase and stores of the department, there are no special features which differ to any marked degree from ordinary practice.

2 Diplomatic Staff

While this organization will be small, it is none the less important. If the munitions are for a foreign government, there will undoubtedly be foreign representatives stationed at the plant as receivers. These men are not accustomed to our methods. Their temperament is entirely different from the people we are ordinarily meeting. Possibly they do not speak our language. If sufficient attention is given to them, and their points of contact with the organization limited as far as possible to a few chosen men, it will be much easier to reach a practical working basis and to prevent expensive and often unnecessary misunderstandings and delays.

This department is responsible for seeing that these receivers are provided with the information they desire and that it is presented to them in such a way that they get a correct impression of the conditions. If they appreciate the difficulties which may be arising and the action the organization is taking to eliminate causes of trouble, it naturally affects their attitude toward the plant.

The diplomatic staff sees to it that any instructions issued by the receivers are transmitted to the proper department so that they go into effect.

Through this department, the shop can approach the receivers for information or rulings on conditions which may not be clear.

Even in the cases of work for our own government, I believe such a department is advisable. The fewer people who have official relations with these receivers, the less the chance of contradictory instructions or of false or unnecessary information or misunderstandings.

3 Production Department

Under the Production Department comes

a Maintenance of equipment
b Operation of equipment
c Selection and training of workmen
d Tool and gage production
e Establishment and operation of wage payment and penalties systems

This department is responsible for maintaining production and developing economy, and has full control of all agencies which bear directly on the operation of equipment.

Maintenance of equipment has been included under this department for two reasons: First, it brings the time element of repairs largely under its control. Much loss of production can be avoided by a careful and frequent inspection of machines and transmission. A few hours in [illegible] may save days of shutdown later. And, second, because the men who make up the maintenance crew are usually the general group of millwrights who see to the location and setting of equipment, which again is a direct corollary of production. When breakdowns occur, operations have to be readjusted and it is often more economical to take an idle machine out of a battery and replace with a spare than to interrupt the flow of product. Such work is obviously up to the repair gang.

In this connection I am inclined to think that twenty hours per day is about the economical limit to run machines under the conditions of forced production usual on this work. The

requiring four hours for repair—a most excellent instance.

Having given the production chief the means of supplying the working force with equipment to use, we must turn to a study of the workers.

Because of the difficulty of getting skilled mechanics, it has been necessary to develop that type of an organization which can produce results with the average workman in the shortest possible time. This is one of the reasons why it is well to subdivide the operations into simple elements and eliminate complex machines. Because of the very nature of the class of workmen available, it is necessary to make the most out of a continually changing force. This has been done successfully by selecting from the better grade of men a class which might be called *tool setters* or *machine starters*, and giving them charge of a battery of machines. This builds up a secondary line of defense, as it were, and it is possible to develop a fairly permanent organization of this kind of men. Behind these machine starters come the group foremen, assistant superintendents, etc.

For somewhat the same reasons the tool and gage manufacturing department is made a part of the production chief's organization. I say tool and gage *manufacturing* department instead of tool room advisedly, for it has to be a real manufacturing department with the demand for flat cutters, boring bars and heavy supplies of special tools which immediately occurs when one starts to reach maximum output on single-operation machines. The good tool maker is not as a rule a production man and it is a difficult thing to get a tool room into the spirit of manufacturing.

The method of wage payment for all these men is immaterial provided a maximum incentive is given to each man. Personally, I am in favor of a thorough piecework system, as it is simple for the workmen to understand and not expensive to operate. However, premium or bonus plans are all right if the rewards are immediate. The setting of standards is an important part of the wage basis and the opportunities for the competent operation and time-study man are wonderful. He, too, is part of the production chief's organization.

In this connection, while in general the theory of penalties is not desirable, it has been found that it is a good balance wheel to the continuous insistence put on production, especially where the workmen are not trained in the true spirit of machine shop existence and often are only transients with very little interest in the quality of their work.

4 Inspection Department

The work of the Inspection Department comprises

a Inspection of operations
b Intermediate inspection
c Final inspection

To some it may seem that at least part of the inspection organization should be directly under the chief of production: for example, the first or operation inspection which occurs between each operation. I believe, however, that better results and a more consistent and thorough inspection will ensue by creating a staff of inspectors responsible to their own chief to handle all inspections wherever they occur. It is easier to train men for these jobs and instil into them the necessary standards of work and habits of thought and action if they are included in a branch of the organization which is all their own.

Assuming that the complete inspection is organized into a department of its own, it may well develop according to the following scheme:

If the work has been subdivided so that operations occurring on individual machines are simple, it is possible to station back of each group of machines an inspector or inspectors and gage every piece for the controlling dimensions. We might class these inspectors as *operation inspectors*. It is their duty to see that each piece produced falls inside the tolerances which are allowed.

As the work progresses and a series of operations are performed upon a piece, it is often found desirable to have an *intermediate inspection*, as in many cases the later operations materially change the form of the piece so that it is impossible to check the work previously done. It is usually found desirable to set aside a certain part of the shop for this purpose and have all the product delivered to the inspection room.

This intermediate inspection is a general overall check on the production reported by the operation inspectors. The advantages are obvious when considered from the payroll point of view.

When a piece is finally finished and ready for presentation to the receivers, either of our own government or of a foreign government, there should be organized a thorough *final* inspection. Under this final inspection, all dimensions possible are checked and in general the same procedure as may be instituted by the receivers is followed out. In case the product does not come up to the standard, it is either sent back for repairs or else set aside and presented as a special batch with full explanations to the receivers. In this way the shop establishes a very desirable basis of fair play with the receivers and, as a usual thing, the policy results in the granting of special limits to cover slight deviations from specifications, which, if sent through with the other work, might arouse suspicion and work to the detriment of the shop.

In connection with the inspection organization, it is very necessary that an ample gage-checking force be organized. All working gages should be checked at least once a day and, in case of some of the finer type of gages, it may be necessary to check oftener if the standards are very exacting.

PROCURING SPECIAL MACHINES FOR MUNITIONS MANUFACTURE

By H. V. HAIGHT, SHERBROOKE, QUEBEC

Member of the Society

In asking for an introductory paper on the subject of the manufacture of munitions the Committee on Meetings suggested that the writer might "analyze the different types of machines required and indicate whether it is better to buy them or to make them."

As no two manufacturers of munitions follow the same methods or use the same machines, any opinions the writer may advance must be based on his own experience or observation and will be subject to confirmation or modification when compared with the experience of others. A few words as to the basis of the writer's experience will, therefore, be in order.

The firm with which the writer is engaged is machining and assembling the 18-lb. British shrapnel and the British 8-in. howitzer shell. Under the plan of organization of the Canadian Imperial Munitions Board, the work is all sublet by the board. The contractor for machining and assembling

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shrapnel, for example, is furnished with forgings for the bodies, with finished component parts such as disks, sockets, copper bands, tubes, tin cups, bullets, etc., and with the other materials required such as resin, solder, paint and shipping boxes. The following notes, therefore, cover only the machining and assembling of the above two sizes of shells which will be taken up separately. In addition to the experience mentioned, the writer has visited many shell shops both in Canada and the United States.

EIGHTEEN-POUND SHRAPNEL

When undertaking the first contract for shrapnel our firm had a machine shop which could be converted to shrapnel production and an experienced working force. As shrapnel production increased and as the regular work picked up, additional machines were purchased or made, until all the regular tools had been withdrawn from shrapnel production. In many cases these regular machines were withdrawn because required for producing the regular product; but there was the additional reason that for four-fifths of the operations the new tools purchased or made were more productive than the regular tools used at first. Our experience, therefore, has covered the use of standard machine tools, special purchased machines and special machines made by ourselves.

The following notes relate to the principal operations on the shrapnel and the machines which our experience shows were the best to use. Fig. 1 shows the shell at several stages and the numbers indicate the operations described below.

1 *Cut off open ends.* Standard 4-in. cutting-off machines with air expanding mandrels. Production 900 in 8 hours. We also tried a special machine to cut off both ends at one setting and another machine of the type of a pipe-threading machine, but both proved failures and were returned to the makers. On the regular machines the air mandrel is preferred to the universal chuck as it is much quicker and costs less to keep in repair.

2 *Rough turn body.* We used at first heavy 24-in. engine lathes, 24-in. Gisholts, Lo-swing lathes, etc., with fair results, but we are now using single purpose lathes of our own make which produce more work and are much simpler to keep in repair. These lathes have cast iron spindles, $6\frac{1}{2}$ in. in diameter in the front bearing, with driving gear integral with the spindle. They have tight and loose pulleys on the back-gear shaft, thus eliminating countershafts with their troubles. The feed is by belt, eliminating feed-gear troubles. The work is chucked on an air expanding mandrel and turned with a bar cam to give the necessary enlargement at the open end of the shell for the subsequent bottling.

3 *Rough face base.* We have used 36-in. engine lathes, 42-in. and 60-in. vertical boring mills, 36-in. planers, 30-in. planer-type millers, etc., on this work, but have abandoned them all for 4-in. standard cutting-off machines. On milling machines the tool upkeep is too great, on planers the work is hard to hold, on planers and boring mills the intermittent cut is hard on the machines and on all except the cutting-off machines, the labor cost and upkeep are too high. On the cutting-off machines the regular universal chuck is omitted and a plain hinged chuck used, as a universal chuck will not stand shell work. The regular cutting-off tool blocks are replaced with a tool block to hold a facing tool. When the countershaft clutch pulleys give out, they are replaced with tight and loose pulleys. Each man runs two of these machines.

4 *Finish face and turn base.* Standard 16-in lathes, with air collet chucks supported by steady rests give satisfactory service on this operation. Only hand feeds are used.

5 and 6 *Rough and finish bore.* It has been found best to rough bore on one machine and finish on another. Turrets are not desirable on shell work, where they can be easily avoided. We used a well-known make of turret lathes on this work, but they proved pretty light and required considerable repair. They were eventually withdrawn for regular work and replaced by special boring lathes of our own make, in which the work is held inside the spindle by an air collet chuck. Two different feed mechanisms are in successful use, one a central rack with power feed and air return, the other a crank and "Scotch Yoke" with hand feed. Another Canadian munitions plant made very successful boring machines from gasoline engine patterns. We built a double spindle lathe for this work but it proved a failure.

7 *Rough band groove.* This work is being done on cutting-off machines and also on lathes of our own make. In both cases

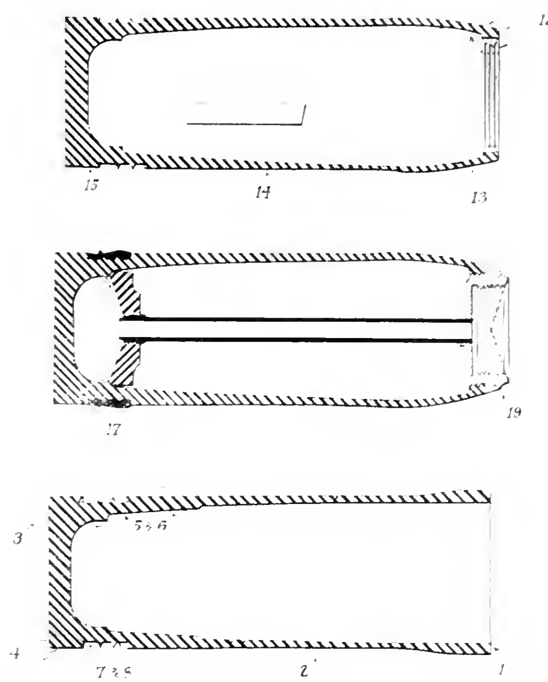

FIG. 1 INDEX OF OPERATIONS OF MACHINING SHELL

the work is held in push-out air collet chucks. No longitudinal feed is required and only a hand cross-feed.

8 *Finish band groove.* This consists of undercutting the edges and forming the waved ribs. Potter and Johnston automatics are in successful use and stand up well. It has been found, however, that a man can do more work on one machine than he can on two or three, so the automatic feature is of no use on this work. Regular 20-in. engine lathes with special fixtures, and simple lathes of our own make with similar special fixtures, are now preferred as they produce rather more work. This is the only operation on which universal chucks are still used, but they will probably be superseded by air chucks. Two different purchased waving machines, built for this purpose alone, were tried but proved unsuccessful.

9 *Harden.* We used at first muffle furnaces, with cast-iron pot muffles holding eight shells, but now we use large semi-muffle furnaces, holding 50 shells. The furnaces are built to designs furnished us by another shell manufacturer, but appear to be copied from a commercial furnace. We used pyrometers at first, but now the operators go by color. An "Irite" pyrometer is used to train new men.

10 *Bottling.* The nose of the shell used to be heated by dipping in a pot of lead. This was rather expensive in the use of lead, and also gave a little trouble from lead poisoning. The present method is to heat in an oil furnace having holes through which the shells project into the furnace. A water jacketed front was tried, but the brick with iron thimble has been found better. We built these furnaces after the style used in another shell shop. The bottling presses used at first were air presses which we made ourselves from drill sharpeners, but the present practice is to use geared crank presses which are purchased. After bottling, the shell is put back in a similar furnace to anneal the nose.

11 *Shot blast.* The regular foundry sand blast was used at first, but present practice is to use a small shot-blast machine of our own make. This has two jets, one of which cleans the band groove and the other the base. The shot blast gives practically no dust, and can be used anywhere in the shop.

12 *Turn and thread nose.* This requires a fairly heavy turret lathe, and we are using both 24-in. engine lathes, and also single purpose lathes of our own make, both of which are equipped with turrets. We prefer the latter lathes as they take the work inside the spindle and eliminate the steady rest. Air collet chucks are used. This is the only operation on the shrapnel where a turret is used and this requires five holes of the turret.

13 *Grind nose and* (14) *Grind body.* Standard grinders, slightly modified for the wide wheels used on shell work, give satisfactory results, as do also special purchased shell grinders. The grinding machine manufacturers, of all the regular machine tool builders, come out with the greatest credit from the viewpoint of shell production. In most other cases, the shell manufacturers themselves have built more suitable machines than either standard or special machines built by the machine tool manufacturers.

15 *Grind base.* Simple machines of our own make give good results.

16 *Press copper band.* Two different hydraulic hand presses, both designed and built by other shell manufacturers, are giving good results on this work.

17 *Turn band.* A heavy engine lathe with special equipment and an air collet chuck gives good results, but costs more money than a very good special band turning lathe, built by another shell manufacturer.

18 *Fill.* This is nearly all home-made equipment and hardly requires detailed description here.

19 *Turn socket.* A 16-in. engine lathe is heavy enough for this. A clutch on the back gear is convenient. A turret is not desirable.

20 *Paint.* We use with satisfaction a small portable machine of our own make, driven by a $1/6$ hp. motor.

The foregoing does not cover the use of purchased single-purpose lathes, of which there are now a large number of designs on the market, but from experience with three or four types of these on 8-in. shells, it appears that they should give good results on shrapnel work. The features they should have would be a large spindle, 4-in. to 5-in. diameter, with hole at least $1\ 3/16$-in., strong drive and feed, a good feed-engaging clutch, or better still a drop worm. The countershaft should have tight and loose pulleys, though the use of air chucks will largely eliminate countershaft troubles, as it is not necessary to stop to change the work. It is better, however, to have tight and loose pulleys on the headstock and eliminate the countershafts, as they take up so much room overhead that it is difficult to group the machines to best advantage. The elimination of countershafts also reduces the cost of belting, which is quite an item. A special point for consideration is the depth of dovetail on the carriage, for the cross slide. This should be $1\frac{1}{8}$ in. to $1\frac{1}{4}$ in. deep, but there are at least two of these lathes on the market with dovetail $3/8$-in. to $1/2$-in. deep, and a taper gib. The very small surface is not sufficient to resist the side strain of a cam, which is used on two of the operations, and the height is not sufficient to use a straight gib with set screws. It is usually necessary to replace the regular cross slide with a special cross slide, and when doing so it is much simpler to use a straight gib with set screws, rather than a taper gib.

To sum up, a manufacturer starting to make shrapnel would be well advised to consider the following suggestions:

a Do simple operations and use simple machines. Do not try to do several operations at one setting, and do not buy automatics, turret lathes or other complicated machines.

b A pretty safe and satisfactory plan is to get a quick start at some fraction of full intended capacity and to add equipment and build up production after some experience has been gained.

c Suitable purchased machines for making a quick start would be regular cutting-off machines, regular engine lathes 16-in. to 24-in. swing, simple single-purpose lathes, regular or special grinders and such special machines as bottling presses, band presses and band lathes.

d It will be worth while to consider the organization of a lathe building department to supply many of the machines required to increase the capacity. This department might also undertake the making of air chucks, waving devices and other special attachments, and thus relieve the tool room. Later, this department would become a repair department, which is an important and busy department when work is being pushed day and night.

[The author concludes his paper with a brief description of the operations on 8-in. howitzer shells.]

PRACTICAL WARTIME SHELL MAKING

BY LUCIEN I. YEOMANS, CHICAGO, ILL.

Member of the Society

SO many utterly foolish statements have been offered the public in regard to the manufacture of munitions and the possibility of this or that automobile factory or implement works, or other equally ill-adapted shop, being turned upon very short notice into a shell factory, that it seems well to consider of how little value for the manufacture of munitions is the present equipment of the average shop.

It should be emphasized that outside of the already existing munitions plants, the old equipment which manufacturers brought to the new business of shell making consisted mostly of their money, their credit, and the nucleus of an organization. Even the old floor space was infrequently used. The machinery and tools were more than ninety per cent new and it is significant that the greatest success has been made by those companies which were not even owners of machine shops of any kind.

It is well for the mechanical engineers and the manufac-

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turers to review carefully accepted methods of munitions production and to ascertain just what time-honored precedents may be abandoned, what "red tape" may be cut, what traditions of the mechanic arts are sacred but unnecessary, where the corners may be cut and the result attained economically, directly, and without delay.

It would seem ridiculous to construct an office building of steel and terra cotta for the field headquarters of an army division, but we see nothing strange in the equally ridiculous proposition of a nicely built permanent factory for the comparatively simple operations of machining shells.

There is a strange twist in our mental conception which permits an engine for one purpose to be nicely housed in a pressed-brick and tile-lined structure, while another equally expensive and nicely made engine may be properly located on the open deck of a vessel, entirely unprotected from the weather. It is the same deference to tradition that makes us assume that machine tools must be guarded from every exposure, and we fail to see readily that their performance would be equally good for unusual service if they were heavily coated with rust on every idle surface.

The suggestions made here for emergency factory construction are to be understood as applicable strictly to emergency conditions and to meet a demand for an unusual amount of ammunition with the least possible delay and in no way as suggestions for permanent, private or Government arsenal construction.

First must be considered locality with reference to labor supply and transportation. Within easy reach of all our large centers of population may be found level, unoccupied, naturally well-drained acreage that is suitable for the purpose and that is gridironed by railroads. These are the sole requirements for such a plan.

The essential difference between this method and the conventional one is in the assumption that this particular machine work is no more an indoor occupation than is carpentry, brick laying, car repairing, or structural ironwork, and that in such emergency it should promptly be decided that outdoor equipment is satisfactory.

Final inspection, cleaning, painting, tool making, etc., would be provided for in fully enclosed buildings at the delivery end of the plant; but the large part of the work would be performed with the lightest kind of shelter over machines, operators, and transfer track, and in the opinion of the writer circumstances would not always justify even this.

The dimensions of the plant should be determined by the size of shell to be manufactured, and units of a given hourly capacity would be located between, and perpendicular to, two lines of railroad siding at the ends of the plant. One track would be entirely a receiving track and the one at the opposite side a shipping track. The distance between the tracks would represent the proper length of each unit to avoid congestion and afford the simplest movement and transfer of product.

The number of units required, as so determined, would establish the other general dimension of the plant.

Assuming that the shell was to be the well-known British 9.2-in. high-explosive and the required output 250 per hour, the general dimensions of the plant would be approximately 1000 ft. long by 300 ft. wide, and it would contain six units each capable of producing 42 shells per hour.

Each unit, commencing at the rear of the plant, would start with an unloading platform and extend in a double row of opposed machines for the different operations toward the finishing end, where the machinery installation would be replaced by hand operations and inspection, to the packing and shipping track.

From the end of the machine installation to the finishing end a single-story shelter would be built to house these operations and also the tool maintenance sections.

All machine tools would necessarily be horizontally belted, but since space is not considered, the convenience of having all transmission machinery within easy reach is a consideration.

In the construction of the plant, lines of concrete piers would be located to carry the line shafting, storm water drains would parallel the lines of piers, concrete foundation walls for the machine tools would come next, and transfer tracks intermediate the machine foundations.

Throughout the length of each machine-foundation wall would extend a cutting compound drain to a sump and pump at the end of the line or at intermediate locations. From each concrete pan under or at the machines would extend a chip channel, having a slightly raised bottom, connecting with chip tanks sunken in the ground and covered, but readily removable by the cranes.

Between each two rows of machines would be an industrial railway upon which would be operated platform cars for transfer. At each machine would be car-floor-height platforms from and to which all tools and material would be transferred.

Such a complete plant could be erected and operated to capacity within 60 days from the time authority was given to build it.

The purpose of this paper is to invite discussion, suggest a practical departure from the conventional and present a method of emergency construction that it is hoped will be of some benefit.

A complete series of machines for all shell-making operations could be designed along lines that would permit of their construction in immense quantities within 30 days from the time when the necessity for them arose, and at a rate of output that would supply any conceivable demand within the following 60 days.

The United States Government could easily be prepared to deliver such machines in the desired daily quantities within 30 days by the following method:

In each selected industrial center establish a Government storage plant in which would be stored the necessary patterns, jigs and equipment to make such machines; and in which would also be kept a list of the plants in the territory equipped to make the required parts. Upon order from Washington the patterns would be shipped to the designated foundries and, beginning with the third day, castings would be received at the rate of one casting a day per pattern. It would probably require about three weeks to manufacture the various working parts of the machine, but within 30 days at the outside, completed machines would be ready to run in the munition plants. The number of machines added to the equipment daily would be the same as the number of patterns from which castings were made. This record could be bettered by stocking in the warehouse the various machine parts, aside from the large bed castings, sufficient to make up machines of a desired daily output during the period found necessary. If this were done completed machines could be delivered to the munition plants within a week of authorization by the government.

Ten such manufacturing centers could be established, as for example, Philadelphia, Cleveland, Cincinnati, Buffalo, Pittsburgh, Minneapolis, Milwaukee, Birmingham, St. Louis, and Chicago, and within 30 days each unit could be producing shell-making machines at the rate of from 10 to 40 machines

000, depending on the size and nature of the machine being produced. Moreover, the total cost to the U. S. Government for the patterns, jigs, and equipment necessary for such a day would be approximately but $1,000,000.

MUNITIONS DESIGN FOR QUANTITY MANUFACTURE

By J. E. OTTERSON,[1] NEW HAVEN, CONN.

This paper deals with the question of the relation of design to quantity manufacture, with particular reference to the problem arising from the undertaking of quantity manufacture under abnormal conditions, and especially by manufacturers who may not have previously manufactured the particular product in question.

The term *design* must be broadly and specifically defined, and will here be taken as including not merely the general conception of the particular product which might be termed the *inventive design*, but also the full consideration by the designer of all questions affecting the design, manufacture, and service. It is obvious that the design must lend itself to abnormal manufacturing conditions. The term *design* will, therefore, be here understood as including the determination of all the limiting conditions which will permit the product to fulfill the purpose of the design.

Quantity manufacture should not be undertaken when the design is in the experimental stage. Models and samples should first be made and thoroughly tried out to the satisfaction of the designer, the manufacturer, and the consumer. Such models should embrace the limits of tolerances and thus serve to test the judgment of the designer in establishing such tolerances.

It is essential that the designer and the manufacturer recognize in full their respective responsibilities. The designer is responsible for the proper functioning of the completed product, provided it fulfills the specifications set forth in the design. The manufacturer is responsible for fulfilling the specifications set forth in the design.

The designer should make his design and specifications so clear, precise, and complete as to preclude any possibility of subsequent misunderstandings as to the exact intention of the design and as to the responsibility for any failure to function.

Standards of design should be absolute and not relative, expressed in terms of standard units of measurements and not in terms of relative exactness involving personal opinion and judgment as to the relations existing.

Designs for quantity manufacture usually prescribe some requirements as to interchangeability, and presuppose a system that is commonly called *interchangeable manufacture*. The term *interchangeable*, as frequently used, is indefinite and relative, and should not be used by the designer as a save-all to care for omissions from the specifications or as a substitute for the exact and absolute expression of the requirements of the design in terms of standard units of measurements. The term *interchangeable* has some significance as evidence of broad intent and general purpose, but is so lacking in exactness as to form no satisfactory basis for contractual or other obligations. It is, therefore, a dangerous term and should be used only in a supplementary sense.

Interchangeability increases in difficulty of attainment in ratio to the complexity of the product, the volume of manufacturing, the continuous operation of equipment, the abnormal and rush conditions in manufacturing accompanying national emergencies, the employment of unskilled and untrained labor and of labor having natural qualifications lower than those desirable for the work in hand. We must recognize that cutting tools lose their edges and exact form through wear, that machines do not continually remain in exact alignment and adjustment, that materials do not run absolutely uniform, and that the human element is a variable one. By reason of a combination of adverse conditions, absolute interchangeability may be impossible of attainment.

The designer must recognize, therefore, that peace-time standards of exactness cannot be maintained under war conditions, and that the standards of a factory that has been making a given article over such long and continued periods of time as to permit of the tuning of material and the training of personnel to exact repetitive performances, cannot be applied to the factory that must expand its facilities manyfold over night and deal with untried equipment, processes, and personnel.

In peace time the designer may quite properly seek to establish standards with such restricted tolerances as to enforce a high engineering standard, in order to preclude all possibility of failure of his design, and insure the success of his own work by placing a greater burden of accomplishment upon the manufacturer; but where the problem is one of production for war, the interest of the individuals must give way to the common good, and they must recognize a common purpose free of all antagonism and give each other all the tolerance that is possible, with the provision of a satisfactorily functioning product under urgent adverse conditions.

The problem before the designer of products for quantity manufacture under such conditions is, therefore, to give the manufacturer as *wide latitude* as possible without embarrassing the functioning of the product, and the suitability of the design to quantity manufacture under war conditions may properly be measured by the extent to which it meets this requirement.

It is recognized that this places upon the designer a decidedly heavier burden than is ordinarily assumed by him, but it is necessary that this should be the case if the design is to lend itself to the most rapid manufacture under the adverse conditions presumed.

This can best be accomplished by establishing as an essential part of the design a definite system of gaging, including the determination of gaging and holding points the control of which will control the functioning of the product, and prescribing tolerances at such points that are possible of attainment under the abnormal conditions of manufacturing under discussion.

It is the practice of some designers and manufacturers to prescribe exact dimensions as between two gage points and to establish no tolerances in connection therewith. The intention is that the manufacturer shall work as near to the absolute measurements as possible. Obviously this establishes no standard whatever. Since it is impossible to work to exact measurements, it places an unreasonable burden upon the manufacturer, who must assume the responsibility of prescribing the tolerances and instructing his help, permitting them to prescribe the tolerances according to their own judgment—obviously a loose method of operation. Every gage point should, therefore, have the tolerances clearly defined by the designer and these tolerances should be acceptable to the manufacturer, and, once accepted, should be adhered to. To

[1] Winchester Repeating Arms Co.

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prescribe tolerances less than required for proper functioning is uneconomical, since it demands unnecessarily exact operation and enforces extreme inspection practice, with consequent unnecessary rejections and reworkings.

Absolute requirements or measurements are justifiable only as applied to unimportant points or parts, where it may be safe to leave the question of tolerances to the judgment of the operator or of the inspector. In other words, we apply absolute measurements to those points about which we are not particular; where exactness is required tolerances should in all cases be provided in connection with the design.

In addition to providing a workable system of gaging, the designer must give consideration to materials and processes of manufacture. The materials prescribed by him must be such as to be readily obtainable in the broadest possible market under the abnormal conditions existing. It is important that the specifications for materials provide as great latitude as practicable, and that no restrictive requirements be included which will unnecessarily prevent the use of commercial material. In addition, the materials prescribed must not present any serious difficulties of working nor place an unnecessary limit upon cutting speeds, nor unnecessarily increase the consumption of cutting tools.

The responsibilities of the designer and the manufacturer are further defined by consideration of the problem of inspection. Inspection should be of two kinds and for two purposes:

a *Process Inspection*—the inspection of the work in process to determine the satisfactory performance of the operations; and

b *Product Inspection*—the inspection of the completed product to determine its satisfactory functioning qualities and its acceptability for the purpose for which it was designed.

The process inspection is obviously the responsibility of the manufacturer, and is his assurance that his manufacturing facilities are performing according to the standards set, his guide for the correction of manufacturing errors and shortcomings, and his protection against the rejection of the completed product.

The product inspection is obviously the responsibility of the organization that is going to use the product, and is at once an inspection of the design and of the manufacture.

If, in connection with the product inspection, the product should be found not to function properly and yet pass a satisfactory process inspection—that is, come within the tolerances laid down by the designer—the responsibility is obviously with the designer, and the adjustment must be between him and the consumer of the product.

PROCURING MATERIALS FOR MUNITIONS

By C. B. NOLTE,[1] CHICAGO, ILL.

After the first two months of the present war General French, of the English Army, said: "The problem set is a comparatively simple one—munitions—more munitions—always more munitions." The General's statement is undoubtedly true to a large extent at least, as it has been brought home to us that munitions certainly do constitute a most important problem in a war of any magnitude; but there are probably many manufacturers in this country today who will not exactly agree as to the simplicity of the problem.

The United States is exceptionally fortunate, however, in the possession of extensive and valuable deposits of the principal metals and materials for explosives required for manufacturing munitions. Of the world's supply, this country normally produces approximately 40 per cent of the coal and iron, 60 per cent of the copper, 65 per cent of the petroleum, 32 per cent of the zinc, and 33 per cent of the lead. It is apparent, therefore, that our domestic supply of the most important raw materials is ample for the manufacture of artillery ammunition, guns, cartridges, and vehicles which probably constitute the class of munitions that is required in the greatest quantity.

The United States Government arsenals are entirely inadequate, in time of war, to supply the needed products for war use, and this duty will fall, to a large extent, upon private industries. The amount of munitions that has been supplied during the war is no criterion of the amount that can be produced in this country. Many concerns that have participated in this new industry built entirely new plants for that purpose in order not to interfere with their increasing domestic trade. In addition to innumerable smaller manufacturers, there are over 35,000 manufacturing and equipment concerns in this country, each doing an annual business of over $100,000. Almost every industrial plant has operating equipment suitable for producing some munition part.

The manufacture of shrapnel and other shells does not require special machinery, and car-building and car-material plants, motor-car factories, and forge and machine shops are equipped to participate in this work. Watchmaking, typewriter, printing-machinery, office-equipment, scientific-apparatus, and electrical factories, as well as many other small machine shops, have been readily adapted to the manufacture of shrapnel and high-explosive fuses. The majority of machinery and locomotive manufacturers have machined shells. In addition, car and locomotive builders can construct field kitchens, ammunition wagons, gun carriages, and conveyances. Optical and jewelry factories are producing sights, aiming devices, and periscopes.

It requires more special machinery to produce small arms and small cartridges satisfactorily, but even interesting and surprising resourcefulness has been exhibited in the manufacture of these in ordinary plants.

Only powder manufacturers, however, are able to make the necessary explosives. The most important materials used in explosives today are obtained from coal tar, a by-product of coke ovens. Coal tar and its derivatives are produced principally by the various steel companies, and whereas there was but one concern recovering benzol and toluol before the war began, nineteen concerns had constructed new plants for this purpose by the end of 1915.

The motor truck has proved [illegible] part of army equipment; but [illegible] the many pleasure-car factories, with their ever-increasing outputs, are readily converted into motor-truck factories. Aeroplanes, most important for fire-directing, are now being made upon a commercial basis in this country by over twelve firms. In addition, there are over forty factories producing a small number of machines of some special or experimental type which can be standardized in wartime. On account of the short actual flying life of the aeroplane, however, it will

[1] With Robert W. Hunt and Co.

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be necessary to adopt extreme measures to bring the production to a satisfactory figure.

Since, strictly speaking, munitions include all supplies and equipment necessary in war, with the exception of men and money, only the characteristics of the more important materials can be considered within the limits of this paper.

The gun proper of the usual field gun is subjected to a suddenly applied pressure of from about 35,000 to 40,000 lb. per sq. in. and is generally made of nickel steel of over 90,000 lb. per sq. in. tensile strength, 60,000 lb. per sq. in. elastic limit, and an elongation in 2 in. of 18 per cent. Rigid inspection and tests of this material are necessary before it is worked. The artillery wheels, springs, hollow axles, and recoil cylinders of field guns are made of ordinary materials used at automobile wheel factories and forge plants.

The two principal types of projectiles are the shrapnel and high explosive shell. The shrapnel body is not intended to break or explode when subjected to an internal pressure of about 20,000 lb. (the force exerted when the charge leaves the shrapnel), and is made of steel with a yield point of from 80,000 to 100,000 lb. per sq. in. Further, American shrapnel must, when finally treated, give a tensile strength of, in some types, 110,000 and others 120,000 lb. per sq. in., with an elastic limit of 80,000 lb. and 90,000 lb. per sq. in., elongation in 2 in. of 15 and 16 per cent. and reduction in area of 40 and 45 per cent, respectively. Steel for this purpose is furnished by the steel mills, and contains carbon from about 0.35 per cent to 0.45 per cent, manganese 0.50 to 0.80 per cent, phosphorus and sulphur not over 0.04 per cent each, chromium 0.70 to 1.20 per cent, vanadium 0.12 to 0.24 per cent.

Shrapnel steel, as produced by the large steel mills in this country, is furnished in three different forms: rough-turned bars, forgings, and rolled-steel rounds. The latter form has been used with considerable success and exceedingly rapid production.

The ordinary shrapnel fuse is made of several brass parts, the material for which can be produced by modern brass foundries. The usual composition of this material is about 59 to 61 per cent copper, 37 to 39 per cent zinc, and about 2 per cent lead, resulting in a tensile strength of about 45,000 lb. per sq. in., elastic limit of 27,000 lb. per sq. in., and 30 per cent elongation in 2 in. The fuse bodies and caps are generally forged, whereas the timing rings and other parts can be cut from brass tubes. The brass cartridge cases which hold the propelling charge for the shrapnel are drawn from brass disks cut from bars rolled by the various brass rolling mills. There is nothing unusual in the specifications for cartridge-case material, copper varying from 66 to 73 per cent, according to different purchasers' specifications, with zinc from 27 to 34 per cent, and with a tensile strength from 43,000 lb. to 54,000 lb. per sq. in. and an elongation of from 28 to 32 per cent in 2 in. The usual specification allows a range of 3 per cent in the copper and zinc contents; for example, 69 to 72 per cent copper and 28 to 31 per cent zinc.

The high-explosive shell is made of steel and is intended to break into a large number of pieces upon impact and explosion. It is unusually forged from steel rounds, billets, and cast ingots, with carbon from 0.40 to 0.55 per cent, manganese 0.40 per cent. to 1.00 per cent, phosphorus and sulphur not over 0.04 on 0.06 per cent each, and silicon from 0.18 to 0.30 per cent. Some of the steel for this purpose also contains nickel not to exceed 0.50 per cent and copper not over 0.10 per cent.

This grade of steel is easily produced by practically all of the large and small steel mills in this country, and, in fact, has been produced already in considerable quantities for such purposes. The fuse for the high-explosive shell does not present the same difficulties as that of shrapnel and is usually made of ordinary steel and copper alloys.

The first problem in the procuring of shrapnel, high-explosive shells, fuses and cartridge cases, is the delivery of suitable raw material. Care must be taken, therefore, to secure steel and brass of the proper chemical composition and physical characteristics. In addition to a careful study and understanding of the specifications and drawings, one of the most effective and economical means of obtaining the desired material rapidly and without excessive loss has been found to be by inspection of the material at the rolling mills before it is shipped to the finishing plants, by an experienced and trained organization.

Regarding explosives, the majority of commercial explosives are not suited for use in shells on account of their inability to withstand, without explosion, the shock of firing from the gun. Smokeless powder is produced by special plants which treat cotton fiber with such materials as nitric and sulphuric acid, alcohol, and ether. Nitrogen, used in the manufacture of nitric acid, is chiefly derived from the sodium nitrate found in Chile, but European nations are now obtaining a large amount of nitrogen from the air by the fixation process. Pyrites for making sulphuric acid is found in this country, although much of the best is imported from Spain. The United States manufactures ether and alcohol in abundant quantities. Glycerine, a by-product of soap manufacture, is produced in large amount at home. Cordite, the explosive which has come into such great favor because of its combination of propellant and high explosive qualities, is obtained by further treatment of gun cotton and nitro-glycerine with acetone, which is a product of wood distillation and which is also obtained from a special fermentation of starch. Trinitrotoluol is obtained by nitration of toluene, which constitutes about 36 per cent of crude benzol, a by-product of coke ovens.

Trinitrotoluol possesses an explosive force of about 119,000 lb. per sq. in., while the explosive force of picric acid is about 135,000 lb. per sq. in. Owing, however, to its propellant qualities and the fact that it does not form dangerous salts by combination with iron and other metals in contact, trinitrotoluol is superior to picric acid as a war explosive. Picric acid does yet, however, play an important part in priming compositions and propellant powders. It, too, is obtained from coal-tar derivations.

Although, as has been outlined, the United States is well equipped to furnish the principal materials for munitions, it is apparent that there are many other phases of the problem which it has not been possible to consider here. If the requisites of war are to be successfully met, every industrial worker, whether he be engaged on the farm, in the mine, or in the factory, has an important task to perform; every manufacturing plant has a definite obligation; and all the resources of our country must be systematically brought to their utmost utility.

LIMITS AND TOLERANCES FOR THE MANUFACTURE OF MUNITIONS

By A. W. ERDMAN,[1] SCHENECTADY, N. Y.

THE purpose of this paper is to direct attention to some of the practical aspects of the question of limits and tolerances, as customarily applied to the manufacture of

[1] General Electric Company.

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munitions, rather than to attempt to establish standards of high technical value in assigning definite limits to the several classes of dimensions involved.

Most mechanical men who have had recent experience with munitions manufacture will agree with the statement that their troubles have not to any great extent been due to inherent difficulties with the tolerances in general; but have principally been caused by such factors as incomplete or inconsistent drawings and specifications, and lack of mechanical judgment on the part of inspectors in interpreting the drawings and specifications and in the use of limit gages. In fact, these aspects of the subject are of such major importance that it would seem that technical refinements may be postponed until standards of practice have been established with respect to these factors.

The average munitions drawing is fairly open to criticism and leaves much to be desired in the way of clearness and consistency. Such defects as the following are often encountered:

a Flat dimensions without any tolerances

b Dimensions with one tolerance only, either plus or minus

c Overlapping tolerances on two parts which assemble together

d The sum of the tolerances on intermediate dimensions are not in agreement with the tolerances on the overall dimension

e No limits are specified as to permissible eccentricity between concentric cylindrical surfaces, or between two parts which assemble together

f In the case of screw threads on two parts which assemble together, but where interchangeability is not required, no specifications are given as to the nature of the fit.

Defects *a* and *b* can be readily remedied by establishing an invariable rule that all dimensions must be the mean dimensions with equal plus and minus tolerances.

Defect *c* usually occurs in the tolerances for external and internal threads on two parts which assemble together, and is occasioned by losing sight of the fact that the maximum external thread must be slightly smaller in diameter than the minimum internal thread, in order that these extremes may assemble properly.

Defect *d* can best be avoided by establishing the invariable rule that all dimensions in the same direction must start from a common reference line.

Defect *e* is a fruitful source of trouble to the munitions maker, and consequently in all cases where close concentricity of cylindrical surfaces is essential, definite limits of eccentricity should be specified on the drawings.

Defect *f* can conveniently be illustrated by considering the fit of a nose-piece or base-plug external thread, in the internal thread in a shell. In this case the nose piece or base plug virtually becomes an integral part of the shell after it has been assembled. In fact, it is common practice to finish-machine or grind these parts after they have been assembled, and in subsequent operations such as loading keep them together by similar markings. Manifestly, all that is required from the standpoint of utility is that the nose piece or base plug should screw into the shell easily, but without too much looseness. As such threads are usually quite coarse, liberal tolerances are in order, but the dimensions and tolerances must be properly assigned in order to avoid the possibility of too much looseness. This can readily be accomplished by letting them overlap to some extent, which will of course result in producing some nose pieces and base plugs which will be too large to enter shells having minimum threads. This apparent difficulty is overcome by grading the nose pieces and base plugs, as, for instance, small, mean, and large. A mark can also be put on a shell at the time it is gaged which will indicate to the assembler which grade of nose piece and base plug to use.

RELATION OF TOLERANCES TO WEIGHT

Perhaps the most striking defect, in shell drawings particularly, is the discrepancy between the tolerance specified for the weight of the shell and the variations in weight of the shell from making one to maximum external and minimum internal dimensions, and another to minimum external and maximum internal dimensions. As a rule, shell drawings and specifications allow a variation in weight of plus and minus one per cent of the mean weight for the smaller sizes and less for the larger sizes, whereas the extreme dimension tolerances would permit two or three times as much variation in weight. Furthermore, no dependence can be placed on the assumption that a shell machined to the mean dimensions will have the mean weight specified on the drawing. Whether or not these discrepancies are intentional or accidental the writer is not informed, but it seems obvious that the drawings should be revised.

From the standpoint of ballistics uniformity in weight of shell is highly desirable, and consequently close weight tolerances are to be expected; but the drawings and specifications should sound a clear note of warning so as to prevent a manufacturer from proceeding on the assumption that the dimension tolerances can be used indiscriminately. Some tolerances bear evidence of having been added—probably to meet some difficulty in manufacture—without perhaps due consideration being given as to the extent to which the weight would be affected. In any event, it seems imperative that the drawings should be revised so that shells machined to the mean dimensions, and of steel of the specified quality, will have the mean weight.

If ballistic considerations permit, the weight tolerances should be increased, since they are at present the limiting factor. The drawings plainly state that advantage cannot be taken of all the extreme tolerances on any one shell.

These considerations are not advanced as an argument against larger dimension tolerances than weight tolerances, since liberal dimension tolerances afford a maximum of munitions production; but rather to caution the manufacturer to consider carefully all possible combinations of the tolerances which will produce the greatest uniformity in weight of the finished product, and also to suggest to the ordnance engineer the desirability of plainly pointing the way to attain the desired results.

THREAD TOLERANCES

Perhaps the most difficult operation in munitions manufacture is the cutting of internal and external threads within close limits. The Whitworth form of thread is particularly difficult to cut and has been the cause of endless trouble in recent munitions work. We all regard the rounding of t[he] top and bottom of this thread as particularly iniquitou[s] we are apt to regard the United States form of threa[d] greatly superior. As a matter of experience, it is quite d[iffi]cult to maintain the size of the United States form of threa[d] within close limits. The requirement that this form of thread shall fit on the top and bottom, as well as on the all-important angle, is the chief source of trouble. The very existence of this requirement results in most of the fitting occurring at the

top and bottom of the thread, rather than on the angle. It is practically impossible to avoid this condition since the tops of the threads on a tap wear away very quickly and therefore the tap does not continue to cut internal threads of full depth. As the thread gages are made of standard form, it is obvious that much of the work will not pass the gages, although perfectly correct as to angle diameter and pitch. To a less degree is the same condition true of dies and external threads. This defect is universally recognized in American machine shops and is quite commonly overcome by making the diameter of taps slightly larger than standard, so that they will cut an internal thread deeper than standard and also cut a larger hole or core than standard. This affords a clearance at the top and bottom for the external thread. It seems manifest that this necessary and customary practice should receive official sanction in the drawings and specifications for munitions, and that limits for these clearances should be specified.

INDIVIDUAL JUDGMENT OF INSPECTORS

Next in importance as affecting the manufacture of munitions is the question of mechanical judgment in interpreting the drawings and specifications on the part of the inspectors, and also in regard to the proper use of limit gages. Although many inspectors are men of excellent mechanical judgment and experience, a large number of necessity have not these qualifications. In fact, it would be detrimental to other lines of manufacture to require that only experienced mechanics be selected as munitions inspectors. It therefore seems that the obvious solution of this difficulty is to make the drawings and specifications so clear and comprehensive that men with little mechanical experience can become efficient inspectors. The specifications should clearly specify such details as kind and quality of finish for all surfaces, whether by turning or grinding, and if by turning whether the tool marks must be removed by filing. Some surfaces can, in the interest of maximum production, be left semi-finish-turned, and the specifications should in such cases so state. In general, this plan can be made most effective by basing the requirement of the specifications on actual results obtainable with modern machine tools, and all unnecessary refinements should be eliminated.

Regarding the proper use of limit gages, it is perhaps difficult to lay down general rules, but certainly such a fundamental one as that gages should never be forced can be advanced without hesitation.

MACHINE-TOOL LIMITATIONS

The limits of accuracy attainable on machine tools must be taken into consideration in determining how limit gages should be used. The screw thread affords a good illustration of this point. In a part where a threaded hole goes entirely through the part, it is not very difficult to cut threads of uniform diameter in the sense that the thread is uniform throughout its length and that it does not taper. In bottom-tapping a shallow hole, however, or in cutting a short external thread, both are apt to taper slightly, or at least the first thread or two will be thin. In the first case it is perfectly proper to require that the maximum thread gage shall not enter at all; but the second case manifestly demands different treatment. A rational rule would be to allow the minimum thread gage to screw in one-third or one-half the depth of a shallow not-through hole, and the same allowance should be made in the case of a short external thread. This proposition should be judged from the standpoint of utility rather than ideality, particularly when one stops to consider that the mechanic can, by cutting the external thread in the proper direction, make these inaccuracies actually balance each other.

To sum up, maximum production, which is the principal aim of any revisions, can be most readily attained by increasing the weight tolerances in the case of shells particularly. If, however, the ordnance engineer cannot allow any greater variations in the weight of shells, then, at least, the alignment of mean weight with mean dimensions, as outlined in the foregoing comments, will, it is believed, prove to be an important step in the right direction. As regards other munitions, where weight variation is not so important, much can be accomplished by aligning the dimension tolerances with the capacity for accuracy possessed by modern high-speed machine tools.

GAGES AND SMALL TOOLS

By FRANK O. WELLS, GREENFIELD, MASS.

Member of the Society

Of first importance in the manufacture of rifles, guns and munitions of war are gages. There are many types of gages, but the one used in the manufacture of munitions is the dimension or limit gage. Whatever instrument is used must be able to measure accurately and rapidly, and must also be durable, as very slight wear will destroy the accuracy.

It has been well said that if we can measure an article we can make it. The difficulty lies not in the making, but in the measuring; and our greatest obstacle in exact measurement is the human element.

In olden times the human element was the controlling factor in all operations. Work was done in very small quantities and was not interchangeable. Some work was good and some was poor, all depending on the man who did it. To meet the demand of the present day, we must have progressive manufacturing, where each man has only a small part of the work, and that part must be done by an ordinary workman. All this calls for a method of measurement different from that formerly used. Then we wanted one piece, now we want thousands of pieces, all alike and each one an exact duplicate of the other. This is easily accomplished by our printed instructions and gages, and with these we can start a large number of factories making war materials that will be one hundred per cent good, and also standardize the cost of production.

Improperly designed gages cause poor work and a lack of interchangeability, making the cost of production and the cost of assembling greater. Our Government should take advantage of the knowledge of this fact, obtained at such great cost in the present war, and should standardize all its operations, gages, and measuring tools, so as to avoid a repetition of mistakes of this kind.

The Government should have, first of all, its blueprints prepared indicating the proper tolerances perfected by tests and careful practice. The sequence of operations and the time taken to do the work should also be perfected and put in printed form with the necessary illustrations showing the set-up, as well as the best way to handle the work, both in the operation and gaging. This would enable all factories to standardize their productions.

The importance of the best methods of measuring is illustrated in a report from the U. S. Ordnance Department, in

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which the statement is made that the cost of inspection is from 10 to 12 per cent of the total cost of manufacturing. These are startling figures, and indicate that the proper gaging methods had not been used.

The output of the U. S. Government arsenals for the year 1915 was $11,284,113.95; for the year 1916, $9,471,300. It has been estimated on good authority that this could have been increased at least 50 per cent without increasing the size of the plants, by having a larger supply of gages and tools. The cost of such tools and gages is estimated at 20 per cent of the total cost of the plant, which shows conclusively the need of gages and small tools.

Few people realize that our Springfield rifle has more than one hundred parts and requires 1400 distinct factory operations. To produce 1,000,000 rifles requires $360,000 worth of gages for the original equipment, while renewals cost $400,000, making a total of $760,000. Each 1000 rifles made require 4800 gages. The renewal of the gages costs about 50 cents per gun. To make 10,000,000 rifles in 200 days requires at least sixty more arsenals than we now have. The war material most talked about is ammunition, of which our Government uses about 17 sizes at present. The cost, including the upkeep of gages, used in the making of 1000 rounds of ammunition per day, with a steady production for 200 days, is at least $2,225,000. These figures have been carefully worked out by makers well versed in the manufacture of gages for ammunition. It has been estimated by good authority that we should be able to make at least 200,000 rounds per day. The vast importance of the whole gage question can be realized.

Of course, some sizes of ammunition have to be made in much larger quantities than others. Careful estimates show the special jigs and fixtures would cost nearly double what the gages would. So far, the paper has only touched on ammunitions and rifles. To have everything on hand necessary, the figures given have to be multiplied many times.

There are today some 3,500,000 people in Great Britain engaged in making munitions of war in over 4500 factories. In doing this work to advantage, each workman should at least have $25 worth of gages, tools and fixtures.

The majority of contracts taken for ammunition in this country were taken by manufacturing organizations without experience on war material, and the gages first designed were not the best possible to insure economical assembling of the parts, with the result that a great many rejections were inevitable during the first months after production was attempted.

Our Government should provide itself with all the gages, tools, jigs, and fixtures far in advance of any possible expectation of requirement; the cost is small compared with the results obtained. This is a very simple business proposition — what every efficient manufacturing company would do.

It is a very poor policy to cut down on the number of gages and small tools. It is far better to use every labor-saving device possible. All this means a saving in high-priced labor, and this is very important in time of need when we cannot get the necessary skilled labor.

It is considered the best practice in manufacturing to put the thought and money not so much in the large machinery as in the small tools. The most important of all are the gages, and these must be so designed as not to have any guesswork about it. We must know that every part is machined right. We must be able to say, "We know this is right," and not say, "I guess we are right."

To most people gages seem of small importance, but as this paper endeavors to show, they are quite the reverse.

IMPORTANCE OF INTELLIGENT INSPECTION IN MUNITIONS MANUFACTURE

By E. T. WALSH, NEW YORK, N. Y.

Member of the Society

A STRIKING example of the difficulties that may arise in inspection work has been afforded during the present war in one contract for the manufacture of 5,000,000 rounds of ammunition which was completed by the contractor subletting the work among more than one hundred manufacturing plants in the United States and Canada, the time and the magnitude of the work making this necessary. The contractor, for his own protection, had to inspect all the product as it was made by the sub-contractors, and a corps of inspectors was required in each plant, the number of such corps being equal to the number of plants doing work. Great difficulty was experienced in getting men qualified to do this work, because there were practically none in this country who had experience in the manufacture of munitions, and but few available who had any kind of inspection experience.

To expedite the delivery of the finished product, the Russian Government placed its inspectors in the plants of the sub-contractors where they received the finished parts directly from the contractors' inspectors. Russia was as little prepared to provide the required number of qualified inspectors as was the contractor, and in consequence the manufacturer had inflicted upon him so-called inspectors selected from every walk in life, it seemed, except the mechanical, and barbers, bartenders, butchers, students and teachers were the usual thing and the practical man the exception.

The specifications for the ammunition were so drawn as to leave a great deal to be interpreted by the inspector, who was rarely qualified to intelligently pass upon the point at issue. The following extracts, copied from the specifications, will serve as examples:

> "There shall be no scratches, slivers or cuts on these parts."
>
> "If, independently of the above, in order to ascertain the qualities . . . the Receiver shall deem it necessary to make . . . other experiments, the factory shall give him all necessary means for making such tests."
>
> "For the measuring and verification of the projectiles the factory is under obligation to furnish a sufficiently vast, light, dry and warm room and place at full disposition of the Receiver, as well as furnish cupboards for the keeping of verifying instruments, scales of sufficient sensitiveness, electric lights of sufficient energy, for the examination of projectiles and gross power."
>
> "For the measuring of the projectiles, the factory shall furnish the Receiver, for his exclusive use all verifying working instruments . . . prepared according to the instructions, *as well as according to the indications of the Artillery Receiver.*"
>
> " . . . the finish of these surfaces must be brought to such a degree as is obtainable when working with a tool."

The slightest scratch or tool mark was soon magnified into a cause for rejection. One sub-contractor claimed that he was required to unbox several thousand shrapnel because the Rus-

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[illegible] a flyspeck on the copper band of one of [illegible]. In spite of the fact that gages were called for by the [illegible] for certain [illegible] points, the inspectors were not satisfied with them, but asked to be furnished with others of a design that would be more searching and exacting. Under the [illegible] covering the finish of the shell, the inspectors were soon demanding a finish that could only be obtained by buffing, and the unfortunate part was that the manufacturers had no redress, because there were no standards of finish established, there was no set of standard gages, nor was there any superior authority to whom the contractor could appeal and whose decision was final.

From [illegible] experience of two years' struggle to produce work under such conditions, the writer is constrained to appeal for coöperation in the endeavor to standardize and systematize the production of munitions, so that manufacturers will in future have definite instructions and standards to work to and, in the case of honest differences of opinions, a Bureau of Appeal, where questions will be decided definitely and authoritatively.

Drawings should be checked and re-checked until the possibility of error has been reduced to a minimum. Tolerances should be decided upon that will allow the greatest leeway compatible with good work.

Every effort should be made to make the specifications simple, clear, explicit and absolute. They should leave nothing open to the discretion of the inspectors. The specifications should describe the gages to be used and how to use them.

The gages used should be as few as will check up the product in all of the important features. What these gaging points and their limits should be, should be determined by competent military engineers, working with the idea of getting a product that will meet all requirements and still be practicable, so that the quality produced will not be curtailed by unnecessary refinements. Exactness should be required where it is necessary, and where it is not necessary there should be no holding down to ridiculously close limits.

Corps of inspectors should be enlisted from our numerous manufacturing plants and thoroughly drilled in the use of gages and the meaning and intent of the specifications, with particular stress laid upon the fact that inspection should be made with the idea of accepting as many as possible, rather than a high count of rejections.

Each manufacturer should be supplied with a set of correct sample gages, with their masters and grand master, by which the working gages should be made and checked.

An approved sample of the product to be made should be furnished to each factory, to be used for comparing the same with the regular product when necessary. These samples should be official, and product equal to sample should be accepted without question.

It is most important to have a bureau composed of qualified engineers to interpret specifications and render final decisions on all points that may arise. Manufacturers should have the right of appeal to this board and its unbiased opinion. At this bureau should be kept on view officially accepted samples of all parts in the various stages of manufacture, to be referred to when making decisions.

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The Académie des Sciences, according to the *Génie Civil*, has resolved to establish a national physical and mechanical laboratory for the purpose of scientific research directed toward industrial uses. The laboratory will be controlled by a council, of which half the members will be nominated by the Academy, one-fourth by the State Department, and the remainder by the chief industrial associations. The executive control will be in the hands of a small technical committee. Existing laboratories engaged in similar work will be affiliated to the National Laboratory, and will work in close relationship to the latter. Substantial funds will have to be provided for the working expenses of the laboratory and for the assistance of the affiliated institutions.

Stellite vs. High-Speed Steel. According to an account given in *Métaux et Alliages,* the hard non-ferrous alloy, stellite, invented three or four years ago in the United States by Elwood Haynes, marks a still greater advance in the art of cutting metals than established by the notable results obtained with the introduction of high-speed steel some years earlier. Where rate of production is a critical matter, as in the manufacture of ammunition, it has already made a remarkable record in competition with high-speed steel, a material which in point of capacity of production outclassed steels previously used. One of the advantages of stellite is that its hardness, which it maintains even at a red heat, is solely dependent upon the composition of the alloy, tungsten and chromium with additions of cobalt and molybdenum, and not upon the difficult and uncertain operations of heat treatment. Its fundamental advantage, however, lies in its ability to withstand a marked increase in speeds and feeds over those previously used with high-speed steels.

Among the already numerous machine shops employing stellite, the Fonderie des Gobelins in Paris reports that a daily production with high-speed steel of 120 shells of 155 mm. was increased to 200 by the use of stellite. With high-speed steel 21 minutes were consumed in roughing out at a speed of 17 meters and a feed of 0.7 mm. For finishing, the same speed and feed were employed and the same time was consumed. With stellite the roughing-out occupied 11 minutes at a speed of 25 meters and a feed of 0.85 mm. For finishing a speed of 37 meters was maintained with a feed of 1.67 mm. consuming 4 minutes. For completely finishing 1,000 shells of 155 mm., the cost of stellite is about 0.30 francs per shell. Other firms report equally favorable results in this class of work.

MACHINE SHOP PAPERS

SPECIAL emphasis has been placed on the Machine Shop Session of the Spring Meeting for the reasons that Cincinnati is the machine-tool center of the country and that the National Machine Tool Builders' Association will be in convention at Cincinnati at the time of the opening of our own meeting. Three papers are to be presented and discussed at this session, which is under the auspices of the Society's Sub-Committee on Machine-Shop Practice.

A FOUNDATION FOR MACHINE-TOOL DESIGN AND CONSTRUCTION

By A. L. DE LEEUW, PLAINFIELD, N. J.

Member of the Society

THE rapidity of progress of the various branches of engineering may be said to be in proportion to the ease with which their principles can be reduced to mathematics. This was never so clearly shown as in the case of the development of alternating-current apparatus. It may almost be said that the branch of alternating-current engineering was, like Pallas Athene, born full-grown. Here was a case where the science, the mathematics of this branch, was at hand, waiting for somebody to apply them. As a result, alternating-current apparatus has known no period of experimentation, of stumbling, fumbling progress.

Compare this with the slow, hesitating development of the steam engine in its first stages. In that case nothing was known except that steam would exert pressure; but no knowledge existed of the properties of steam, of thermodynamics, nor of the mathematics of engineering materials. The moment that the fundamental facts of thermodynamics were understood and were reduced to mathematics, the progress of the steam engine became more rapid.

It then became possible to imagine an ideal steam engine, which is another term for a 100-per-cent-efficient steam engine, and to show what is the maximum obtainable efficiency in any steam engine. It was therefore possible to express the efficiency of existing or of contemplated steam engines in percentage of the ideal engine. In other words, the ideal steam engine became the standard or unit of measurement. It was no longer possible for any designer or builder to think that he had produced a steam engine of the highest possible efficiency, merely because his steam engine was twice as efficient as some other existing engine.

SCIENTIFIC DEVELOPMENT OF MACHINE TOOLS

What are the things we should know about tools and machine tools to enable us to make these important servants of our present-day civilization follow the line of development which the steam engine has enjoyed?

Is it possible to develop a theory of the ideal machine tool, such as has been developed for the steam engine?

Fig. 1 shows two stress diagrams of cold-rolled steel, of which one specimen had a tensile strength of 95,000 lb. and an elongation in 4 in. of 12 per cent, and the other a tensile strength of 85,900 lb. and an elongation in 4 in. of 7.4 per cent. The area of both pieces was ½ sq. in. and the length between gripping jaws 2 in. The amount of work done in separating the first piece was 3500 ft-lb. per sq. in. of section, and for the second piece 2000 ft-lb. per sq. in.

In parting the pieces, the same result was obtained as if half the piece were removed by means of a cutting tool. Of course, this way of removing metal does not permit of controlling the shape or the finish of the remaining piece; but just the same, a certain amount of metal has been removed as effectively as if it had been done with a cutting tool. If this amount of metal had been removed by a cutting tool used in one of the present-day machine tools, the amount of power required to do this work would have depended on the quality of the tool and the nature of the machine; but in no case would it have been less than ½ hp., assuming a reasonable time element.

If the only function of a machine tool were the removal of metal, we would find that our best machine tool has an efficiency

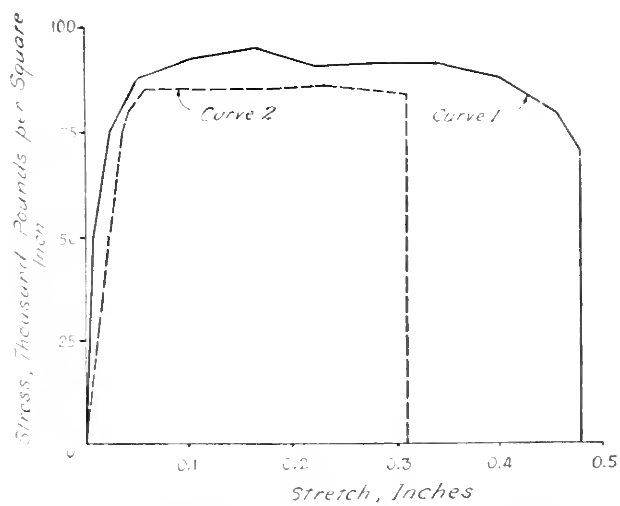

Fig. 1 Stress Diagrams of Cold-Rolled Steel

of from 0.12 to 0.22. Even the better of these figures is very low compared with the efficiency of other machines.

If chips could be removed from a piece of work by a straight pull, the ideal machine tool would be one which would remove material with the same amount of power expenditure as that required by the testing machine. While we would not expect to obtain such efficiency in practice, we would certainly aim to reach a much higher efficiency than we are able to obtain now. However, the question is whether material *is* removed by a straight pull, and this leads to the confession that the writer does not know what the exact nature of the cutting of metal is, and he believes further that he is not alone in his ignorance.

To the writer's knowledge, no experiments have been made which establish the true nature of the cutting of metals with a reasonable certainty. In The Art of Cutting Metals and elsewhere diagrams are shown of the supposed action of a cutting tool. (See Fig. 2.) The writer believes that these diagrams represent a very good first guess; but he wishes to point out that this guess is not based on anything better than the inward vision of the authors of these various works. If this guess is

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correct, then the act of cutting metal is a removal of the chip by tension, and the amount of power consumed for cutting should not be more than that required by the testing machine. If this is so, the total wastage of power in all the machine shops of the world is enormous, and it certainly would be worth while to investigate this matter thoroughly, merely from the standpoint of the conservation of energy.

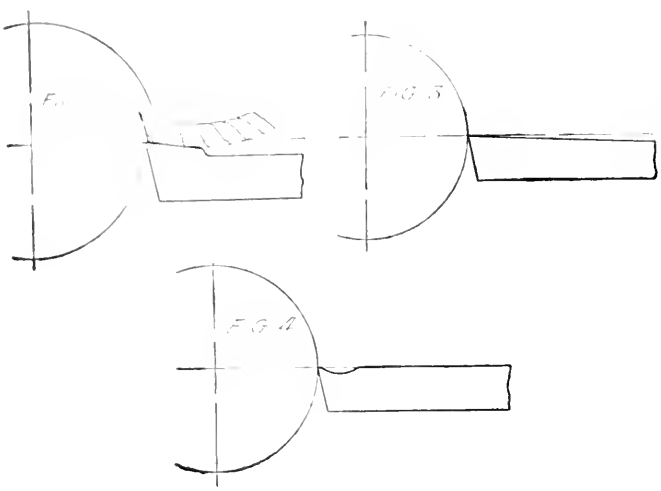
QUESTIONS WHICH NEED TO BE ANSWERED

Among the questions which should be answered before we can design machine tools in a thoroughly scientific manner are the following:

1 When we turn up a narrow disk by means of a square-nosed turning tool of which the width is greater than the width of the disk, is the action of removing the chip purely a matter of tension; or, if not, what is it?

2 Does the front end of the tool have any function at all?

3 How far from the edge of the tool is the point where the chip strikes the tool?



FIGS. 2, 3 AND 4 CUTTING WITH LATHE TOOLS

4 If the action is purely a matter of pull, and the chip does not strike the top of the tool at the cutting point, but some distance farther back, then is it necessary that the cutting edge of the tool be sharp?

5 What is the nature of the lamination of the chip?

6 How much power is required for the actual removal of the chip, for the friction between chip and tool, and how much for laminating the chip?

7 What would be the best shape for such a turning tool for this particular turning operation?

8 How does the amount of power vary with the various angles of the tool?

9 If the turning operation is not as simple as the one assumed in Question 1; if, for instance, there is a side feed, such as in ordinary shaft-turning operations, how is the cutting action modified by this side feed?

10 If the chip is removed by the action of the top of the tool, that is, if the front of the tool has no function, then what determines the nature of the finish of a cut.

11 In what relation does the power required for the side feed stand to the power required for the actual removal of the chip.

A great many other questions which could be asked cannot be answered at the present time, and still more questions would naturally present themselves as soon as we had some little elementary knowledge on this subject.

ACTION OF A CUTTING LUBRICANT

As dark a subject as the action of the tool itself is the action of a cutting lubricant. It is a well-known fact that the use of a lubricant and the nature of the lubricant used affect both the finish and the size. A very pertinent question which might be asked, is this: If the chip is laminated by tension, that is, if the point where the chip begins to separate from the work is some distance ahead of the point of the cutting tool, how can the cutting lubricant affect either size or nature of finish?

Another equally puzzling question is: If one of the functions of the cutting lubricant is to reduce the friction between chip and tool, why should we not use a heavy lubricating oil instead of a light lard oil, which has practically no lubricating qualities?

Or again, we might ask this question: If, as facts seem to show, the best results are obtained with a cutting lubricant which has little viscosity and which therefore, can readily rise between chip and work by capillary action, what is the action of the oil on the separation of the chip, seeing that the oil only gets to the point after the chip is separated?

Even more puzzling than the effect of a cutting lubricant on finish is the effect it seems to have on the size of the work. We do not see at the present time how it is possible for the lubricant to influence the size, yet that it does do this has been observed a great many times.

The writer had occasion to look into this matter when trying to determine the best cutting lubricant for automatic screw machines on small and medium-sized work. The lubricant in use was a mineral oil with 15 per cent lard oil. A certain job was selected, for which a form tool was used, and 24 screws were made with the regular compound. The screws came true to size within the limit of one-half of one thousandth. The oil was then removed from the machine and machine and tools were cleaned. The cutting compound to be investigated was substituted and another 24 screws were made. These screws were all larger than those cut with the regular oil. Furthermore, they varied from two and one-half to five thousandths over size. The machine was once more cleaned, and the original oil put back. The screws again came uniform and to size, showing that the cutting of the first 24 screws had not dulled the tool or caused any other disturbing element to enter into the equation.

The fact that the cutting compound caused the screws to be over size might possibly be explained by a difference in heating or cooling effect of the different lubricants; but how can the difference in size of screws made with the same lubricant be explained, when there was no such difference with the use of the oil?

Many other questions could be asked which can not be answered at the present time. This should not prevent us from carefully investigating the true action of cutting metals, and determining the fundamental data, if we are interested in this matter in a purely scientific way. However, the engineer should not indulge in scientific investigation, unless he feels that the results will be of practical value.

To be of value, the results should lie in the direction of saving of power, diminished wastage of tools, and less strain on the machine; or in the direction of increased output, with

or without the other advantages. That such advantages may be reached seems very clear to the author, and he wishes to outline some isolated experiments which, though not complete in themselves, point to very interesting possibilities.

Forged spindles of sixty-point carbon steel were roughed by a tool as shown in Fig. 3. As a rule, the tool was able to rough three spindles before a breakdown. In its broken-down condition the tool appeared as shown in Fig. 4. A hollow had been ground out by the chip, but a land of a little more than 1/64 in. in width had been left at the front end, showing that the extreme front of the tool had not been in action. The experiment consisted of carefully measuring the broken-down tools and making new tools of just that shape: in other words, a tool like the old tool, but with a hollow ground in the top of the same shape, size, and location as in the old tool.

This tool is shown in diagram in Fig. 4. The hollow was carefully polished, and a tool thus prepared would rough from 9 to 13 spindles. Examination showed that the hollow in the tool would remain smooth almost to the last, and that a complete breakdown followed very soon after the surface of the hollow began to show scratches. No tests of power consumption were made, but it may be expected that the power required with the old tool was more than with the new tool, as the chip did not have to bend so sharply and as the work required for hollowing out the tool was omitted.

Another interesting point about this tool was that the actual contained angle between the front of the tool and the front of the hollow was much less than we would have dared to make between the front and top of an ordinary lathe tool, especially if this lathe tool were to be used for roughing. Nevertheless, under the conditions given, this tool, with the small front angle, stood up better than the original tool with the large angle.

In The Art of Cutting Metals, Mr. Taylor stated that his experiments showed no perceptible difference in power consumption for various contained angles of the cutting tool. The writer thought that this conclusion would probably be correct only for the range of cutting angles tried by Mr. Taylor. He imagined that the relation between contained angle and power consumption would probably be a curve of the nature of Fig. 5, and that all the experiments made by Mr. Taylor were within the horizontal part of the curve.

The writer, therefore, set out to experiment with angles much below the angles mentioned in The Art of Cutting Metals. Realizing that an ordinary lathe tool would not stand up with much smaller angles than those used in present-day practice, he devised the tool shown in Fig. 6. This tool is a body of revolution, and was held in a rigid block of metal and directly over the lathe carriage. Fig. 7 shows the arrangement of tool and tool holder used. The tool was used for turning, preparatory to grinding, milling machine overarms, about $4\frac{1}{2}$ in. in diameter and 5 ft. long. When the tool gave out, it was turned in the tool holder so as to present a new piece of the edge to the work. In this manner, from 12 to 16 settings could be made with one sharpening of the tool. The sharpening itself was a matter of circular grinding. The tool would make a very smooth cut, and without a steady rest would turn half the length of the bar with a variation in diameter of less than three thousandths. The surface of the work was unusually smooth, and the amount required for grinding was much less than usual. Unfortunately, the lathe on which this work was done was too large and heavy to make accurate power readings for so slight an amount of power consumed, the cut being only 3/16 in. reduction in diameter, and with a feed of 1/16 to 3/32 in. The action of the tool was quite peculiar, and did not give one the impression that metal was being cut. Though nothing was learned about the relative efficiency of this tool, the writer thinks it worth while to bring it to the attention of the Society, on account of the possibilities for further investigation to which it points.

This matter of the relation of the contained angle to the power consumption for a given cut had previously led to the introduction of the helical cutter, where the actual angle of the tool is not small, but where the tool is presented to the work in such a manner as to have the effect of a small angle.

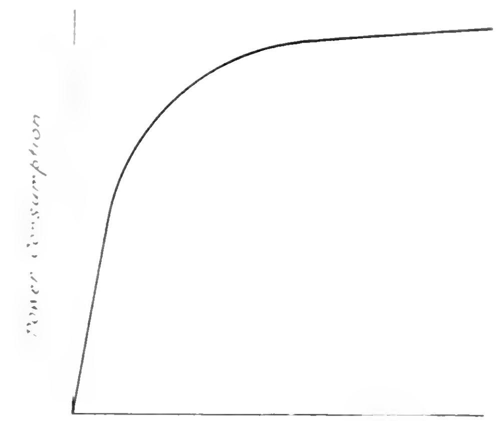


Fig. 5 Probable Relation Between Contained Angle of Cutting Tool and Power

Another experiment, more or less related to the same question, was an attempt to use a rotary lathe tool, such as shown in Fig. 8. The edge of this tool would bear up against the work Fig. 9, so as to have a very slight difference in speed between the work and the tool, and it was further set in such a way as to make the virtual cutting angle very small. The result was that it became possible to use very high cutting speeds without any apparent effect on the tool. The cutting speed was limited by the machine only. With work [illegible] in. in diameter and a feed of 12 [illegible] of 650 ft. was used for cast iron as well as [illegible] cutting was done dry. Again no attempt [illegible] accurate data as to power consumption [illegible] realized that the lathe in its present form [illegible] adapted to this kind of cutting tool. The chips made by this tool were not broken up, and were practically solid steel bars. Furthermore, the chips as they came off the lathe were cold enough to be caught in the hand. It is therefore very likely that a test would have shown a remarkably low power consumption.

Though the foregoing experiments are incomplete in them-

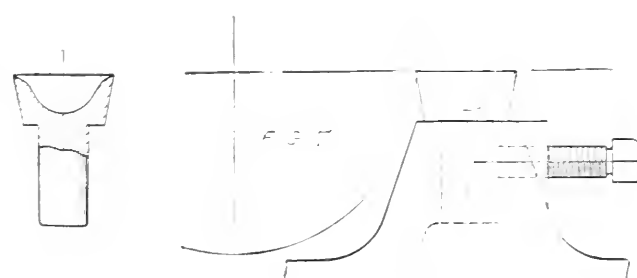


Fig. 6

Figs. 6 and 7 Author's Small-Angle Tool and Tool Holder

[illegible] they do show that there are great possibilities before us, and, further, that these possibilities lie away from the present-day shop practice. The writer believes that it would be almost useless to try experiments along a great many lines, and by a great many experimenters, without a complete plan of campaign, and that such a plan of campaign should be based on some theory, or at least on some hypothesis; and he further believes that no such hypothesis can be developed unless we start in collecting some elementary data.

A few years ago, Mr. L. P. Alford, who was then in close touch with the writer on this subject, approached Dr. Stratton of the Bureau of Standards, with the view of having that bureau take up the first investigation of the process of cutting metal. Dr. Stratton promised the assistance of the bureau, and at a preliminary meeting a general plan of campaign was discussed. The writer believes that an order was placed for a special dynamometer for measuring the stresses in various directions when planing metal. This proceeding will probably give some valuable data, but, according to his ideas, not

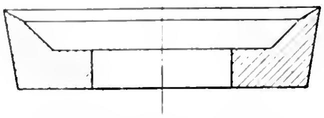


FIG. 8 EXPERIMENTAL ROTARY LATHE TOOL

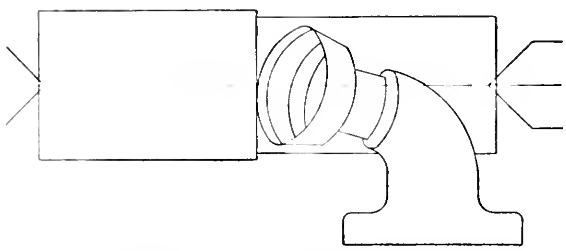


FIG. 9 ROTARY TOOL MACHINING SHOULDER

of a kind which will make it possible for other experimenters to use them as a basis for their own experiments.

SUGGESTED LINES OF EXPERIMENTATION

The writer believes that interesting results may be obtained by following a line of experimentation such as the following:

An instrument should be built, somewhat along the lines of a microtome, in which a soft material is to be cut by a razor-like blade or tool. This tool should be arranged so that it can present various angles to the work, and tools of various contained angles should be experimented with. The angles presented to the work should vary as to angle of clearance, angle of rake, and angle of shear. A dynamometer, which should be part of the instrument, should register the pull required for the cut. The material to be cut should be standardized, and it is suggested that paraffin may fill all requirements; by selecting a paraffin of standard melting point, we would also get a material of standard hardness. In this manner the relation between cutting angles and power required could be established over a very wide part of the curve. Though the actual figures obtained would not be immediately applicable to metal cutting, it would make it possible to find the controlling law, and this done, it would then be possible to investigate the cutting of harder materials over a small portion of the curve, and compare this portion with the corresponding portion of the curve already obtained. The same instrument could possibly be used for tests on such materials as lead, soft white metal, etc.

Another line of experimentation would be to arrange some machine tool, such, for instance, as a lathe, for running at very low speed, say 1 in. per hour; mount a steel disk on this lathe, and take a cut at the circumference of this disk. In this manner the cutting action would be of the simplest kind, as the tool to be used could be a square-nosed tool of greater width than the thickness of the disk, so that there would be no side cut. A moving picture taken at a high rate of speed could then be reeled off at a low speed, and it would probably be possible in this way to visualize what actually takes place in cutting metal. It would readily show whether cutting is merely the result of tension, or whether shear plays a rôle, or whether both are responsible. It would probably show whether the chip leaves the work ahead of the tool point, and whether or not the front end of the tool is in contact with the work. It would probably show many other things besides, and might be made the foundation for a number of lines of experimentation.

The writer believes that the time has come to try to interest as many engineers as possible in the subject of collecting fundamental data in regard to the cutting of metals, but rather than to suggest individually some method by which universities, industrial establishments, and engineers might be asked to coöperate, he prefers that this matter should be discussed by the Society, and would like to have this paper lead ultimately to a systematic effort in this direction, fathered by The American Society of Mechanical Engineers.

MACHINE-SHOP ORGANIZATION

BY FRED G. KENT,[1] CINCINNATI, OHIO

IN this paper it is my purpose to outline briefly the basic structure of an organization for a shop building the average line of machinery. I shall not touch at all on the commercial side of the organization, such as sales, advertising, financial, and purchasing, but will confine the paper entirely to the manufacturing end.

As all my experience has been with concerns in operation for some years before my becoming connected with them, I have always had the advantage of having considerable high-grade material, both in the way of men and equipment, ready at hand to work upon, which accounts for some of the ideas expressed below.

While I have been associated with some very large concerns, I would rather these remarks apply to the shop employing 600 men or less, for a shop of this size, from the very nature of its growth and the volume of business transacted, has just as many, if not more, obstacles to overcome as the larger plant, and is usually in no condition financially to set aside any large sum for betterment work. For this reason it is necessary in a business of this sort to plan any forward move with the greatest care, in order that there may be sure profit in each change made, and all such changes may take place at such times as to cause no interference with getting out the regular product.

This, of course, means rather slow progress, which is apt

[1] Lodge and Shipley Machine Tool Co.

For presentation at the Spring Meeting, Cincinnati, Ohio, May 21 to 24, 1917, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form and advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

to be discouraging to the man who is anxious to see things go, but, on the other hand, it has a decided advantage in the fact that the evolution is so gradual that there is very little opposition or unfavorable comment from foremen or workmen inclined to discredit innovations. This in itself is a very important factor toward any reorganization scheme, for, notwithstanding arguments to the contrary, the stability of any shop system depends very largely on whole-hearted coöperation, from the chief executive clear down the line to the sweeper.

Some time ago James Collins made the statement in a magazine article that "during the next few years some of the largest profits in American industry will be saved out of operation. Heretofore our profits have been made, but saving a profit is a different thing altogether." I quite agree with this, and my work for several years has proven to me that hundreds of small details are allowed to take the wrong course simply because they have always gone that way. We have all of us been too much concerned in systems of paying wages, with the object, of course, of getting more work at a lower cost. Sometimes straight piece work has been adopted, and again it might be some one of the several forms of the bonus or premium plan, and in nearly every one the feverish desire to get something started has precipitated action without proper planning, and has brought about useless waste of time and energy, and, in many cases, ill-feeling among the workmen. If for no other reason than that of harmony, let us leave the time-study and wage-payment schemes until we feel sure that we have very nearly gone the limit in stopping other leaks.

My first point is that wage payment, premium schemes, bonus arrangements, etc., should be the last point of attack rather than the first.

Let us suppose that we are going about the reorganization of such a shop as I have mentioned. What is the best course to take? It is my opinion that the easiest way out, and at the same time the one most profitable, is for the directors to place a man of proven executive ability at the head of a military or line type of organization, giving this man plenty of time and a free hand to work out the solution of their problems. This arrangement will prove successful more times than any other.

The selection of a title for the man who is to lead the way is a matter of considerable importance, and, if possible, the position should be a newly created one. For instance, if the chief executive has been known in the past as a supervisor or general superintendent, let the new position be that of Works Manager. Such an arrangement enables the old superintendent to retain his prestige with the men until it may be deemed proper to make a change, and it also starts the new man off with more of a punch.

The question is often asked, "Where can we get the right sort of man?"—and the answer is that he is not half so hard to find as is generally thought. Many a time the man is already in the organization, but he has been so thoroughly "hog-tied" that he has never had a chance to show what was in him.

Assuming that the right man is on hand ready to take hold, if he is a newcomer in the concern he should be given at least two months to get acquainted, first with the owners, carefully analyzing their statements of troubles. After two or three days on this end of the job, let him go out into the shop and get acquainted with the department heads, encouraging them to talk of their troubles, and if possible have them express an opinion as to the causes of failures in the past. Let him drop into the works in the evenings and cultivate even the watchman's acquaintance. He will find that long hours spent alone in the shop are frequently productive of leads of value. Let him walk through the machine and erecting departments on Saturday afternoon, and an occasional Sunday for a time, looking into every corner and cubby-hole. The number of points that can be brought out in a survey of this kind will surprise one who has never tried it. All this is a mere matter of getting acquainted with the job, and it goes without saying that if this point is neglected all future work will rest on an insecure foundation.

The location of the headquarters of the new works manager should be open to all shop employees and the men encouraged to come in. It should, therefore, be in the place most accessible to the works, and it should also be perfectly plain in its appointments. The business to be transacted with the shop can be carried on over common oak desks and bare floors with a far better feeling than it can over mahogany furniture and oriental rugs. The average workman does not care to come with his greasy shoes, soiled clothes and dirty face into an elegantly appointed office to talk about the things the manager ought to know about, and when he does, he is self-conscious and ill at ease, and goes away without half stating his case and irritated because of a feeling that he has been put at a disadvantage.

Now, when the works manager has learned to find his way around without a guide, and the men in the shop have learned to take his presence as a matter of course, let him start the first forward move by analyzing his shop conditions and personnel, and laying down a definite organization. Of course, any organization that he may plan in the start will be changed in minor details many times, but there is no reason why the main structure should not remain practically the same as originally planned.

It is understood, of course, that what one is seeking for in this move is to subdivide the entire plant into a number of different units, placing a definite responsibility upon the head of each unit, and it is understood that the heads of these units will be respected in the positions that they hold, or, in other words, there must be no splitting of authority or going over one's head with orders of any sort. For instance, the giving of orders directly to a workman by a general foreman or anyone else higher in authority is a serious breach of discipline, as it soon weakens the foreman's standing with the men to such an extent that he soon becomes useless as an executive. The same thing holds good, in a much greater degree, in the relationship of the owners to the head of their manufacturing operations. This may seem an insignificant point to bring out in a paper that is only touching the high spots, but I believe that many shops in need of reorganization owe 90 per cent of their troubles to the failure to fix definite responsibility and live up to it.

This subdivision of the shop is readily visualized by means of an organization chart which will give the layout of responsibility as well as the physical layout. In making up this organization chart, I have found that the easiest way is to use round metal-bound cardboard tags distributed on a large drawing board (see Fig. 1).

The first tags made out should contain the names of the main departments. The average typical shop should have the following departments: Works Office, Engineering Department, Pattern Shop, Tool Design and Storage, Tool Making and Repair, Plant Engineering and Power, Machinery, and Erection.

This division of the shop is merely typical, and it must be understood that all sorts of variations are necessary, due to the

varying factor of the personnel from which the organization has to be made. I might say here that I am a very strong believer in using the personal material at hand rather than replacing the old employee by new help.

The next step is to add to each department tag the name of the man who is selected to have charge of that department. With these tags spread out on the drawing board, with two more tags for the Works Manager and an Assistant Works Manager, and a number of smaller tags for the subdivisions of the major departments, the general shop organization begins to take shape.

I want to insert here that the Assistant Works Manager should be capable of assuming the work of the works manager in the latter's absence from the plant, and both the works

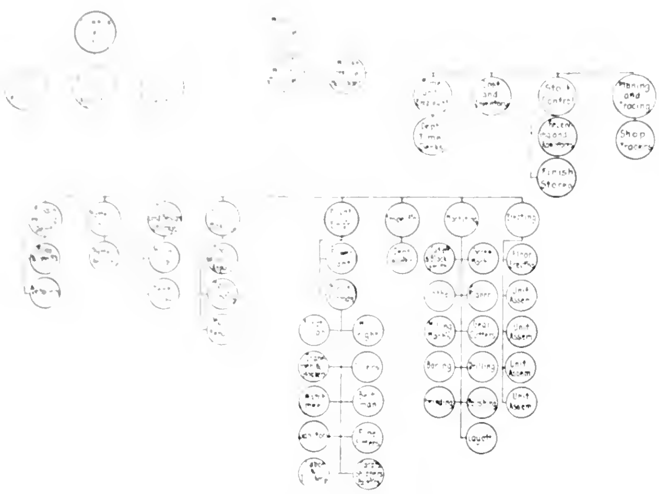


Fig. 1 Typical Organization of Shop with 300 to 500 Employees

manager and the assistant should have as few routine duties as possible. Their time should be spent in planning improvement and in bolstering up the weak points in the organization. A great many men get the idea that organization once done is done forever. On the contrary, the only organization that is final or complete is a dead one. I have cleaned up two plants after several firms of so-called efficiency engineers had had a shot at them. They had gone away after a time, leaving a mass of charts, forms and card indexes which were supposed to have accomplished a complete reorganization. Even if this reorganization was sufficient for the needs of these plants at the time they left, which it was not, it would be foolish to suppose that it would automatically administer affairs for an indefinite period. The business that is managed by live men is always subject to profitable changes.

The balance of this paper is covered by an analysis of the departments enumerated above, beginning with the Works Office, which the author considers the most important division of all, and concluding with the Erection Department.

The author states that the paper just touches the high places, but it outlines the basic structure of an organization for a medium-sized shop building the average line of machinery.

The chairman of the British Engineering Standards Committee, Sir John Wolfe Barry, has accepted the invitation of the Council of the Institution of Civil Engineers of Great Britain to give the James Forrest lecture on Wednesday, May 2.

METAL PLANERS AND METHODS OF PRODUCTION

By CHARLES MEIER,[1] CINCINNATI, OHIO

The problem of providing the increased speeds and power to develop the possibilities of high-speed steel and to meet the increasing necessity for greater production has been a comparatively simple one in such machines as lathes, drilling machines, boring mills, milling machines in which the cutting is continuous and the motion of the tool is in one direction only. In this type of machine it has meant merely adding power and strengthening parts.

The speeding-up process introduces, however, a vastly different problem in such machines as slotters, shapers and planers, in which the cutting is not continuous and which have a return motion of the tool. The principal limitations of machines of this class, especially the planer, are twofold, *first*, the inertia of the moving mass at the moment of reverse; *second*, the speed at which the tool enters the work. The problem of overcoming these limitations has had the attention of quite a number of engineers, and while considerable progress has been made the complete solution does not seem to have yet been reached.

The evolution of the planing machine has followed along the lines of increased table speeds. The earlier demands were all for a higher return speed, in the belief that great savings could be effected by reducing the idle time consumed in the return of the table.

It next followed that further gains could be made by increasing the cutting speed, owing to the fact that this part of the cycle consumes the greater part of the time involved. The advent of high-speed steel can be credited largely with the marked advance in this part of the development.

After fairly high speeds in both directions were obtained there came the demand for variable cutting speeds. It soon became a recognized fact that to operate a planer having only one cutting speed was both wasteful and detrimental to the best methods of increased production.

This constant change of conditions, and the desire to obtain the highest possible speeds in both directions, led to serious difficulties for which a change in design became imperative.

One of the objections to the speeding-up of the planer was the difficulty encountered at the reverse, namely, the inertia of the moving parts. Several tests were conducted which established the fact that the greater part of the trouble was caused by heavy machine pulleys and their high speeds.

Various types of magnetic, pneumatic and mechanically operated clutch drivers were designed in which the pulleys were not reversed. Our experience with these drives was that they developed the objectionable features inherent to friction clutches, namely, the slippage and wear which take place before the parts are properly engaged. The most successful of these types was the pneumatic clutch.

A few planers were built which embodied heavy springs to overcome the shock at reversing. We designed one machine in which these springs were added into the driving gears, and in another machine the table rack was made floating and held in place by two heavy springs at either end. These designs did not prove satisfactory, owing to the variable pressures while under heavy or light cutting. Also the springs had very little effect at the moment of reverse.

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[1] The Cincinnati Planer Co.

For presentation at the Spring Meeting, Cincinnati, Ohio, May 21 to 24, 1917, of The American Society of Mechanical Engineers. The paper is here printed in abstract form and advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

It seemed that none of these arrangements quite met all conditions, and to overcome the difficulties in the standard belt-shifting machines experiments were conducted with lighter driving pulleys. A step which marked quite an advance in this direction was the use of an aluminum alloy for the pulleys instead of cast iron. It was found that not only did this overcome the greater part of the objections to the heavier pulleys, but that higher speeds were possible so that a decided gain was made in the number of cutting strokes owing to the fact that less time was consumed in the reverse. Table 1 gives results of a test made on a 30 x 30 x 14 ft. planer and gives a good idea of the gains effected by the use of aluminum pulleys.

These pulleys were also found to effect quite a saving in power. Table 2 shows a test made on a 76 x 62 x 32 ft. planer, in which the saving in power was about 25 per cent.

The subject of individual electric-motor drive for planers has received considerable attention in the past few years. One type of drive which has been successfully developed is the variable-speed drive. This consists of a 2 to 1 variable-speed motor coupled direct to the top driving shaft of the planer. The speed of this motor is controlled by two separate sets of resistances which are automatically operated by a master switch connected to the shifting mechanism of the planer.

The cutting speed can be varied from 25 to 60 ft. per min., while the return speed may be varied if desired without affecting the cut. The controller handles are set to a predetermined speed before starting. The planer is operated in the usual manner from the tumbler, and the master switch automatically varies the speed of the motor at each reversal. This type of drive has the desirable feature of eliminating the mechanically operated speed variators and is quite simple in operation. It provides a very flexible arrangement when variable speeds are desired. This is especially true on the smaller sizes of planers.

Probably the most interesting motor application to planers in recent years is the reversible-motor drive. While it cannot be claimed that the application of this type of drive is new, it can be stated that the drive approaches more nearly the ideal planer drive than any other method heretofore used. By coupling the motor direct to the first driving shaft, the entire reversing mechanism, pulleys and belts, are eliminated and all the objections before enumerated are successfully overcome.

The motor is an adjustable-speed motor, having a speed range of 1 to 4 so that a large range of cutting speeds from 25 to 50 ft. per min. can be obtained. A double set of resistances is provided making it possible to vary either cutting or return speed independently of the other. This arrangement has also simplified the problem of variable speeds in connection with this drive.

The operating mechanism is handled in exactly the same manner as is the standard belt-shifting type planer, so that no complications are encountered by the operator. Two predominating features in this type of drive are the total absence of belt slippage under heavy cutting and the lower peak loads at the moment of reverse. Table 3 shows the superiority of these two features over the belt drive.

It can be said that the reversible motor drive as applied today furnishes about all that can be desired of an efficient planer drive.

The study of fatigue of the operator and easy control of the machine is receiving quite a lot of attention in almost every machine operation, and there is no doubt but that great possibilities in this direction exist in machine-tool construction.

Power operation of heavy machine parts seems to have found a permanent place in the construction of all classes of

TABLE 1 TEST ON 30 x 30 x 14 FT. CINCINNATI PLANER TO SHOW THE GAIN IN STROKES AND EFFICIENCY OF ALUMINUM DRIVING PULLEYS OVER CAST IRON DRIVING PULLEYS

Cutting Speed 40 Ft.; Return Speed 90 Ft.

Length of Stroke, Ft.	Time Table was Running, Min.	Cutting Strokes with C. I. Pulleys, Weight 56 Lb.	Cutting Strokes with Aluminum Pulleys, Weight 20 Lb.	Number of Strokes Gained	The[illegible] Number of Str[illegible]	Per Cent Efficiency of Aluminum Pulleys
2	30	306	350	44	[illegible]	84.[illegible]
4	30	165	189	24	207	9[illegible].3
10	30	76	82	6	8	98.7

TABLE 2 TEST OF 76 x 62 x 32 FT. CINCINNATI PLANER WITH CAST IRON AND ALUMINUM PULLEYS

Amperes Gear Box and Loose Pulley	Amp. Platen in Direction of Cut		Amp. Platen in Direction of Return		Amp. Reverse from Cut to Return		Amp. Reverse from Return to Cut		Length of Stroke, Ft.	Remarks
	C. I. Pulley	Alum. Pulley	C. I. Pulley	Alum. Pulley	C. I. Pulley	Alum. Pulley	C. I. Pulley	Alum. Pulley		
15	20	20	27½	28¾	132½	106¼	91¼	75	0.66	Lengthening stroke from 0.66 ft. to 20 ft. does not alter result 2 amp. either way.
14	22½	20	30	28¾	132½	105	93¼	76¼	20	
16	21½	21¼	30	30	130	105	95	76¼	20	
15	21⅓	20.4	30	29[illegible]	132½	105	93⅓	76[illegible]		The[illegible] average
4.4	6.3	6	8.8	8.6	39	30.9	27½	22.[illegible]		Av[illegible] Hp.

TABLE 3 TEST MADE BY GENERAL ELECTRIC CO. [illegible] PLANER

	Single Belt Drive	Double Belt Drive	Pneumatic Clutch Running at 200 r.p.m. on Cut and 600 r.p.m. on Return	Pneumatic Clutch Running [illegible] on Cut and [illegible] r.p.m. on Return	Direct connected Electric Motor [illegible] Cutting Speed Range [illegible]
Dr[illegible] Hp.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Stroke, Ft.	[illegible]	8	[illegible]	[illegible]	[illegible]
Approx. Cutting Load Hp.	[illegible]	[illegible]	[illegible]	[illegible]	
Peak Load, Reverse to Return Hp.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Peak Load, Reverse to Cut, Hp.	25	[illegible]	[illegible]	[illegible]	2[illegible]
Time Return Stroke, Sec.	7.2	7.2	[illegible]	[illegible]	[illegible]
Time Cut Stroke, Sec.	20	20	[illegible]	[illegible]	[illegible].4
Time of Cycle, Sec.	27.2	27.2	2[illegible]	[illegible]	[illegible]9
Ft. per Min. Return Stroke	66.6	66.6	6[illegible]	[illegible]	8[illegible].7
Ft. per Min. Cut Stroke	24	24	24.[illegible]	[illegible]	[illegible].8
Ratio Cut to Return, One to..	2.78	2.78	2.57	[illegible]	2.4

[illegible]. There is an increasing demand for elimination of lost time between cuts, and this feature has also found its way into the design of planers.

Rapid power traverse is now being generally used in manipulating planer heads in all directions. This is quite a departure from the standard construction in which the heads are operated entirely by hand. Experience has demonstrated that the new practice eliminates a considerable amount of wasted time throughout the day, and that it is also a decided help to the operator, as it saves him from undue exertion and fatigue.

The building of high-grade planers has established itself as an important factor in the machine-tool-building field. Many users seldom realize that, unlike smaller machine tools, the building of a planer requires a more extensive equipment of machinery, as well as a large number of costly fixtures and measuring instruments. The planer is necessarily a large and expensive machine, and proportionately larger returns are obtainable from it than from small machines owing to the higher expense or burden charged against it. The planer, therefore, should receive special attention from the time-study department.

GAS POWER PAPERS

DURING the past few years there have been marked improvements in gasoline-engine construction which have led to the extensive use of the high-speed type, particularly for aeroplanes. There will be a general discussion of this subject at the Gas Power Session of the Spring Meeting together with that of gas-engine regulation. Other papers treat of motor fire-engine tests and motor trucks.

THE PROBLEM OF AEROPLANE ENGINE DESIGN

By CHARLES E. LUCKE, NEW YORK, N. Y.

Member of the Society

THE problem of the aeroplane engine appeals strongly to every engineer because it is a problem of the lightest power plant. The lightest weight of engine proper per horsepower is to be secured first by obtaining maximum mean effective pressure at maximum speed: in other words, the product of the mean effective pressure and the speed must be a maximum. At the same time the weight of metal per cylinder, or per cubic inch of cylinder displacement per working stroke must be a minimum,—and with both of these factors the engine must be reliable in operation. So far, this reliability factor has been weakest, though lightness has been secured in engines good for short periods of running.

Not only must the metal weight of engine per horsepower be a minimum, but in addition the fuel weight to be carried must also be a minimum because, as can readily be seen, the fuel weight necessary for flights of any length predominates over the engine weight. For example: taking a half pound of fuel and oil per hour per horsepower as a fair value, it is readily seen how quickly that will catch up on engine weight when the latter is 4 or 5 lb. per horsepower.

In undertaking an analysis of the aeroplane-engine problem from the records, the only conclusion that can be drawn is along the line of type. Data are almost entirely lacking. On the question of general engine types, attention might be called to a few points:

The air-cooled motor has entirely failed in comparison with the water-cooled motor,—the reasons are perfectly sound and secure. The 2-cycle engine has given way to the 4-cycle type.

Fixed cylinders have prevailed over rotating cylinders. Odd cylinder arrangements of queer, freaky forms have all been relegated to the scrap heap in favor of a few modern arrangements. The standard cylinder arrangements of today, which are the survivors of what may be called the inventive period, or at least the first inventive period, are the six and eight cylinders in line and the eight, twelve and sixteen V's.

It really appears therefore that the one valuable result of all our experience has been the selection of a few typical arrangements which we are now compelled to study, as minutely as circumstances permit, for the purpose of standardizing and mechanically perfecting these particular types as standard machines which will run as reliably as our stationary engines and which can be manufactured as economically.

Taking up each of the factors of aeroplane-engine design that seem important, in as specific a way as seems proper, the first one I wish to consider is the value of efficiency and the relation of efficiency to minimum weight.

Plotting hours of running as abscissæ against weight of engine, with fuel and oil, as ordinates, for the air-cooled and the water-cooled types of motor, respectively, so that the intercept on the vertical axis represents the weight of engine metal alone, and the ordinates away from the axis represent the weight of metal plus fuel and oil, one finds that the two curves cross at some period of running beyond which, therefore, the water-cooled heavier engine, because of its lower fuel consumption, becomes lighter in comparison.

The metal weight of the water-cooled motor is about one and one-half times that of the air-cooled motor, and the slope of the combined-weight line of the latter compared with that of the former is as two is to one,—that is to say: the consumption of the air-cooled motor is approximately twice that of the water-cooled motor. These facts are responsible for the crossing of the lines.

Of the conditions for efficiency which bear upon this question of fuel weight, and which have led to the selection of the water-cooled motor as a type, the first is the compression. The higher the compression the higher the efficiency, and there is no limit until preignition occurs. Statements will be found in textbooks to the effect that there is a limit, but they are the results of mistakes in interpretation, and are erroneous. The amount of compression possible is limited, however, by the metal temperature and by the temperature of the mixture as admitted. Naturally, the warmer the mixture during suction, the sooner it reaches ignition temperature by compression. Therefore, suction heating is a limit. Again, the interior metal temperature, if it is high (as it is always), may cause trouble by contact with the mixture during compression, and

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some portion of the mixture may be brought to its ignition temperature by hot-wall contact long before the main mass is brought to this ignition temperature by compression alone. It requires only one such hot spot to wreck a well-laid plan.

The next factor in efficiency is the mixture quality, and in this there are the following controlling elements: first, mixture proportions. Any excess fuel means direct waste, but it also means carbonization and fouling. Excess air quickly makes the mixture practically non-burnable. Therefore, mixture proportions must be accurately controlled—more accurately than is possible with any existing carburetor. Carburetors are not yet satisfactory, and as soon as satisfactory carburetors are secured from the standpoint of proportionality of the mixture, we may expect to see a further reduction in fuel consumption and more reliable operation.

Dryness of mixture is a matter of coördinate importance with mixture proportions. When mixtures are wet, that is not completely vaporized, the air and fuel cannot be uniformly distributed to the various cylinders by the manifold system. One cylinder will get a different charge from another, as can be easily proved by pressure gages. There are rarely two cylinders alike as to maximum pressures on a multi-cylinder engine using wet mixtures. Drying of the mixture will cure that fault, and also cure the carbonization that comes from the vaporization of the liquid in the presence of the burning gas when it has been admitted to the cylinder in a liquid state.

The third factor of the mixture question is homogeneity. However accurately the mixture may be adjusted as to fuel and air ratio, however carefully the mixture may be distributed, cylinder to cylinder, the fact remains that, in order to produce economical results, the charge in any one cylinder must be uniform in every cubic inch of it. It is not sufficient that the right amount of air be in the cylinder even if the fuel is vaporized when the latter is all in one corner.

Following mixture quality, the next factor in efficiency is rate of flame propagation with reference to piston speed. It can be shown that the explosion line of the indicator card following compression must be maintained vertical for maximum efficiency. Now, the rate of propagation is the one factor that tends to hold it vertical. If the propagation rate is high enough for a given piston speed, so that the explosion line is vertical, the efficiency will be high. But should the piston speed exceed a certain value, then the explosion line will begin to lean toward the expansion line, until by and by it becomes horizontal and merges into the expansion line, with a consequent large loss of work area and low efficiency or high fuel consumption. Therefore, there is for every given mixture a limiting piston speed that cannot be exceeded without destroying efficiency, and we are now approaching that speed in aeroplane engines.

The next related factors are mean effective pressure, and speed. These are the prime factors for the output of a cylinder.

If the mean effective pressure were constant, then horsepower with reference to speed would follow a straight line. The mean effective pressure is not constant as the speed varies, however. Therefore, plotting horsepower against speed gives a curve having the general form of concave downward and consisting of several separate portions, each worthy of study. There is usually a straight portion over a given speed range, during which the mean effective pressure is constant. For lower speeds the mean effective pressure is lower, and for higher speeds the mean effective pressure is again lower. From the point where, with increasing speed, the straight line becomes a concave-downward curve, the mean effective pressure is decreasing as speed increases, until at the point where the tangent to the curve becomes horizontal, the rate of increase of speed is exactly equal to the rate of decrease of mean effective pressure. At a little higher speed mean effective pressure decreases faster than speed increases, and finally the curve drops down toward zero power.

So much for the facts. An analytical engineer cannot be content with those facts, however, but finds it necessary if he is to apply a cure to go behind the facts to ascertain the reasons. The first step in doing that is to determine the volumetric efficiency of the engine by measuring the air and fuel, and comparing the total volume of mixture taken in, with the piston displacement. If the volumetric efficiency be plotted against the speed, much light is thrown on the situation. In the first place the volumetric efficiency falls off in the region of very low speed, where the mean effective pressure is low; it is constant over the region of constant mean effective pressure, where the horsepower speed line is straight, and then at some high speed it again decreases. It is clear, therefore, that curvature of the horsepower-speed line is due to a corresponding variation of volumetric efficiency. It may be found, however, that at some high speed the horsepower-speed line falls before the volumetric efficiency. This calls attention to the fact that the falling-off of mean effective pressure at high speeds may not be due primarily to volumetric efficiency but to other causes, and recognition of this starts a search for those causes.

The first of these causes is too slow a combustion, or too high a piston speed. That is to be corrected by adding an additional ignition source, or by moving the spark plug from a side wall to a center point. Igniting at more than one point or at a more central point will cure this defect, and again cause the dropping points of both horsepower-speed and volumetric efficiency-speed curves to lie on the same speed line.

Again, it will be found that a change in the valve setting changes this mean-effective-pressure curve at both ends, but every change in the valve setting also changes the mean effective pressure, and the volumetric efficiency is itself the direct measure of whether or not one has the best valve setting.

Now, it is curious that most people have played with cams and adjusted them back and forward by guesses, and have never bothered about the air meter, which is the only positive means of arriving at best cam forms and valve timing for sustained mean effective pressure at high speeds.

Many more analyses along the above lines could be given, but enough has been said to call attention to this most important means of studying the problem of maximum power at high speed, not only revealing what is the matter but pointing out clearly the direction in which to correct the fault.

So much for efficiency and mean effective pressure, or efficiency and horsepower per cubic foot of cylinder. Those two factors bear directly on the fuel weight to be carried and the output per cubic foot of cylinder. What will be the weight of that cubic foot of cylinder? This has to be judged both by qualitative and quantitative analysis. It is impossible to give any quantitative analysis without long mathematical treatment, so I will undertake only the qualitative analysis.

The first point in qualitatively analyzing unit metal weight of the multi-cylinder engine is to recognize that the engine can be divided laterally by planes into sections of one cylinder each. The end sections are the same as each other, but are different from the intermediate sections. Therefore, to study qualitatively the relative weights of two typical constructions,

the mind must be concentrated upon these sections, each one of which includes a cylinder, a piece of frame, a piece of shaft and the other parts that go with the section.

From this point of view, consider multiplication of cylinders in line vs. radially or circumferentially. It will appear that the weight of the cylinder, piston and connecting rod, is just the same no matter how the cylinders are arranged, but the frame weight and shaft weight are reduced by any multiplication. It is clear also that, other things being equal, the lighter arrangement is circumferential rather than longitudinal multiplication.

Now, going back to the history of the situation, we find every conceivable combination has been tried, but these have finally crystallized to not more than two kinds, giving the V type engine and the engine with cylinders in line.

Considering the effect of cylinder diameter upon unit metal weight, it will appear that from the unit weight standpoint the cylinder diameter should be as large as possible, because the wall thickness of a cylinder is always greater than necessary for the stress for other structural reasons. A 1/16-in. cylinder of steel will not be stressed over, say, 10,000 lb. per sq. in. The cylinder could be made much thinner than this and still have a good working stress if there were not other structural objections to it. This being the case, the larger the cylinder for a cubic foot of displacement the less the unit metal weight in the wall, and the only limit to large diameter is good running.

Considering the stroke, as this is increased the metal in the cylinder piles up endwise, or axially, too fast with reference to volume, and therefore for minimum unit metal weight, the shorter the stroke the better. In proportion, we are using, normally, shorter strokes in aeronautical motors than in automobile engines for that reason.

Again, as affecting the metal weight, we have the connecting rod length. Clearly, the shorter the connecting rod the shorter the frame, and therefore the more metal saved. The only objection to the shorter connecting rod is an excessive angularity, which introduces stresses requiring metal thickening in other places.

The number of cylinders should be as large as possible up to the point where the weight of the connecting parts has to be increased. A 2-cyl. engine has less than twice the weight per cubic foot of displacement than a single cylinder, for the reason that the number of end supports for the shaft, etc., is not increased. Similarly a 3-cyl. has less than three times, a 4-cyl. less than four times, and so on; and the weight per cubic foot of displacement gets less and less until a certain number of cylinders—somewhere about six—is reached where the shaft diameter and the weight of the frame must be increased so as to retain the necessary stiffness, whereupon the saving in weight by multiplication is neutralized. This appears to be about the limit of saving by line multiplication.

The metal weight per cubic foot of cylinder displacement has to be taken up along the lines indicated, extending the study to the form vs. weight of each individual member. It will appear, as one examines the forms of these individual members, that one form is clearly susceptible of less weight than another—even with the same working stresses or with equal factors of safety.

The first of these studies should be undertaken with reference to cylinders. The first cylinders built were made of cast iron, with head, cylinder and jacket cast in one piece, and the valves being arranged in a side pocket—the ordinary T- or L-head construction. It is clear that the weight of the valve pocket is detrimental. The first step in any cylinder-weight reduction, then, is to take that pocket away, retaining the cast cylinder (on the assumption that we do not know how to make any other kind) and putting the valve in the head. This results in the valve-in-head construction, which is now practically universal, but which, strange to say, it took six or seven years to realize.

A similar instance of slow realization of facts exists with reference to the cast-iron jacket wall, which has no other function than to hold water. Cast iron for that purpose, especially in an aeroplane engine, is wasteful of material, so the next step is to get rid of the cast iron. When one stops to think how it is to be done, a structural difficulty becomes apparent, and therefore one must not too readily condemn the holding on to the cast-iron jacket. The difficulty is of course the necessity of providing openings for the intake or outlet from each valve, an igniter plug hole and at least two pipe connections for the jacket, and in an aeronautical engine under heavy stress there is some driving gear which requires fastenings. This naturally tends toward the use of a casting.

Suppose such a casting is used, with inlet and one exhaust valve each with a port leading out, and such valve seating in the head which turns down to form the cylinder; then the casting may be led around the top, forming the enclosure of the head jacket and joining the several outlets and coming down outside the cylinder. The cylinder-head jacket casting ends in the form of a skirt at about the level of the valve deck, and to this end a tube jacket can be added by any one of several possible fastenings. That is the next step: cast iron for the cylinders, head and head jacket in a one-piece casting, but with sheet metal for the jacket over the cylindrical barrel. It is a logical step, but it took several years to reach it just the same.

Proceeding along the same line of weight reduction, the next step is to cut away this cast iron joining the ends of the ports and forming the wall of the head jacket, and substitute sheet metal welded to the ports by the oxygen welding system. Wherever there are connections to be made for attachment of gears, there must be some additional supports welded or brazed on. The cast-iron cylinder is still there, and with cast-iron ports.

There is a fundamental objection to a cast-iron cylinder for aeronautical work, and it is a perfectly valid one. Cast-iron cylinders do not have to be very thick to be amply strong, so far as the gas-pressure stresses are concerned, but the fact remains that so long as they are cast iron, no one knows whether they are good cast iron inside or not, and the use of cast iron cut down to $\frac{1}{8}$ in. in thickness incurs taking some chances. Hence attention is turned toward steel.

Drawn steel or forged steel is a reliable material and a logical selection, so designers have sought means of using it; but when one stops to think how to use a drawn-steel tube for a cylinder, and get the necessary attachments on it, one soon recognizes that the matter is not so easy as it looks. That is the reason the adoption of the steel cylinder was so long delayed.

There are now several schemes developed for steel cylinders. The first of these is a steel cylinder of a drawn tube formed without a head, screwed into a separate head carrying the ports and the head jacket cast in one piece. This is rather a satisfactory way of attaching a head, but it involves more than one difficulty. When such a screwed head is set up against the shoulder, it is not at all clear just where it is going to stop; and to secure the proper position one must either scrape the faces or shim them—neither of which is a nice job. A further objection is the considerable weight of the cast iron in a rather

complicated casting, and also the inner wall of that cast iron is a stress wall, the stress of which must pass through the thread to the cylinder. There is no objection to using a casting if it is not stressed, but a casting under stress is not satisfactory and is to be retained only in the absence of something better.

Complete elimination of castings has been tried by using all steel and sheet metal welded together, but this did not prove satisfactory for a very interesting reason. A flat sheet-metal head on which the valves are seated will not remain flat, and a round valve seat will not stay round. Such sheet metal tends to warp out of shape, and with it the valves will not stay tight. However, the material does not break, which is something worthy of thought.

To eliminate the weld between the steel cylinder and head, another construction was developed. In this, a seamless drawn-steel shell with head just like a cartridge is used, and two holes are arranged in the head to seat the valves. It is evident that this is a structure which is sound against all kinds of stresses. It still has some of the difficulties of warping the seats, causing leakage of the valves; and when a valve leaks the amount of heat developed is tremendous. Once a valve starts to leak, it is only a question of a short time before it will be completely destroyed.

The particular construction of cylinder just described is rather difficult to attach to its jacket ports. It is interesting to note one case at least in which a satisfactory attachment has been worked out, and that is the Hispano-Swissa engine, now used on the European war front, and now also being built in this country. In this particular engine the entire outside of the cylinder is threaded, and the cylinders are screwed into an aluminum casting which is double-walled just like the cast-iron block casting of an automobile engine. The thread performs the double purpose of holding the cylinder in place and bringing its head up against the aluminum cast head which carries the ports, and also acting as a thermal bridge between the metal of the cylinder and the metal of the aluminum casting which carries the jacket water. Without the latter there would be poor thermal contact and overheating of the cylinder. While this construction is not entirely satisfactory, it is nevertheless very interesting and suggestive. It immediately calls attention to the fact that a water jacket may be made of an aluminum casting and the ports formed just as easily as in iron, the steel interior carrying the stress due to the interior gas pressures.

It is, however, quite feasible to get rid of the double aluminum wall down along the cylinder barrel into which this steel cylinder is placed and which carries the ports above, by leaving out its interior wall and retaining the outside, or even by stopping the wall just below the head as a skirt to take a short thin tube which may itself be of aluminum, ending at the bottom in a cast stuffing-box ring to act as a joint against the steel cylinder. That, so far as I know, represents the last word in this direction, the steel cylinder head being bolted up to the aluminum head-port casting at the valve seat bases, and not just pressed up against it by a remote thread.

Finally, there is to be noted the one-piece steel-forging construction for cylinder, cylinder head, ports and ignition holes, surrounded by a sheet-metal welded jacket, a very satisfactory though expensive construction.

These heads are themselves a subject of considerable study. We have first a plain head in which the valve inside diameter is half the cylinder less the width of seat, and half the bridge between the valves. Both valves have stems pointing upward and parallel. The plain cylinder, then, which can be made of a plain seamless-drawn steel cartridge, and which is so desirable structurally, limits valve diameter, and this is a factor against it. Valve diameter is a strong influence in volumetric efficiency and weight of charge, controlling, as it does, flow-resistance conditions. Naturally, designers must get the volumetric efficiency as high as possible by keeping flow resistance as low as possible. Therefore, the tendency is to go towards larger valves than is possible with the previous arrangement.

One variation in form for this purpose is the flat bulged head where the valve diameter is larger than before by the amount of the bulge. The flat bulged head is a very desirable thing for larger volumetric efficiency and higher mean effective pressure, but offers some difficulty in manufacture when one is making a one-piece seamless drawn-steel job, but not a serious difficulty.

Another suggestion for getting the same result is to bulge this head upward in the form of two flats and put the valves on the two inclines. It is perfectly clear that a very large increase in diameter can be secured in this way. The valve stems in this case are not parallel but diverge at any angle and the limit is reached when the angle is 180 deg., in which case they are horizontal.

The question of block arrangement of cylinders and their jackets vs. separate units, deserves some attention. In some cases each cylinder with its jacket and head is entirely separate. In other cases the jackets are cast or welded in a block form, around more than one cylinder—sometimes two and sometimes four, and in some cases six. It is clear that the more cylinders included in the jacket block, the less will be the weight of the jacket, because the length of the tangent to two jacket circles is less than a half circumference. But there are objections to the block, and in some cases it may not pay to use it.

In a case in point, a cast-aluminum block jacket was set down over four steel cylinders which were bolted to the frame by their usual flanges and studs. These cylinders gave trouble on the outer flanges, the end studs breaking off or pulling out. The trouble was caused by the crankcase running hot, expanding; and the aluminum-block cylinder casting running cool, because it was water-jacketed, not expanding. The cylinders being bent inward tore the stud ends right out.

Another point: the steel cylinder is naturally flexible, and it belongs—in fact the entire motor belongs—to that class of structures which should properly be termed flexible, exactly similar to bridge structures.

These flexible motors weave just as the engine of a steamship weaves. To attempt to hold one against springing is to attempt what is practically impossible. The cylinders of aeroplane engines should all be perfectly free to go as they will, and not be held on the top in any way. All the block arrangements of cylinders of the sort just described, are therefore objectionable.

Steel cylinders have a natural spring and give to them, and if let alone they will serve well, but attempting to secure them may result in serious distortions, or in highly localized excess stresses.

Proceeding in the same qualitatively analytical style, the complete paper takes up successively the problems of the piston, valves, valve gears, frame, etc., indicating how a gradual realization of conditions has led to modifications of design, and pointing out factors not even yet considered and making suggestions for meeting them. For instance, in connection with the valves the author makes a thermal study of the problem which, he says, has not been undertaken by anyone in the shops. He does the same for the piston, and the

crankcase be analyzed from its consideration as a stress member.

The paper sums up with the pointed statement that the aeronautical engine is emerging from the stage of invention to the stage of design, as a light, high-tensioned steel structure, consisting of seamless tubing and forged or welded steel parts, possibly formed in drop-forge dies. Add to that steel stress structure certain members, such as the piston, exhaust valve and guide, designed primarily for heat flow conditions and not for stresses. Add to that again certain closing members, such as the ports for the intake and exhaust, which can be very properly cast in aluminum, and the oil crankcase closure, which can be made of any desired materials.

TEST OF A MOTOR FIRE ENGINE

By HORACE JUDD, COLUMBUS, OHIO

Member of the Society

DURING the past ten years the city of Columbus, Ohio, has remodeled many of its horse-propelled steam fire engines and equipped them with motor-driven trucks so that now more than 70 per cent are motor-driven. The city also has two complete combination gasoline motor-driven and pumping units. One of these combination units, put into service in April, 1916, was loaned to the Ohio State University through the courtesy of the Columbus Fire Department for a more extended test than could be undertaken during the acceptance trials by the Inspection Bureau.

In view of the importance and value of the motor-driven engine in getting under way and reaching the fire, as well as the ability to change the motor instantly from propulsion to pumping, the writer offers the results of a performance test on this motor fire engine to those interested in fire prevention.

The motor fire engine unit was manufactured by the Seagrave Company, Columbus, Ohio, and consists of a motor-driven, direct-connected, centrifugal pumping unit combined with a hose truck. (Fig. 1.)

The motor is a 4-cycle, water-cooled, six-cylinder motor, 79.3 hp., A.L.A.M. rating, and of rugged construction to meet the requirements of fire service. The cylinders are vertical, T-head, cast separately, with integral water jackets. Cylinder bore is 5.75 in., stroke 6.5 in. The crankcase is parted horizontally through the plane of the crankshaft, the upper section supporting the cylinders and crankshaft bearings and the lower section easily removable and forming a reservoir for oil. There are two cam shafts, one on each side of the motor, with the cam gears located in the forward end, encased but easily accessible. The intake and exhaust valves are 2.625 in. in diameter with 13/32 in. lift.

Forced feed lubrication is used. The cooling water is supplied by a separate centrifugal pump operated from the cam shaft. The carburetor is of the float-feed type with automatic auxiliary air intake and is controlled by the throttle lever. The ignition is of double type, (*a*) Bosch high tension, waterproof magneto for one set of spark plugs, (*b*) current from a storage battery through a timer to the second set of spark plugs.

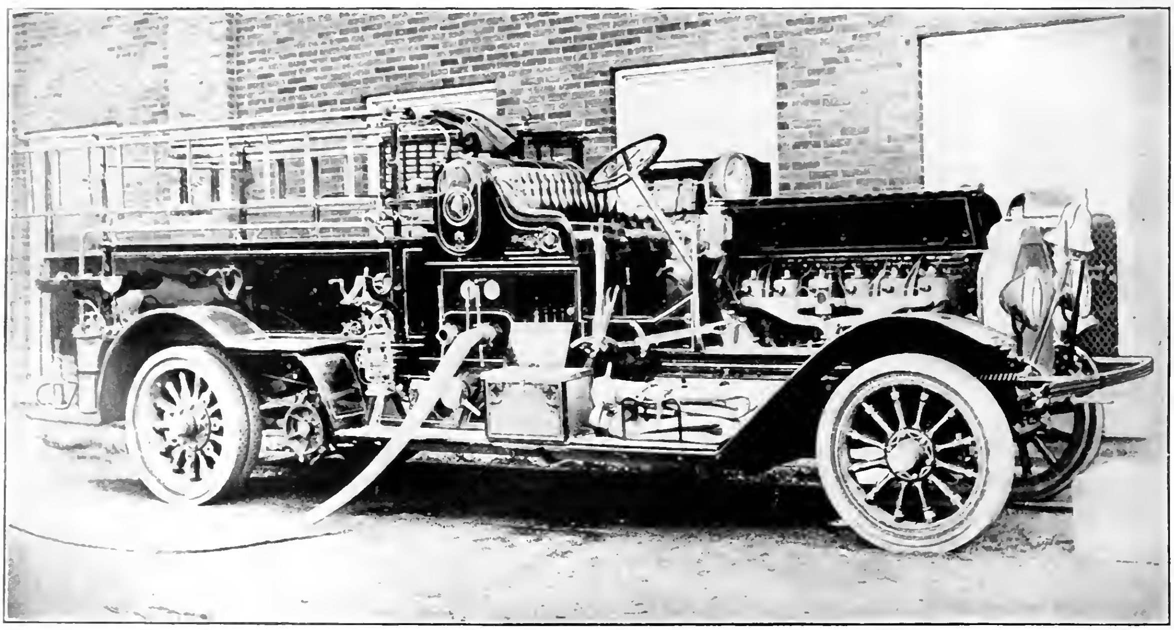

Fig. 1 The Motor Fire Engine

The centrifugal pump (Fig. 2) is a 4-stage (two stages for each impeller) turbine pump mounted under the driver's seat about midway between the front and rear axles. The casing is of bronze and includes in one piece the guide, or diffuser, vanes, and the water passages connecting the successive stages. The two bronze impellers are mounted on a hollow steel shaft which fits over the drive shaft to the differential and is driven by hardened steel gears which can be thrown out of mesh when the engine is on the road.

Each impeller has 12 vanes 1 in. wide and 9/16 in. net depth of water passage between the vanes. There are six diffuser vanes surrounding each impeller. (Fig. 3.) The water enter-

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[1] This paper is based on the results embodied in the thesis work of Messrs. E. W. Leatherman, H. V. Walborn, and E. R. Wilson, graduates in Mechanical Engineering, Class of 1916.

ing at the center of the pump passes into the first stage on the inner half of one propeller, is thrown out by centrifugal force through the diffuser vanes and, passing around the impeller through the water passage, enters the second stage on the other side of the same impeller. From the second stage it enters the third stage on the inner side of the second impeller and is discharged into the other side of the impeller

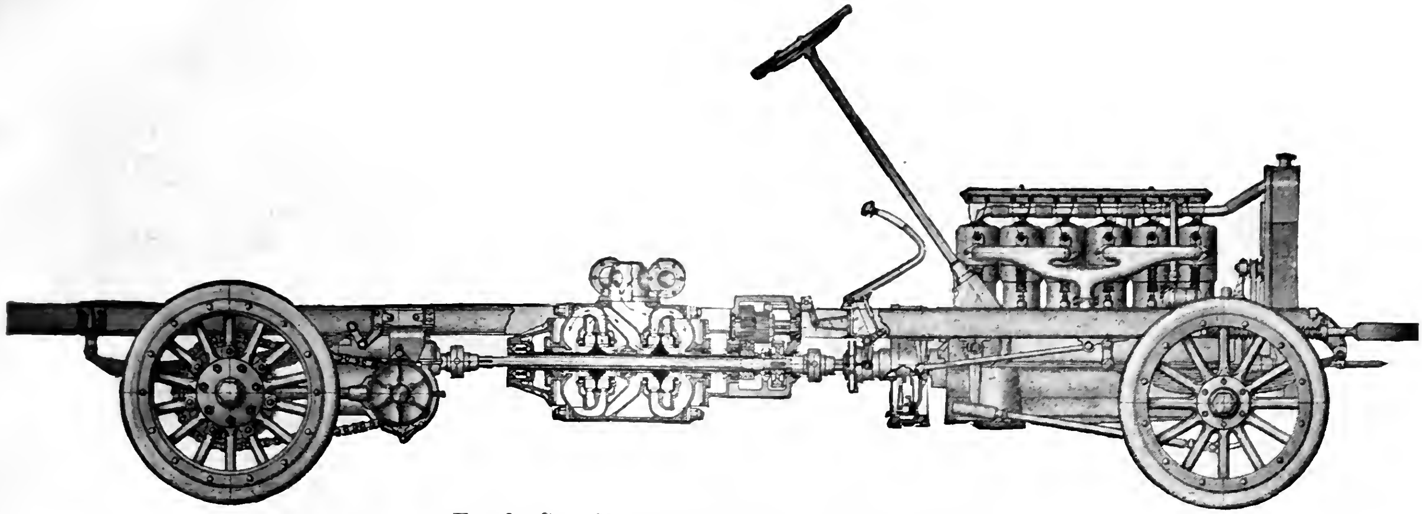

Fig. 2 Side View of Centrifugal Pump Chassis

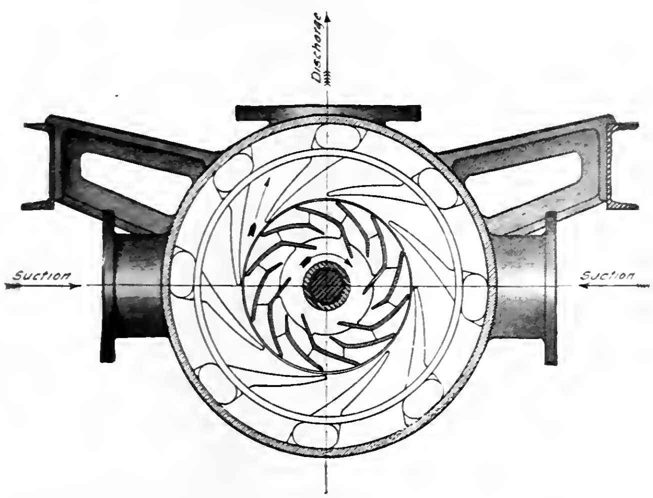

Fig. 3 Sectional View of One Stage of Pump Showing Impeller and Diffusion Vanes

(fourth stage) and from thence it passes into the discharge line. Since the water enters both impellers on the inner side the end thrust is practically eliminated, although end-thrust shaft bearings are also provided. Two suction connections and three discharge connections are provided.

When necessary the pump may be primed by means of a rotary vacuum pump, which will exhaust the air and enable the pump to be put into operation in about 20 sec.

The speed ratio of the pump and engine is 2.06 to 1. The speed range of the motor during the tests was about 800 to 1100 r.p.m., corresponding to a speed range of the pump of about 1650 to 2270 r.p.m. The rated capacity of the pump is 750 gal. per min. at 120 lb. net pressure at the pump discharge.

The purpose of the tests may be outlined as being to determine:

a The capacities of the fire engine when working against the usual range of pressures and with such sizes of fire nozzles as are commonly used.

b The fuel consumption of the engine.

Such a series of tests required the accurate measurement of the fuel used, the water pumped, and the pressures maintained at engine and nozzle.

The tests were carried on in the hydraulic laboratory of the University, where the water was taken from one of the large cisterns, or bays, 25,000 gal. capacity, as shown in Fig. 4, through three lengths of 5-inch standard rubber suction hose, and was discharged through the desired length of hose line, first into a series of tumbling bays and finally into the suction bay after passing through an 8-in. by 20-in. standardized rectangular weir. The discharge of the nozzles was also read at the jet by means of the pitot gage, or piezo-

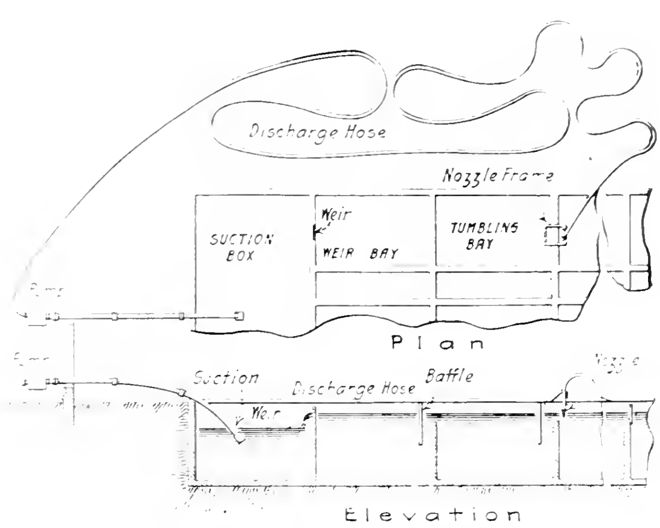

Fig. 4 Arrangement of Apparatus

meter, now widely used in fire-service work to give instantaneous readings of the nozzle discharge. The gasoline used was weighed on carefully calibrated platform scales. The pressures at the engine were taken by the regular service gages and their readings corrected for error. The pressure drop in the hose line was taken by means of a specially con-

[illegible] connection for the pressure gage which was located at the hose coupling as shown at A in Fig. 5.

The discharge hose was taken from the city service and had seen considerable use but was in fair condition; it was rubber lined cotton hose with nominal diameter of 2.5 in. and average actual diameter of 2 11/16 in. The smooth conical nozzles, shown in Fig. 6, were taken from the regular equipment of the

FIG. 5 FIRE STREAM FROM TWO-HOSE SIAMESE UNION

and continued for 30 min. for the runs with double line using Siamese hose connection, and for 20 min. for the runs using single-hose lines. At the completion of the runs the engine was stopped at the instant and the gasoline tank refilled, and the amount put in was taken as the equivalent of the amount used.

The Siamese hose union was a 4-hose connection, but in this

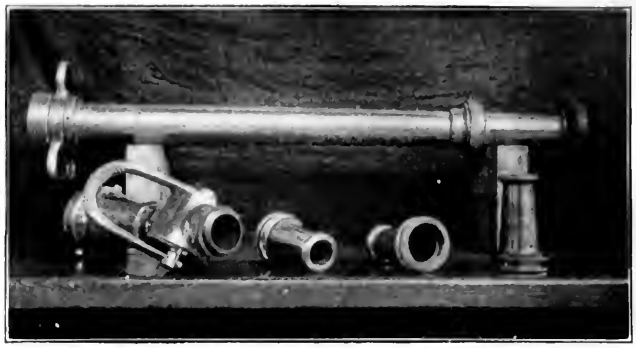

FIG. 6 PLAY PIPES AND SMOOTH NOZZLES

case was connected to the pump with but two 250-ft. lengths of 2.5-in. hose. To the Siamese union was attached the 12-ft. length of 3.5-in. hose with the play pipe and the 1.5-in., 1.75-in., and 2-in. smooth nozzles. Single-hose lines, both 250- and 500-ft. lengths, were used with 1.125-in., 1.25-in., and

TABLE 1 AVERAGE DATA AND RESULTS FOR MOTOR FIRE ENGINE, COLUMBUS FIRE DEPARTMENT, COLUMBUS, OHIO

DIAMETER CYLINDER, 5.75 IN.; NO. CYLINDERS, 6; DIAMETER OF HOSE, 2.69 IN.; STROKE, 6.5 IN.; NO. OF CYCLES, 4; A.L.A.N. RATING, 79.3; GASOLINE, 59.8 DEG., BAUME, 19,000 B.T.U. PER LB.

Item	Siamese connections			Two 1.25 in. on single lines. $d=1.246$ in. Area=0.00847 sq. ft.			One 1.125 in. on 500-ft. line. $d=1.121$ in. Area=0.00685 sq. ft.			One 1.25 in. on 500-ft. line. $d=1.246$ in. Area=0.00847 sq. ft.			One 1.375 in. on 500-ft. line. $d=1.37$ in. Area=0.01024 sq. ft.		
1 Number of run	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2 Revolutions per minute; engine	981	954	966	812	884	969	772	1,000	1,132	770	995	1,116	768	997	1,096
3 Revolutions per minute; pump	2,020	1,965	1,990	1,674	1,820	1,995	1,590	2,060	2,335	1,586	2,047	2,300	1,582	2,055	2,258
4 Suction by gage, ft.	14 84	15.88	18 7	15.88	17.23	19.05	7 93	9.75	11.32	7 48	10 43	12 48	7.93	10.78	11.68
5 Suction by gage, lb.	6 43	6 88	8.09	6.88	7.46	8.25	3 43	4.22	4.90	3.24	4 52	5 40	3.44	4.67	5.06
6 Suction (measured) ft.	5.25 (equals 2.27 lb.)														
7 Discharge pressure, lb.	157 3	133 5	121.9	95.0	113.0	134 0	117.0	197 4	249.6	116.7	193 5	242 0	115 7	196 0	236.2
8 Discharge head, ft.	363 5	308 0	281 7	219.2	261.0	309 3	270 0	455.0	575.0	269 0	447 0	558.5	266 5	452 0	544.5
9 Total head, ft.	378.3	323 9	300 4	235.1	278.2	328 4	277 9	464 8	586 3	276 5	457 4	571.0	274.4	462.8	556.2
10 Total head, lb.	163.8	140 2	130 1	101.8	120.4	142 2	120 3	201 2	253.8	119 7	198 0	247.2	118 7	200 3	240.8
11 Static pressure at nozzle, lb.[1]	95 5	62 3	45 5	44.0	51.9	61 5	51 5	85 0	106.8	40 0	58 2	69.3	35 0	47.5	56.5
12 Static head at nozzle, ft.	220.8	144 0	105.2	101.7	120.0	142.1	118 8	196.0	246.0	92 3	134 0	159 6	80 7	109.5	130.2
13 Length of hose lines (2.5 in.).	Two 250 ft.			Two 250 ft.			One 500 ft.			One 500 ft.			One 500 ft.		
14 Drop in pressure in one 2.5-in. line, lb.	61.8	71 2	76.4	51.0	61.1	72 5	65 5	112 4	142 8	76 7	135 3	172 7	80 7	148.5	179.7
15 Drop in pressure per 100 ft. one 2.5-in. line, lb.	24.7	28.3	30.3	20 2	24.3	28 4	13 0	22 3	28 4	15 2	26 9	34 3	16.2	29.5	35.5
16 Gallons per minute	637	693	745	620	636	720	246	322	360	264	335	383	275	363	399
17 Cubic feet per minute	85.2	92 6	99 6	82 8	85 1	96 2	32.9	43 1	48 2	35 3	44 8	51 2	36 8	48.5	52.9
18 Pitot gage reading, lb.	94.9	61.25	43.3	45 6	56.5	64 5	48 5	81.5	105.0	35 0	57 5	71 5	29 0	46 8	57.3
19 Gal. per min. from pitot reading.	656 0	718.0	788 0	624 0	699.0	747 0	262 0	340 0	384.0	275 0	353 0	393 0	303 0	384 0	425 0
20 Water horsepower of pump	60.7	56 8	56 7	36 8	44 8	59 6	17 4	37.8	53 2	18 5	38 8	55 3	18 6	42 4	55 7
21 Theoretical velocity at nozzle, ft.	...	....		83.4	90 7	98 6	89 3	114.5	128 4	79.5	95.8	104 6	75.0	87.95	95 9
22 Actual velocity at nozzle, ft.	....	.....	.	81.5	83.7	94.7	80 1	104 9	117.0	69 4	88	100 8	60 2	78 9	86 1
23 Coeff. discharge of nozzle (including play pipe)	.....	.....	.	97 5	92.4	96 0	96 0	91 4	91 2	87 2	91 9	96 6	82 0	89 7	89 6
24 Coeff. discharge of nozzle (by pitot gage)	97	96.6	94 5	99 0	91 0	96 3	94.0	94 6	93 6	92 7	94 9	97 6	90 8	94 5	94 0
25 Gasoline per hour, lb.	86.9	80.0	75 7	52 4	57.5	73 4	30 8	46 6	81 0	35 5	58 2	80 1	31 6	52 0	95 8
26 Gasoline per hour, gal.	14 0	13 0	12 3	8 51	9.34	11.92	5 00	7 57	13 16	5 76	9 45	13 01	5 14	8.45	15 56
27 Gasoline per hour per water hp., gal.	0 231	0 229	0 217	0 231	0 208	0 20	0 287	0 20	0 247	0 306	0 243	0 236	0 276	0 199	0.277
28 B.t.u. per hour per water hp.	27,620	26,780	25,390	27,020	24,350	23,400	33,580	23,400	28,900	35,800	28,430	27,609	32,260	23,280	32,400
29 Duty per 1,000,000 B.t.u., million ft.-lb	73.25	73.95	78 0	73.28	81 3	84 6	58 98	84 6	68 50	55 30	69 65	71.75	61.37	85 06	61 13

[1] For Siamese connection, this gage is located at end of 2.5-in. hose, 12 ft. from nozzle

engines. The sizes chosen were those most commonly used in the city fire service.

During the test the pump was quickly brought up to running conditions, and with a full gasoline tank the runs were started

1.375-in. nozzles. The range of discharge pressure carried at the pump was from 95 to 250 lb.

Readings were taken for the whole run of the gasoline used, every five minutes of discharge pressure at the pump, the

revolutions of the motor, the pressure drop in the line, and every minute and a half of the weir readings.

DATA AND RESULTS

The average values for *the observed data and the calculated results* from these data will be found in Table 1.

Fig. 7 represents the *important results for the motor fire engine*, as a unit. Here are shown the total gallons of gasoline used per hour for water horsepowers at the pump, ranging from 20 to 60; the gallons of gasoline used per hour per unit horsepower; the number of heat units supplied, and the duty of the pump.

The number of heat units is taken as equal to 117,000 B.t.u. per gallon (59.8 deg. Baumé, 0.738 specific gravity, 19,000 B.t.u. per lb.).

Duty is defined as the number of foot-pounds of work done per 1,000,000 B.t.u. supplied.

$$\text{Duty} = \frac{60 \times 33{,}000 \times 1{,}000{,}000}{\text{Gal. gasoline per hp. per hr.} \times 117{,}000} = \frac{16{,}920{,}000}{\text{Gal. gasoline per hp. per hr.}}$$

The maximum capacity obtained during the test was 745 gal. per min., at 122 lb. pump discharge pressure with a 2-in. nozzle attached to a Siamese union with two hose lines each 250 ft. long, as shown in Table 2. This discharge is slightly below the rating of 750 gal. at 120 lb. net pump discharge pressure, and is accounted for by the fact that a 2-hose line instead of a 3-hose line was run from the engine.

TABLE 2 MAXIMUM CAPACITIES FOR VARIOUS SMOOTH NOZZLES UNDER CONDITIONS OF TEST FOR MOTOR FIRE-ENGINES

Diameter nozzle, in.	Discharge press. at pump, lb.	Maximum capacity by weir, gal. per min.	Pitot gage readings, lb.	Capacity by pitot gage, gal. per min.	Deviation of pitot gage from weir, per cent	No. and length of hose line, ft.
1.121	249.6	360	105.0	384	6.4	One 50
1.246	242.0	383	71.0	393	2.4	One 50
1.370	236.2	399	57.3	425	6.0	One 50
1.500	157.3	637	94.9	656	3.0	Two 2[illegible] with [illegible]
1.750	133.5	693	61.3	718	3.4	Two 2[illegible] with [illegible]
2.000	121.9	745	43.3	788	5.5	Two 2[illegible] with [illegible]
Two of 1.246	134.0	720	64.5	747	3.7	Two 2[illegible]
Average		...	....	...	4.3	

The capacity as indicated by the pitot gage is seen by Table [illegible] average 4.3 per cent higher than that by the calibrated weir.

The gasoline used by the motor fire engine may be read from the total gasoline curve, Fig. 7. The range of water-horsepower output was from 18 to 60 hp., with most of the tests grouped about 18, 40, and 55 horsepowers.

The average results as read from the curve are as given in Table 3.

TABLE 3 AVERAGE RESULTS FROM FIG. 7

Water-hp. output	Gasoline per hr., gal.	Gasoline per hr. per water hp., gal.	Heat units supplied per hr. per water hp., B.t.u.
20	5.45	0.272	32,000
40	8.72	0.218	25,500
60	14.35	0.240	28,000

The curves (Fig. 7) show that the [illegible] working point for the engine is about [illegible] at which point the least gasoline per [illegible] and hence a horsepower is obtained with [illegible] of heat units.

Assuming 50 per cent for the overall [illegible], which would seem to be a reasonable figure for [illegible] pump and hose line, it is seen that the most [illegible] conditions are obtained when the probable engine output is [illegible], which is its rated power.

For 40-hp. output, 0.218 gal. of gasoline per hr. per [illegible] used, which is equal to 1.74 pints of gasoline per [illegible]. An average value of 1 pint per hour per brake horsepower was obtained in 1912 on a 4-cylinder Seagrave motor similar in type. The value of 1.74 pints for the complete fire-engine unit seems a consistent figure when the frictional resistances of the pump and hose line are taken into account.

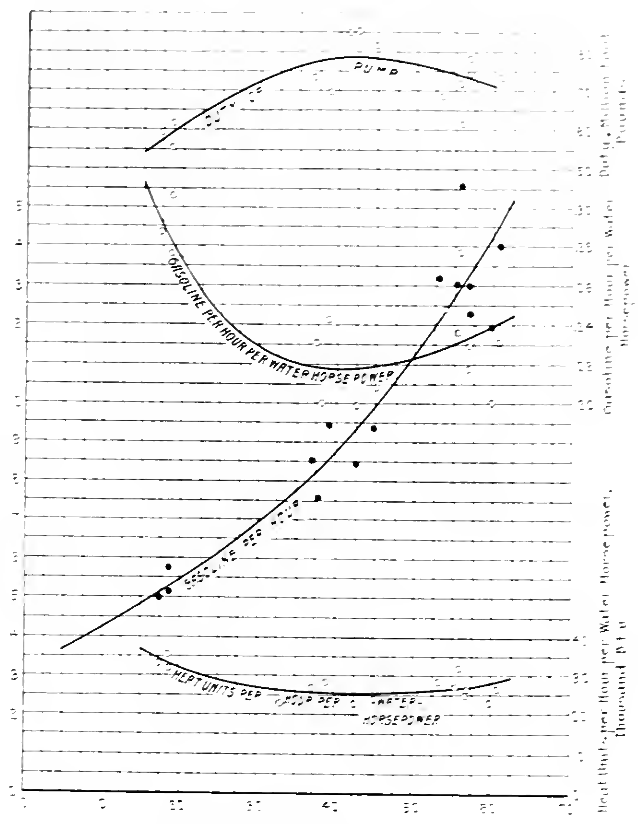

Fig. 7 Performance Curves for Motor Fire Engine

The advantage of the gasoline-driven engine is most noticeable when the comparison is made with the horse-drawn steamer, for the motor fire engine is able to reach the fire in half the time, is readily converted from the locomobile to the pumping engine, and is more easily and economically operated, with the expense of maintaining the proper number of horses entirely eliminated.

The paper closes with a comparison of the gasoline-driven engine and the horse-drawn steam fire-engine unit, leading to the conclusion that the motor fire engine is fully the equal of the steam fire engine in fire-stream capacity, and, except as to a slightly higher fuel cost at prevailing prices, is without doubt its superior in steadiness of pump action, as a time saver, in flexibility, in ease of operation, and in reduced cost of maintenance, especially when compared with the horse-drawn steamer.

THE DESIGN OF MOTOR TRUCK ENGINES FOR LONG LIFE

By JOHN YOUNGER, BUFFALO, N. Y.

Member of the Society

THE [illegible] of a motor truck engine is naturally one where the "[illegible]" compromise. An intense [illegible] to the exclusion of everything else, would result in [illegible] which would be too heavy, too bulky, and [illegible] to run.

An [illegible] definition of *long life* would, therefore, be "[illegible] which is something more than the average expected life, based on present day knowledge and all-around conditions."

At the present day a life of 50,000 miles, without overhaul, would be considered long. This would correspond to a continuous run day and night for 12 months, at a speed of about 100 r.p.m., with no attention beyond oiling and fueling. The load will fluctuate between less than zero (as when in coasting downhill with clutch in, the chassis drives the engine) to the full power of which the engine is capable. The majority of the hauling will be done at an average of 1/3 full engine power. An engine should be capable of at least five or six overhauls, or 300,000 miles, before renewal of the major parts.

This does not look at all severe to the casual glance of the power house engineer, but when one considers that this power plant is operating under widely varying temperatures, power and speed conditions, and that its various axes are constantly changing relatively to the bed to which it is fastened, it will be seen that the problem of long life is not so simple as it looks.

Long life depends on three factors: (1) *Design*, (2) *Manufacturing excellence*, (3) *Operating conditions*.

DESIGN

This may be considered under headings such as: *a* bearing surfaces, *b* lubrication facilities, *c* materials used, *d* factors of safety, *e* general design and use of governor.

Explosion Pressure. All calculations should be based on full load, not on average load. This can be taken as an explosion pressure of 300 lb. per sq. in. on the piston with a 22 per cent compression volume.

Connecting Rod Bearings. The pressure per projected square inch should be about 700 lb. per sq. in., excluding area of oil leads and fillets at ends, or 1 sq. in. per 2.33 sq. in. of piston area.

Oil is conveniently introduced through a hole in the crankshaft, and the bearing may either be grooved with a slightly spiralling oil groove around the whole circumference, or a groove around the bottom half only, or a series of slots or labyrinth checks on the sides, or even no grooves at all. Any of these methods prevent ridge wearing on the crankshaft.

The bearing itself should be a thin shell of hard babbitt metal about 1/32 in. thick, backed up by a thick shell of hard bronze running on a case-hardened or otherwise hard surface. This gives the advantages of the babbitt as a bearing metal, and prevents it from pounding out. The bronze should be carefully turned and have peg holes in it to give perfect union between the two. The running clearance should be small, between 0.0015 in. and 0.0025 in., satisfying practically all truck engines. The split surfaces should be carefully fitted together to prevent rocking or cater-cornered work.

Gudgeon or Wrist-Pin Bushings. Owing to the slight oscillatory motion, pressures may be higher. Under the conditions of space and the necessity for keeping down the weight of reciprocating parts they may be as high as 1800 to 2000 lb. per sq. in. (or 1 sq. in. per 6 sq. in. of piston area).

Lubricating oil should be brought by a small tube (where pressure lubrication is used) direct to the bearing and allowed to ooze out. The majority of bushings are at present lubricated on what might be called the "chance" method,—the chances being, however, chiefly against The metal should be a very hard chill cast phosphor bronze, running on a case-hardened steel surface.

Running clearances should be kept exceedingly low, 0.00025 in. being satisfactory. Very little tolerance should be allowed.

Pistons. The side bearing pressure is low, inasmuch as the facilities for lubrication are poor. Sixteen pounds per projected square inch is satisfactory. The piston should be as light as possible consistent with strength, so as to minimize the loads due to the reciprocating masses.

Three rings above the gudgeon pin are ample. They should be thick radially, and preferably of the concentric type, to even the pressure on the slots and prevent them wearing away. The S.A.E. standard for piston ring grooves is $G = \frac{1}{8}(0.01\,D^2) + 0.005$ where G is depth of groove, and D is nominal diameter of piston. A pressure of about 10 to 12 lb. per projected sq. in. is ample to keep the rings against the cylinder walls.

The piston should be made of a softish gray cast iron, running against a harder cylinder metal. The clearance should be great at the top to allow for expansion due to heat, being four times the piston diameter in thousandths above the top ring, and equal to it in thousandths on the skirt. This bearing surface is, as a rule, relieved around the gudgeon pin.

Cylinders. Cylinders should be of a hard, close-grained, high tensile strength cast iron. Its scleroscope hardness (though this is of doubtful value) will be found to be about 35. It should be made thick enough in the walls so that actually about 0.060 may be ground off the diameter to take care of wear, without causing weakness. For a 5-in. bore cylinder, 5/16-in. walls are sufficient.

Crankshaft. Three bearings—front, center and rear—are considered ample for a 4-cyl. truck engine. Consider the area of the connecting-rod bearing (big end) as 1, then the front and center bearings may have an area equal to 1 and the rear bearing 1.5. If splash or trough system of lubrication is used, the areas of the front and center bearings should be increased to about 1.2.

An approximate rule for the diameter of crankshafts in the usual sizes of motor-truck engines, is that the square of the cylinder bore shall be twice the cube of the crankpin. This gives a 2-in. shaft for a 4-in. bore engine, and about a 2 5/16-in. shaft for a 5-in. bore engine.

Running clearances lie between 0.0015 and 0.003 in., depending somewhat on the nature of the lubrication.

The bushings should be similarly constructed to those on the connecting-rod big ends, except that the spiral oil groove will probably be found preferable to give a continuous supply of oil to the connecting-rod bearings.

The material should preferably be about 0.40 to 0.50 per cent carbon steel, carefully heat-treated to give a tough, hard

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surface (scleroscope 36 to 40). The larger-diameter shafts should have a percentage of chromium and nickel to ensure better heat treatment and resistance to fatigue.

Low-carbon, case-hardening material is sometimes used, but the shaft has to be increased in diameter to compensate for the lessened resistance to fatigue.

Good-sized fillets, no machine-tool scratches and general smoothness of outline will materially help long life.

Camshafts. Camshafts should be made of a low-carbon steel, case-hardened on the wearing surfaces. The bushings should be of a good grade of phosphor bronze. Three bearings are ample for a 4-cyl. car. The diameter of the shafts should be from 1 in. to $1\frac{1}{8}$ in., for the sake of smooth operation. The projected area of the bearings, front to rear, should be approximately 4 sq. in., 3 sq. in. and 2 sq. in., depending somewhat upon whether oil pumps or governors are driven from the camshaft.

Valves. The cams operating the valves should be so designed that just before the valve seats itself the velocity will be considerably diminished, allowing the last few thousandths of its travel to take place in a comparatively long time. This prevents the valve hammering on its seat. It does not interfere with the fuel economy or power, but gives quieter action.

A 45-deg. valve seat is advisable, as carbon will not be driven into the seat, but will more easily clear itself.

Valves containing a percentage of tungsten from 2 per cent upwards are most satisfactory as regards life and freedom from warpage. By scleroscoping them while hot, they will be found to hold a hardness of over 40. Cast iron remains about 30, while other steel and nickel alloys drop to 25 or lower. The tungsten valve has thus a reason for its long life.

Sundry Parts. The rest of the engine should be designed in proportion, such as wide faces on the timing gears and ample bearings for their spindles. The water pump should have ample bearing area, and if of the centrifugal type proper provision should be made for the thrust of the blades.

Studs may be used for fastening down the cylinders, but they should have a length equal to twice their diameter screwed into the aluminum alloy, if such be used. A coarse thread is necessary, but for all purposes where aluminum is concerned, best results are obtained by the use of through bolts.

LUBRICATION

Considerable change has taken place in this in the last few years, although even yet all questions have not been settled, and cylinder lubrication is still somewhat on the hit-and-miss principle.

The method most in favor at present is to carry a supply of oil, about one gallon, in the crankcase of the engine, and pump it under a pressure of anything between 2 lb. and 20 lb. per sq. in. to a header pipe, from which issue leads to the crankshaft main bearings, and often the camshaft and timing-gear bearings. The surplus oil is by-passed by a regulating valve back to the crankcase. This oil and that which has done its work in the cylinders and crankshaft and various bearings drains down to the bottom of the case through a strainer and thence into the pump to renew the circuit.

When the oil gets dirty enough—or say every 300 miles or so, it ought to be thrown out and replaced with clean oil.

The system described works surprisingly well when it is considered that a certain amount of gasoline filters past the pistons and dilutes the oil—that some of the aqueous products of combustion also get past and help form an emulsion.

However, it can only be a matter of time before the adoption of some much better sys[illegible] each bearing in predetermined [illegible] the market and most of them are [illegible]

Incidentally, as a point of design [illegible] for the driver to make sure that [illegible] and of ample quantity.

MATERIALS AND FACTORS OF SAFETY

Naturally extreme consideration has not [illegible] weight, as has been in the case of aeroplane engines [illegible] 2[illegible] lb. per hp. has been reached. A fair weight for a motor truck engine is nearer 20 lb. per hp. at a piston speed of 1000 ft. per min. Aluminum is used for the crankcase and its covers. Cast iron is used for the cylinders and pistons. 0.40 to 0.50 carbon steel is used for the crankshaft and connecting rods. Case-hardening steel is used for the camshafts, valve tappets and gudgeon pins.

In order to ensure the proper factor of safety being maintained, it is advisable to scleroscope each part for correctness of heat treatment or hardness. Forgings like connecting rods, camshafts, crankshafts, should be straightened before machining.

The general design should be such that extreme climatic conditions can be guarded against. Roads, for example, in winter time are exceptionally bad, causing a weaving of the bed of the engine as would correspond to one of the wheels being lifted 12 in. off the road. The engine should be mounted so that no stress due to this will come on the moving parts.

The engine power should be ample for its work. Too much gear work is detrimental to long life. The transmission reduction should be such that the great majority of road work should be done on high gear. For instance, the hilly city of Cincinnati requires a lower transmission ratio than would the comparatively level cities of Buffalo or Cleveland. This prevents the engine from working at maximum capacity for too much of the time.

Speed should be carefully limited. A maximum piston speed of 1000 ft. per min. is desirable, and drivers and purchasers should be educated to the economy of a governor which will enforce this. The governor should be so designed that it will not restrict the power, but should go in or out of action with a maximum 5 per cent variation in speed round the predetermined point.

MANUFACTURING EXCELLENCE

Too much stress cannot be laid on this. Poor workmanship cannot be tolerated in an internal-combustion engine. Cylinders should be ground to a maximum tolerance of 0.002 in., as should pistons, and in addition, a process of selection must be used which will ensure pistons on the high limit being put into cylinders of the low limit. The running clearances should not vary by more than 0.002 in.

Pistons, complete, should be weighed, the maximum variation in any one of a set being not more than ½ oz. Similarly, connecting rods should be weighed and balanced, the variation in one of a set being not more than ½ oz., with the ends varying also by as little.

Connecting-rod and crankshaft bearings should be selected so that a maximum variation from standard running clearance of 0.001 in. plus or minus should be adhered to.

There is some diversity of opinion as to the best way to finish these bearings, but the writer believes that a reamed

surface is superior to the hand and hand-scraped one. Reamers mounted on a rigid bar will line up crankshaft bearings in a way impossible by the hand reamer. Further, the surface left is as nearly round as possible, corresponding to that of the ground crankshaft. The personal element in hand scraping is entirely eliminated.

Crankshafts should be ground smooth with a maximum variation of 0.0005 in. in diameter and 0.001 in. eccentric. Each shaft should be scleroscoped at every bearing. Similarly with the camshaft, pump and magneto drive bushings and so forth, a uniformly high standard should be insisted on.

It follows naturally that rotating parts should be put in static and dynamic balance.

When the engine has been assembled, it should be placed on a stand and run in. Here again opinions differ, but the writer believes a run of at least 30 hours, at a piston speed of about 800 ft. per min., varying the load from zero at the start to practically maximum for one or two hours at the finish, is necessary.

Most of this test, if indeed not all, should be done with some kind of fuel, either gas or gasoline, to get the engine thoroughly warmed up. This will ease off the high spots, let the valves find their seats, and generally take the harshness out of the engine.

At the end of this run, the engine should be partially disassembled and valves reground, piston rings touched up, carbon cleaned and the engine carefully inspected for signs of wear or scoring flaws.

When reassembled, the engine is ready for work.

OPERATING CONDITIONS

One of the secrets of success in gasoline engines is oil and lots of it. After a comparatively short run, the oil (in the average system) is contaminated by gasoline and carbon. It should be drained out every 150 to 300 miles and replaced entirely by fresh oil.

The strainers leading to the pump should be kept clean and inspected frequently.

About once a month the whole engine should be cleansed by washing it out with kerosene, turning the crankshaft by hand and thoroughly draining the kerosene all out.

Screens should be provided on the air intake to the carburetor to prevent entrance of road dust as much as possible.

Gasoline should be cut down in the carburetor as much as possible, not only for the sake of economy in consumption, but also for the prevention of harmful effects by an overplus.

The point of ignition should be properly controlled, so that evils following an "advanced spark" will not result.

Drivers should change to a lower gear immediately there are signs of the engine laboring.

Drivers should be carefully selected and trained men. Good horse drivers make good truck drivers, as they are accustomed to giving care and attention to their "motive power."

A regular system of inspection should be carried out by a good mechanic to detect any signs of trouble developing.

It is understood that hilly country or heavy roads will materially add to the work the engine has to do, and that the life will be proportionately shortened and inspection and overhauling will have to be done more frequently.

The amount of crude petroleum delivered to refineries and consumers in February 1917 from the Oklahoma-Kansas field was 4,546,461 barrels, from the Appalachian field 2,105,744 barrels, and from the Lima-Indiana field, 1,421,520 barrels.

THE RELATION OF PORT AREA TO THE POWER OF GAS ENGINES AND ITS INFLUENCE ON REGULATION

By J. R. DU PRIEST, MOSCOW, IDAHO

Member of the Society

The early forms of gas engines were of comparatively small power, and as engines of this size do not usually require close speed regulation, the "hit-and-miss" system of governing was applied quite successfully. As the machine was improved in design it became more reliable in service and was gradually applied to other classes of service in competition with steam engines and under conditions requiring better speed regulation.

This resulted in multi-cylinder engines to give more uniform turning moment, and "cut-off" and "throttling" governors to give power on every cycle. These improvements have enabled the modern gas engine to give excellent and reliable service, and to have a field almost as broad as the steam engine. However, designers are still striving to improve the machine in every way possible, adapting it to cheaper grades of fuel, improving its speed regulation, simplifying its mechanism, and making it more reliable and economical, so that its field of service may be still further increased.

The object of this paper is to present a method of determining the port area required for any fractional load on a throttling gas engine operating on the four-stroke cycle, and to suggest a means of admitting the fuel so as to get the same degree of speed regulation throughout the full range of load.

DISCUSSION OF PROBLEM

The function of a constant-speed governor on an engine is to control the speed within certain limits (depending on the class of service for which the machine is designed), while the load varies anywhere within the capacity of the engine.

In all types of governors dependence is placed on the change in speed of the governor to effect regulation, and when this governor is driven from the main engine, the speed of the engine must change before the governor can act on the valve gear and exert any influence over the energy supply.

If the load on the engine increases, the order of changes in the governing system is as follows:

a Speed of the engine decreases

b Speed of the governor is reduced

c The change in the position of the governor, due to the change in speed, shifts the valve gear and supplies more energy to the engine to enable it to carry the increased load, and at the proper speed

d The speed of the engine increases, due to the increased supply of energy, hence the speed of the governor increases, and the cycle above described is repeated in the reverse order. This action tends to produce a "hunting" effect on the valve gear and governor until the energy supply is properly proportioned to the existing load.

Apparently, the most desirable results would be obtained if the governor were so connected to the valve gear that equal movements of the governor collar would correspond to equal changes in load.

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The energy supplied to the gas engine is in the form of a combustible mixture of air and gas, the quality of which may vary considerably, also the head causing flow through the ports varies with every change in load, if it is a throttling engine.

In the four-stroke-cycle gas engine, the fuel mixture is made to flow into the cylinder by lowering the pressure in the cylinder below that of the atmosphere during the suction stroke, thus creating a difference of pressure sufficient to force in the charge.

The absolute pressure in the cylinder depends on the quantity of mixture entering the cylinder during the suction stroke. The amount of charge necessary in the cylinder depends on the load the engine is carrying, and therefore it is evident that a different amount is required for every change in load. Hence the absolute pressure in the cylinder during the suction stroke will be different for every different load, and the resulting pressure head causing the mixture to flow into the cylinder will be different.

This point can be most easily understood by neglecting temperature changes occurring during the suction stroke and assuming that the volumetric efficiency is merely a function of the difference between suction and atmospheric pressures. Since a light load calls for a small charge, it must correspond to a low volumetric efficiency. The low volumetric efficiency is always accompanied by a low suction pressure, due to the throttling at the valve, and therefore we have the peculiar condition that the greatest difference in pressure is available to cause flow when the least amount of mixture is required.

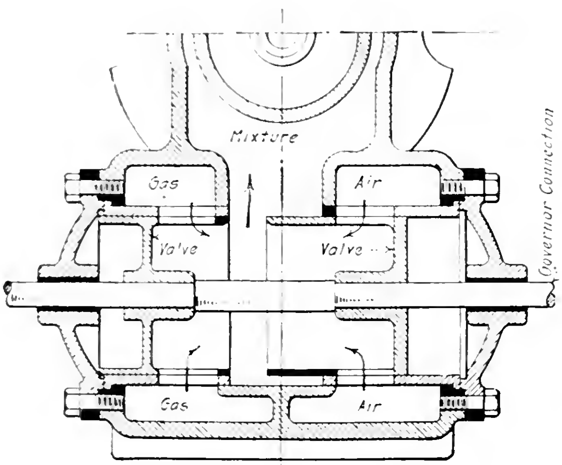


Fig. 1 Section Through Throttle Valve of a Horizontal Double-Acting Gas Engine

The result of this change in absolute pressure in the cylinder is such that when an engine is operating at, say, three-quarter load, with an apparent volumetric efficiency of about 67 per cent, and a change in load occurs which demands a volumetric efficiency of 77 per cent, it will require a much larger port area to give this increase of 10 per cent in volumetric efficiency at the heavy load than it would if the increase were from 30 per cent to 40 per cent. The reason being that, in the first case, the head causing flow through the ports will be about 3.5 lb. per sq. in., while in the second case it will be about 7.5 lb. per sq. in.

On account of the greater head causing the charge to flow into the cylinder at light loads, it requires a very small change in port area for a considerable change in load. Therefore, any system of connecting up the governor to the throttle valve which gives equal changes in port area for equal changes in the governor speed, will make the regulation of the engine very sensitive at light loads and too slow at heavy loads.

Data and Results from Test

The test described below was made to find out as near as possible (1) the conditions under which the fuel mixture enters a gas-engine cylinder, and (2) the relation of port area to horsepower and its influence on the regulation of the engine.

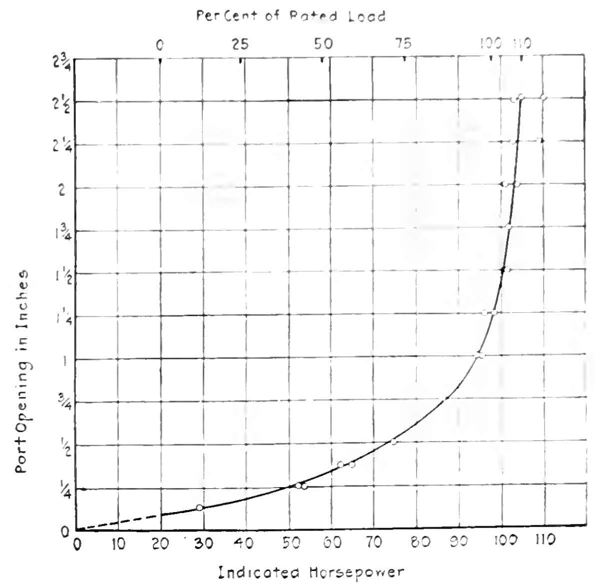


Fig. 2 Relation Between Indicated Horsepower and Port Opening

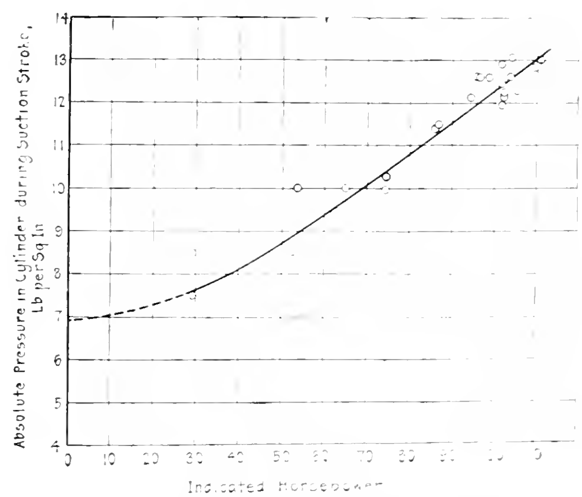


Fig. 3 Relation Between Indicated Horsepower and Pressure in Cylinder During Suction Stroke

Method of Making the Test. The engine tested was a [illegible] × 24-in. horizontal double-acting tandem engine operating on natural gas. The test was made in the following manner: The throttle valve on the head end of No. 1 cylinder was disconnected from the governor and operated by hand, while the other three valves, under the control of the governor, took care of the load on the engine. The throttle valve shown in Fig. 1 is cylindrical, with six rectangular ports cut around the periphery which mate with similar ports cut in a surrounding sleeve when the valve rotates. The throttle valve is made to

opened and closed in unison with the poppet inlet valve and is moved longitudinally by the governor to effect regulation. The travel of the valve was 2.5 in., and fifteen different settings were made, varying from closed to wide open. Two sets of indicator cards were taken for each setting, one for indicated horsepower and the other for suction, two or more cards for each set being taken for every position of the valve. From data obtained from these cards, curves were plotted, respectively, as follow:

Indicated horsepower
- against port opening
- against absolute pressure in cylinder during suction stroke
- against apparent volumetric efficiency

Port opening
- against apparent volumetric efficiency
- against absolute pressure in cylinder during suction stroke

Apparent volumetric efficiency
- against absolute pressure in cylinder during suction stroke.

If the machine friction is assumed constant for all loads, which is very nearly true, the delivered horsepower (d.hp.)

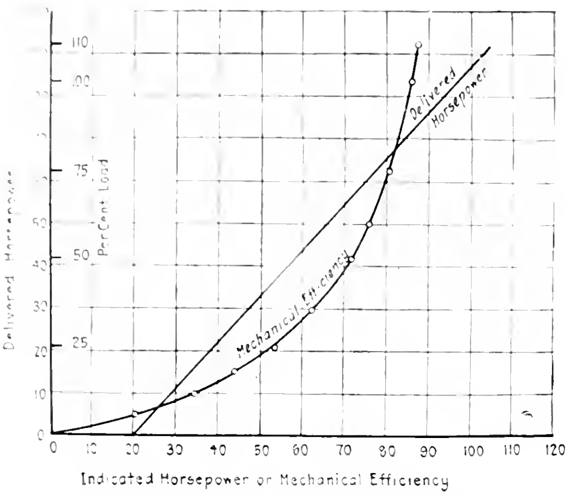


FIG. 4 RELATION BETWEEN DELIVERED HORSEPOWER AND MECHANICAL EFFICIENCY

for any load can be determined from the indicated horsepower by subtracting the loss due to the suction stroke, as measured by the suction card, and the loss due to the machine friction.

The d.hp. for several valves of i.hp. was found in the above manner, and from the results the mechanical efficiency was calculated. The values for i.hp., d.hp. and mechanical efficiency are given in the curves in Fig. 4.

Fig. 5 shows the relation between port area and d.hp. The data for this curve were obtained as follows: Delivered horsepower corresponding to any given i.hp. was taken from Fig. 4. The port openings as plotted in Fig. 2 are linear dimensions, the ports being rectangular in shape, $2\frac{1}{2}$ in. long by $1\frac{1}{2}$ in. wide.

The mixing valve was rigidly connected to the inlet valve and opened and closed in unison with it. The cam arrangement was designed to give a valve-opening curve approximating the sine curve, with the maximum port width (H) $1\frac{1}{2}$ in.

Hence the port area under these conditions is L x H x 0.637. The port opening or length L of port for full load is 1.15 in., as shown in Fig. 2. Therefore, the port area is 1.15 x 1.5 x 0.637 = 1.1 sq. in. for each port and for six ports it is 6.6 sq. in. Port areas for one-quarter, one-half, three-quarter and full load were found in this way and plotted against delivered horsepower, giving Fig. 5.

From Fig. 5 it can be seen that when the engine is operating near the rated-load point, it takes a large change in port area to effect a small change in the work developed by the machine, while at light loads a very small change in port area makes considerable change in the work done by the engine. The reason for this condition can be found by studying Fig. 3, from which it is seen that when the engine is operating at, say, full load, the absolute pressure in the cylinder during the suction stroke is high, being 12.1 lb. per sq. in. absolute or 2.1 lb. per sq. in. below the pressure of the atmosphere, while at one-quarter load the absolute pressure in the cylinder is 8 lb. per sq. in. or 6.2 lb. per sq. in. below the pressure of the atmosphere. The amount the cylinder pressure is below atmosphere pressure is the head available to force the charge into the cylinder, hence the peculiar conditions noted above exist, that when the engine is operating at full load and requiring a large amount of charge, the pressure head to produce flow into the cylinder is small, and when the engine is operating at light load and requires a small amount of charge, a much larger pressure head is available to produce flow through the ports.

From the above discussion and Fig. 5, it is evident that port area does not increase directly as the delivered horsepower increases, therefore, to get the same degree of regulation throughout the full range of load, some compensating device should be introduced between the governor and the throttle valve to take care of this condition. From Fig. 5 and the characteristic curve of the governor to be used, a mechanism can be designed which will give equal changes in load for equal movements of governor collar. This would seem to be a more desirable condition for good operation.

THEORETICAL DEVELOPMENT—OUTLINE OF METHOD

It has been found from tests that the total heat consumption of an engine follows a straight line very closely when plotted against delivered horsepower, and by assuming a reasonable value for the B.t.u. per d.hp-hr. for two points, say full load and half load, the total-heat curve can be drawn. From this curve with the heating value of the gas and the ratio of air to gas known, the cubic feet of mixture required for any fractional load can be determined. This amount of mixture, which must enter the cylinder, occupies a certain volume under atmospheric conditions. At the end of the suction stroke it occupies the greater part of the piston displacement but is under some lower pressure p_2, which can be determined by the relation $p_1v_1^n = p_2v_2^n$, providing the proper value of n be known.

From analyzing a great many low-spring indicator cards taken from throttling engines, it has been found that the absolute pressure in the cylinder during the suction stroke remains nearly constant throughout the greater part of the stroke, except for light loads. For the purpose of this discussion, it can be assumed to remain constant without serious error and will be the pressure p_2 of the charge when occupying the new volume as found from the equation above. The difference between the absolute pressure in the cylinder during the suction stroke and the pressure outside the cylinder is the head causing the charge to flow through the ports.

Knowing the amount of mixture required and the head producing flow, the area of the port necessary to pass the given amount of charge can be determined. In the above manner,

the amount of mixture required for any given load and the port area necessary to pass this charge can be determined, thus giving a relation between power and port area.

[The author here proceeds to apply the method outlined to the engine tested, which ran at 180 r.p.m. on natural gas of

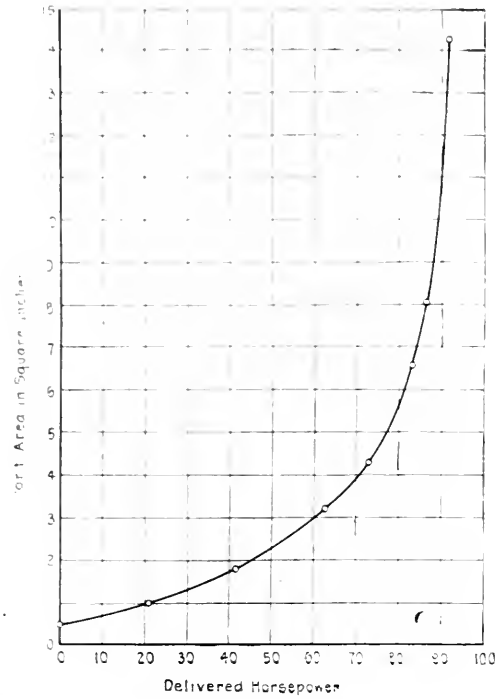


FIG. 5 RELATION BETWEEN DELIVERED HORSEPOWER AND PORT AREA

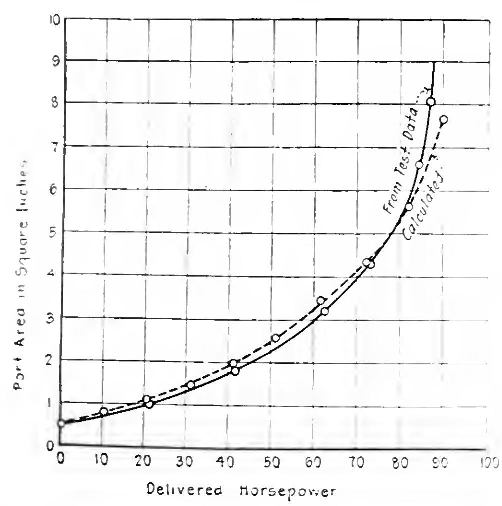


FIG. 6 RELATION BETWEEN DELIVERED HORSEPOWER AND PORT AREA FROM TEST AND CALCULATIONS

about 950 B.t.u. per cu. ft. He employs a value of 0.85 for n in the equation $p_1v_1^n = p_2v_2^n$, and shows in an appendix why this value is chosen.

He also derives an empirical equation for the port area necessary to pass a given amount of charge, which gives results agreeing closely with those obtained from test data. See Fig. 6.]

CONCLUSIONS

The work described has been done to find out as nearly as possible the conditions under which the charge enters the cylinder of a throttling gas engine, and to design a method of supplying the required amount of charge for any load that will tend to make the engine regulate with the same degree of sensitiveness throughout the full range of load. In Fig. 6 there are two curves showing the relation between delivered horsepower (d.hp.) and port area; one is based on test data and the other is plotted from calculated data for the same engine. From these curves and the characteristic curve of the governor to be used, the relation between the travel of the governor collar and port area can be determined and a governing mechanism designed which will give equal changes in load for equal movements of the governor collar. Another way of obtaining the same result would be to shape the ports in such a manner that equal changes in governor-collar travel would give equal movements to the valve, but at the same time give the proper port area for equal changes in power delivered. It is possible that for other fuels and types of engines the constants used in working out the above problem may differ slightly, but it is believed that the method can be applied to any case with satisfactory results.

Metals for Coinage. War conditions, which have been responsible for the replacement of gold coinage by paper money, have also had their effect on the metals used for coins of the smaller denominations. Aluminum money has been used by the Chambers of Commerce of several French towns, and Austria, following the example of Germany, has adopted iron money. The problem of protecting the iron disks from rust has been solved by superimposing a slight layer of zinc. The disks, with some zinc powder, are placed in a vessel and heated for a certain time at a temperature somewhat below the melting point of zinc. A surface is thus formed which not only preserves the pieces from rust, but also enables the die to be impressed without cracking the surface of the metal. The zinc-plated iron money hardly differs in aspect or weight from that formed of nickel.—*Ironmonger*, March 24, 1917.

X-Rays and Metals. Some authorities hold the view that X-rays are destined to play an important part in research of steel and other metals, especially in investigations on the crystalline structure. The perfect crystal has a definite internal geometrical form and a definite atomic symmetry, but the latter is beyond the range of the microscope. The more powerful X-rays may, however, enable the metallurgist to determine the atomic structure of his metals. Students of the new method predict that it will throw light on some phases in metallurgy of which nothing is known at present. The commercial value of the researches remains, of course, to be proved; but the progress of the work is being followed with deep interest in various countries. Professor Bragg, a pioneer in this work, in a recent address on the subject at Sheffield, England, remarked that chemistry told the metallurgist what were the constituents of his metals, but thought X-rays were going to help him to find and study the atoms of the substances, and the actual arrangement of these and the distances at which they lay apart were of considerable importance, but had hitherto been beyond human vision. The X-rays had made it possible to see the architecture of a number of substances. Iron and steel presented difficulties, but there was a good prospect of getting useful information about them before long. The work was going ahead in the United States, and he had received from American physicists particulars of interesting results obtained in respect to iron and steel crystals. —*Ironmonger*, March 24, 1917.

MISCELLANEOUS PAPERS

One session of the Spring Meeting will be devoted to the discussion of miscellaneous papers upon the subjects of tests of uniflow steam traction engines, relation of efficiency to capacity in the boiler room, radiation error in measuring temperature of gases, development of scientific methods of management in a manufacturing plant, and disk wheel stress determination. All of these papers are printed below.

TESTS OF UNIFLOW STEAM TRACTION ENGINES

By F. W. MARQUIS, COLUMBUS, O.

Member of the Society

At first thought it seems strange to find refinements such as the uniflow cylinder and the superheater in connection with traction engines; but when it is remembered that traction engines are used extensively in certain districts (notably the northwestern part of the United States) where fuel is very expensive and water has to be hauled many miles, the reason for taking advantage of every means for reducing coal and water consumption becomes apparent.

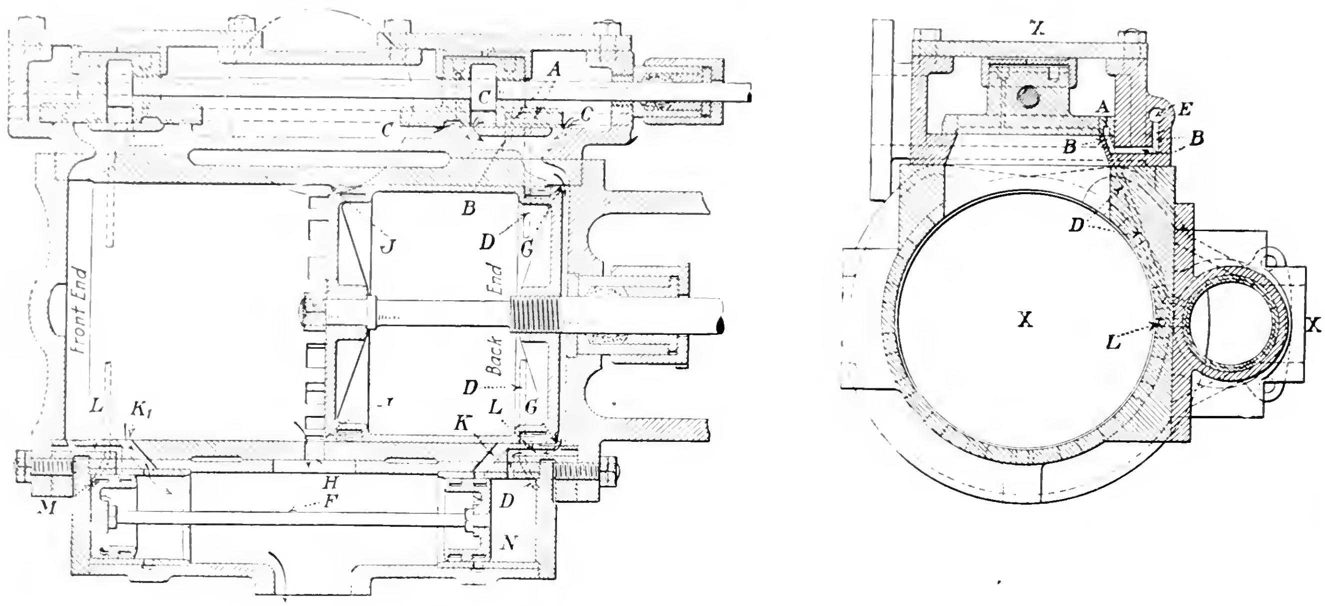
It was, therefore, with a great deal of interest, in the spring of 1915 and again in the spring of 1916, that tests of Baker uniflow traction engines were undertaken as thesis work by members of the senior class of the Mechanical Engineering Department of The Ohio State University.

The engine tested in 1916 was almost identical with that tested in 1915, except that in 1916 the boiler was supplied with a smokebox-type superheater. The piston displacement of the engine tested in 1916 was $8\frac{1}{2}$ per cent larger than that of the engine tested in 1915 and the water heating surface of the boiler $21\frac{1}{2}$ per cent larger. Both machines were made by the A. D. Baker Company, of Swanton, Ohio, and in accordance with their standard designs, except for the uniflow cylinder and the superheater, which were then in process of development.

The principal dimensions of both engines are given in Table 1. Besides the uniflow cylinder and the superheater, the feature of particular interest is the valve gear, which deserves special attention and will later be described.

Figs. 1 and 2 show cross-sections through the cylinder and valves. There are triple-ported admission valves, and an auxiliary exhaust valve which causes the compression to begin late in the stroke.

The operation of the valves can best be explained by following their movement as the piston moves through one stroke. Suppose the piston to be moving towards the right and nearing the end of its stroke; that is, a little to the left of its position in Fig. 1. The admission valves (top of figure) will then be a little to the right of the position shown, and moving towards



FIGS. 1 AND 2 BAKER UNIFLOW CYLINDER AND VALVES

the left. The auxiliary exhaust valve F (bottom of figure) will be at the extreme right end of its travel, and stationary.

When the edge J of the piston uncovers the ports at the center of the cylinder, exhaust commences. About the same time the cavity A in the admission valve uncovers the port at the end of passage B and allows live steam to flow from E (Fig. 2), through passage B, cavity A and passage D into chamber N at the end of auxiliary exhaust valve F. This causes valve F to move to the extreme left of its travel, closing the auxiliary exhaust port K and opening the auxiliary exhaust port K_1. Exhaust is then taking place both through the main exhaust ports and through auxiliary exhaust port K_1. An instant after the auxiliary exhaust valve moves and just before the piston reaches the end of its stroke, admission takes place through the three ports C.

As the piston starts on the return stroke towards the left, exhaust takes place through the main exhaust ports until, early in the return stroke, they are covered by the piston. The

For presentation at the Spring Meeting, Cincinnati, Ohio, May 21 to 24, 1917, of The American Society of Mechanical Engineers. This paper is to be printed in abstract form, and advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

TABLE 1 PRINCIPAL DIMENSIONS OF BAKER UNIFLOW TRACTION ENGINES

	Engine used in 1915	Engine used in 1916
Engine		
Nominal horsepower	16	18
Nominal r.p.m.	240	240
	In.	In.
Diameter of cylinder	8¾	9¼
Stroke	10¼	10
Diameter of piston rod	1¼	1½
Diameter of flywheel	36	38
Face of flywheel	10	11
Diameter of crankshaft	3	3¼
Length of crankshaft	55½	61½
Diameter of crankpin	2¼	2¼
Boiler		
Number of tubes	40	54
	In.	In.
Outside diameter of barrel	29	32
Length of firebox	36	40
Width of firebox	22¼	25
Diameter of tubes	2	2
Length of tubes	78	72
	Sq. Ft.	Sq. Ft.
Grate area	5.56	6.94
Firebox heating surface	23 6	29 1
Tube heating surface	123 2	153 6
Total water heating surface	146.8	182 7
Superheater heating surface	...	47

steam still continues to exhaust through auxiliary exhaust port K, until the piston covers this port, late in the stroke, when compression starts. Meanwhile live steam has been admitted on the other side of the piston until the admission valve has returned and cut-off has occurred. After cut-off and during expansion, the live steam in chamber N, at the head of the auxiliary exhaust valve, is free to expand through passage L and do work on the piston. This passage L enters the auxiliary exhaust valve chamber at such a point that when the valve is thrown some steam is trapped between it and the end of the valve chamber, thus cushioning it and preventing pounding.

The admission valves are driven by a Baker valve gear, which is very similar to the Baker locomotive gear. It is a single-eccentric variable cut-off and reversing gear which maintains equal leads for all cut-offs and in both directions of running. The complete paper illustrates and describes the gear.

The boiler used in the 1916 tests was fitted with a smokebox-type superheater, consisting of a vertical cast-iron header, into which tubes are inserted, as shown in Fig. 3. Steam enters through pipe A, Fig. 4, which leads from the steam dome and passes to the front section of the header. It then passes back through the ½-in. pipes and forward through the 1½-in. pipes into the back section of the header. Thence it passes through B to the steam chest.

METHOD OF PROCEDURE IN TESTING

The tests were conducted in the Mechanical Engineering Laboratory of The Ohio State University and in general the methods recommended in the A.S.M.E. Power Test Code were followed. All coal fired was weighed, sampled, analyzed and the calorific value determined. The feed water was weighed and correction made for injector overflow and other wastes. The quality of steam was taken with a Barrus throttling calorimeter, the sampling pipe being located in the path of the steam as it left the steam dome. Smokebox temperatures were determined with a thermocouple and the smokebox gases were sampled continuously, and analyzed with an Orsat apparatus. Indicated and brake horsepower and revolutions per minute were all carefully determined. All instruments were calibrated and corrections applied where necessary.

The tests were run with the throttle valve wide open, and in general it was attempted to maintain the speed constant at 250 r.p.m. During the preliminary running preceding each test the brake load was adjusted so that the desired speed was obtained

Fig. 3 Superheater Removed from Boiler

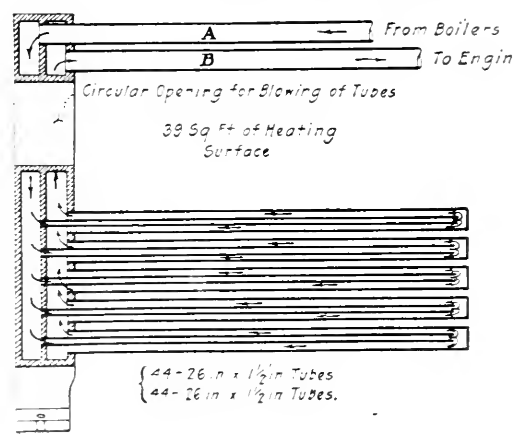


Fig. 4 Diagram of Superheater

when the throttle valve was wide open. During each run all conditions were maintained as constant as possible.

First Series. The 1915 series consisted of 17 tests with various boiler pressures ranging from 125 lb. gage to 175 lb. gage, and various cut-offs ranging from 6 to 49 per cent. Saturated steam was used throughout this series, and the approximate speed was 250 r.p.m. in all tests.

Second Series. The 1916 series consisted of 17 tests, 13 at 180 lb. gage and 4 at 160 lb. gage. Nine of the former were with superheated steam, and 4 with saturated steam. Superheated steam was used for the four latter tests. The cut-off in this series varied from 16 to 75 per cent. The approximate speed was 240 r.p.m., with the exception of three short runs

[illegible] table [illegible] speed [illegible] data concerning the relation [illegible] speed and power

[illegible]

[illegible] performance, with the [illegible] performance are tabulated in the report. Many [illegible] results are also presented graphically [illegible] Figs. [illegible]

In Fig. [illegible] sample sets of indicator diagrams, one with [illegible] and the other with a much later cut off [illegible] lack of wire-drawing during admission, and [illegible] for a slide valve engine running at such [illegible] r.p.m. The drop in the early part of the expansion [illegible] diagrams with an early cut off, and that [illegible] of the diagrams with the later cut off, is caused [illegible] steam flowing into the auxiliary exhaust-valve chamber at the instant the piston uncovers the port leading to this chamber.

Reference to Fig. 5 shows that the highest steam consumption was just under 29 lb., which occurred at 125 lb. boiler

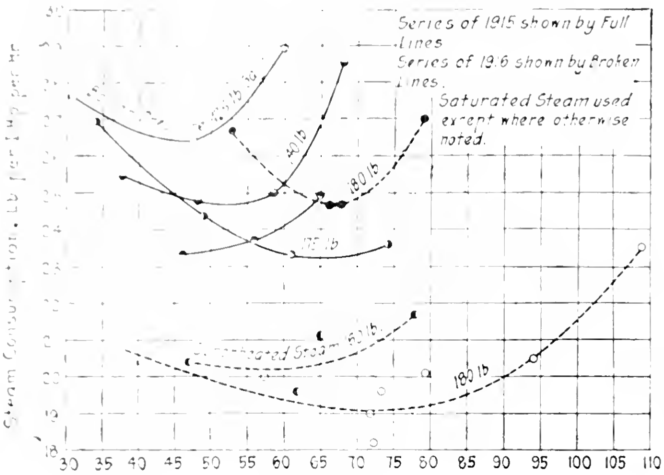


FIG. 5 CURVES SHOWING RELATION BETWEEN STEAM CONSUMPTION AND INDICATED HORSEPOWER

pressure with saturated steam and at approximately 60 i.hp. The lowest was 18.2 lb. per i.hp-hr., in the series of 1916, with 180 lb. boiler pressure and 118 deg. superheat, at about 72 i.hp. Reference to the curve shows, however, that this point was abnormally low.

It seems reasonable to assume that the engine should be rated at approximately the point of best economy. On this basis the rating when operating under 125 lb. boiler pressure would be 45 i.hp. Tests were run from about 30 to about 60 i.hp. or from about 60 per cent to 130 per cent of this rated load, and over this range the variation in steam consumption was from approximately 29 to $26\frac{1}{2}$, or only about $2\frac{1}{2}$ lb.

It is interesting to note that the maximum power obtained was 108.7 i.hp. (102.8 b.hp.) which was obtained with 180 lb. boiler pressure and with 181 deg. fahr. superheat, and with a steam consumption of only 23.5 lb. per i.hp. per hour (24.5 lb. [illegible]). This becomes particularly interesting [illegible] remembered that the cylinder diameter and stroke [illegible] are only $9\frac{1}{4}$ in. and 10 in. respectively.

The curves of Fig. 6 show the relation between steam consumption and boiler pressure. As the boiler pressure increases, not only does the steam consumption decrease, but also the power at any cut off, and the power at which the lowest steam consumption occurs increases. It will be noticed that, with the exception of one point on this curve, the power of minimum steam consumption increases as the boiler pressure increases.

The curves of Fig. 7 show the relation between the pounds of coal used per brake horsepower per hour and the brake horsepower developed.

As a matter of interest from a comparative point of view,

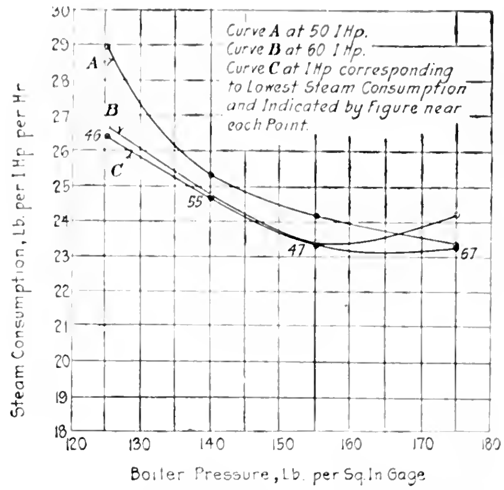


FIG. 6 CURVES SHOWING RELATION BETWEEN STEAM CONSUMPTION AND BOILER PRESSURE, SERIES OF 1915

the steam-consumption curves of a number of the ordinary counterflow type of steam engines, both simple and compound, non-condensing and condensing, have been plotted on the same sheet with certain of the steam-consumption curves of the Baker uniflow engine. These curves are given in Fig. 9. In-

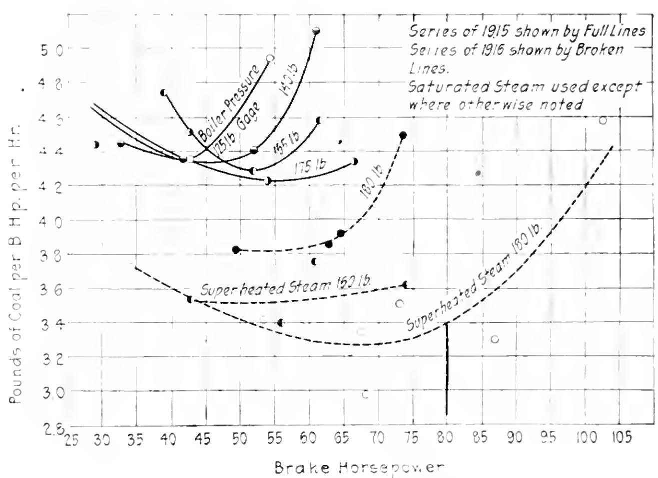


FIG. 7 CURVES SHOWING RELATION BETWEEN POUNDS OF COAL PER BRAKE HORSEPOWER PER HOUR AND BRAKE HORSEPOWER

formation concerning each of the engines whose steam-consumption curve is given in this figure will be found below.

Curve *A*. Simple, slide-valve engine, cylinder 8 in. by 12 in., initial steam pressure 130 lb. gage, non-condensing, and at 200 r.p.m.

Curve *B*. Simple, slide-valve engine, cylinder 9 in. by 12 in., initial steam pressure 140 lb. gage, non-condensing, and at 290 r.p.m.

Curve *C*. Simple, slide-valve engine, cylinder 15 in. by 14 in., initial steam pressure 115 lb. gage, non-condensing, and at 225 r.p.m.

Curve *D*. Same engine as in case of curve *C*, but operating condensing.

Curve *E*. Cross-compound, slide-valve engine, cylinders 7 in. and 13 in. by 10 in., initial steam pressure 150 lb. gage, non-condensing, and at 310 r.p.m.

Curve *F*. Same engine as in case of curve *E*, but operating condensing.

Curve *H*. Tandem compound, slide-valve engine, cylinders 8¼ in. and 13¼ in. by 12 in., initial steam pressure 115 lb. gage, condensing, and at 280 r.p.m.

Curve *G*. Simple uniflow engine, cylinder 8¾ in. by 10¼ in., initial steam pressure 125 lb. gage, non-condensing, and at 250 r.p.m.

Curve *I*. Same engine as in case of curve *G*, but with 175 lb. gage boiler pressure.

Curve *K*. Simple uniflow engine, cylinder 9¼ in. by 10 in., initial steam pressure 180 lb. gage, superheat approximately 130 deg. fahr. non-condensing, and at approximately 240 r.p.m.

It will be seen that the uniflow-engine curves selected are those representing the poorest and the best results obtained with saturated steam, and the best results obtained with superheated steam.

A study of this set of curves (Fig. 9) shows that the poorest results obtained with the uniflow engine, namely, those of curve *G*, obtained with saturated steam at 125 lb. pressure, are better than the best results obtained with any of the simple engines, even when operating condensing, and almost the same as those obtained with the compound non-condensing engine shown by curve *E*. The steam consumption of the uniflow engine at 175 lb. pressure with saturated steam running non-condensing is lower than that obtained with the compound non-condensing

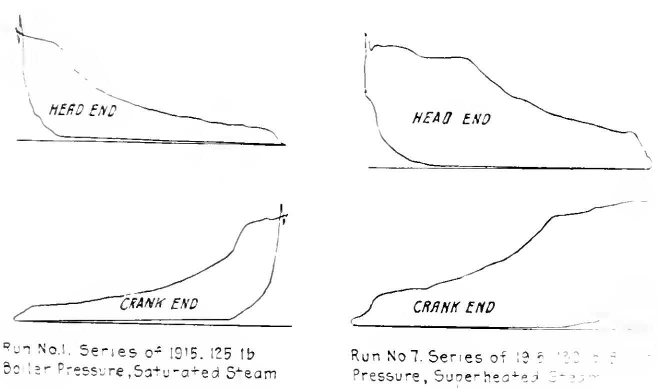


Fig. 8 Sample Indicator Diagrams

engine at 150 lb. pressure shown by curve *E*. Also the steam consumption of the uniflow engine with 180 lb. steam pressure and 130 deg. superheat was lower than that of the compound condensing engine with 150 lb. steam pressure shown by curve *F*.

Thus it is seen that on the basis of the results of the tests and of the information presented by Fig. 9, which is thought to represent fairly the average practice for small simple and compound engines of the older or counterflow type, the simple uniflow engine operating with saturated steam and non-condensing is able to surpass in economy of steam consumption the compound counterflow engine when operating under similar conditions. Also that the simple uniflow engine operating non condensing but with superheated steam will have approximately the same, or slightly less, steam consumption than the compound counterflow engine operating condensing but with saturated steam.

On the bases of these conclusions, it seems probable that the simple uniflow engine will prove a serious competitor of the compound counterflow type, since it is not only more economical in its use of steam, but also simpler in construction, and probably on that account lower in first cost.

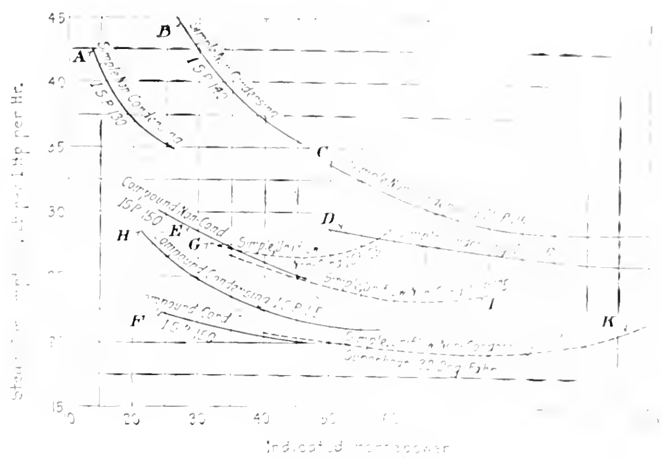


Fig. 9 Relative Steam Consumption of Baker Uniflow Engines and Counter-flow Engines

RELATION OF EFFICIENCY TO CAPACITY IN THE BOILER ROOM

By VICTOR B. PHILLIPS, CLEVELAND, OHIO

There are two ways in which the cost of producing steam may be reduced. They are efficient operation and the attainment of high capacity from equipment. Table 1 gives the typical figures for the various elements of cost entering into the production of steam, according to the accounts of the Cleveland Railway Company[1] for the year 1914. The numbers shown in parentheses refer to the accounting system prescribed by the Interstate Commerce Commission. This table shows the predominating importance of fuel and fixed charges, and hence the importance of both efficiency and capacity and their interrelation.

To the end of establishing the operating conditions giving maximum efficiency for a wide range of capacities, the writer has made an extensive series of tests for the Cleveland Railway Company. The tests were conducted under widely different operating conditions in order to bring out clearly the importance of the several variables and also to throw light on questions of design. In Table 2 is a condensed summary of the data obtained, together with some notes as to procedure.

GENERAL DESCRIPTION OF TESTS

Equipment (see Fig. 1). Taylor six-retort stoker with extension grate. Babcock & Wilcox boiler, 5120 sq. ft. heating surface.

[1] Cleveland Railway Company.

For presentation at the Spring Meeting, Cincinnati, Ohio, May 21 to 24, 1917, of The American Society of Mechanical Engineers. The paper is here printed in abstract form, and pamphlet copies of the complete paper may be obtained by members gratis upon aplication. All papers are subject to revision.

[illegible]. Eight-inch [illegible] provided [illegible] under test conditions [illegible] several days before tests [illegible] which referred [illegible] operation chart. Readings taken [illegible] minute.

Personnel. In addition to regular operating fireman and helper, personnel included six men all of whom had become thoroughly familiar with their duties through previous tests.

TABLE 1 COST FACTORS IN STEAM PRODUCTION

Cleveland Railway Company

		Per cent of total cost	
[illegible]	Fuel	50.1	50.1
[illegible]	Water	3.4	
[illegible]	Oil and miscellaneous supplies	0.4	
[illegible]	Maintenance	6.4	
[illegible]	Employees	9.6	9.6
[illegible]	Depreciation, $1\frac{1}{2}$ per cent on investment	11.3	11.3
To these must be added interest, taxes and insurance, $7\frac{1}{2}$ per cent on investment.		18.8	18.8
Total cost of producing steam		100.0	
Fuel and fixed charges			89.8

Coal and Water. Both items were weighed on newly calibrated scales. Coal sample taken from every wheelbarrow and placed in covered receptacle.

Air Supply. Air delivered to furnace from fan was measured by pitot tubes placed in air ducts and preceded by baffles to create parallel flow; permanently located pitot tubes were calibrated by complete traverses in two directions through the pipe and results checked with an anemometer and by the calorimetric method. Pressure and draft gages checked.

Temperatures. Obtained by thermo-electric pyrometers, checked by manufacturer before and after tests.

Gas Analysis. Conducted by chemist. Continuous samples taken during consecutive half-hour periods. Sampling tube inserted at top of first pass; lined with hard glass tubing and open at end only; moved in and out so as to get representative sample. Analysis made with Orsat apparatus.

Regulation of Fire. Fuel bed was kept uniform and constant in thickness, by very close and frequent observation on the part of three different men, all experienced firemen.

Ash Analysis. All ash was spread out and crushed to about $1\frac{1}{2}$ in. on a large concrete floor and dried before weighing. The sample for analysis was taken by dividing the ash, when evenly spread out, into a large number of squares, and then moving away alternate squares until a comparatively small sample for grinding was obtained. During this reduction process the ash was continually mixed by turning it over. The samples were analyzed for moisture, combustible and in some cases for sulphur or volatile constituent.

SCOPE OF PAPER

This paper proposes for discussion the systematic treatment of the steam boiler in relation to the two fundamental variables—efficiency and capacity. The efficiency which obtains at a given capacity depends upon the interrelation of a large number of variable factors of operation. It is essential that these factors be systematically conceived, and that in a given case some idea of their relative importance be formed. Recent stoker developments to the end of greater flexibility have introduced a large number of adjustments over which intelligent control must be exercised. This merely goes to illustrate the

TABLE 2 SUMMARY OF TEST DATA

Cleveland Railway Company

Test No.	1	2	3	4	5	6	7	8	9
1 Fuel bed thickness		Thin			Medium			Thick	
2 Horsepower output of boiler, (steam pressure 150 lb. gage)	452	661	895	500	736	923	504	718	902
3 Dry coal per hour, lb	1,695	2,450	3,700	1,960	3,100	4,000	2,690	3,600	4,320
4 Coal analysis									
a B.t.u.	12,631	12,718	12,744	12,795	12,888	12,944	12,802	12,802	12,672
b sulphur	4.00	4.00	4.00	4.00	4.00	4.00	4.16	4.16	3.93
c ash	13.2	12.4	12.6	12.4	11.8	11.6	12.5	12.5	13.2
5 Air pressure under tuyeres (inches of water)	0.46	1.33	2.63	0.55	1.68	2.79	1.03	2.41	3.27
6 Draft in combustion chamber (inches of water)	0.22	0.25	0.25	0.25	0.27	0.41	0.15	0.15	0.45
7 Pounds air per hour by meter	20,100	30,900	42,600	15,700	30,200	46,500	20,900	37,200	43,500
8 Average of air by meter and by analysis	25,200	32,000	38,500	17,850	30,300	40,250	21,900	34,250	42,250
9 Temperature of air, deg. fahr	66	66	68	66	69	70	79	80	72
10 Temperature in last pass	532	644	734	500	659	771	509	596	728
11 Sensible heat to stack (per cent)	14.5	17.0	14.6	8.4	12.1	14.7	7.6	10.4	13.7
12 Combustible in ash, per cent loss	5.1	4.0	7.6	4.6	10.0	7.0	17.3	17.3	20.0
13 CO loss [3]	0.4	0.8	10.9	6.6	11.2	13.9	14.8	11.4	....
14 Latent heat of steam in flue gas	3.5	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.7
15 Overall efficiency	70.7	71.2	63.5	66.9	61.7	59.7	49.0	52.1	54.8
16 Furnace efficiency	85.2	88.2	78.0	75.3	73.8	74.4	56.5	62.5	68.5
17 Output of furnace, boiler hp.	544	820	1,100	563	880	1,150	583	862	1,127

[1] Flue gas per pound of coal, taken from items 3 and 8 to which is added 0.8 pound for gasified coal.

[2] One sample for Tests 7 and 8.

[3] The CO analyses, especially for the overload tests (Nos. 3, 6 and 9), were probably somewhat in error due to taking of sample at top of first pass where gases were not thoroughly mixed. During Test 9 both the oxygen and CO content of the flue gas taken at this same point were high. There was also a marked amount of incandescent matter in the flue gas. It is therefore probable that considerable combustion of CO occurred in the second and last passes. This is indicated by the fact that the items of the heat balance for this Test 9 added up to a little more than 100 per cent.

necessity of less prejudice and more rational procedure in boiler-room design and operation.

In what follows, a classification of the variables of operation will be outlined, and a system of testing discussed, whereby their interrelation may be established. The results of the tests already quoted, which were made in accordance with this system, will be used by way of illustration. All mathematical treatment and detail of procedure are listed in an appendix. It should be pointed out at the outset that the test data used are necessarily limited, and in some respects incomplete. Yet perhaps they will serve as a concrete basis or example in outlining the method of treatment.

ELEMENTS OF BOILER UNIT AND BASIC FACTORS WHICH GOVERN ITS PERFORMANCE

The steam-boiler unit is considered here in relation to each of its two elements, the *furnace* or heat liberator and the *boiler* or heat absorber.

The furnace is a means whereby the chemical energy of coal or other fuel is transformed into sensible-heat energy. The function of the furnace is chemical reaction between the combustible fuel and the oxygen of air. As such, it is governed

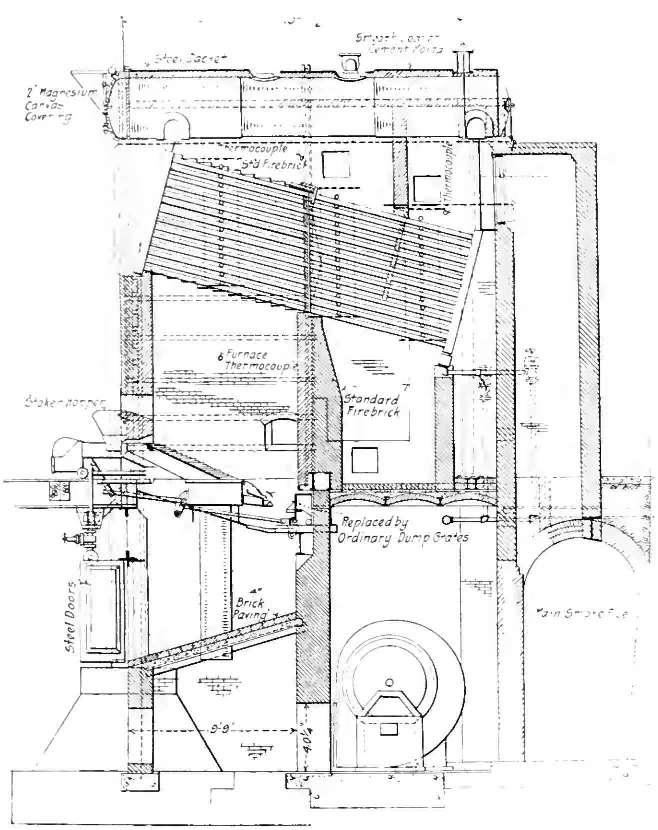


Fig. 1 Sectional View of Boiler Unit of the Cleveland Railway Company

by the three factors, (1) amount of air, (2) degree of air mixture and (3) time. These three factors together govern the rate of combustion, the completeness of combustion and the resultant temperature of combustion; in a word, they completely determine the nature of combustion.

The boiler is a means whereby the heat liberated in the furnace is absorbed and transferred to the water. Its function is heat transmission and it is governed by the laws expressing the several modes of heat transmission,—conduction, convection and radiation. It is evident that the factors which govern combustion likewise govern very largely the heat transmission of the boiler, by the regulation of temperature and amount of gas. Hence, it follows that in the end the performance of the entire boiler unit may be expressed in terms of a number of factors over which the fireman either does or should be able to exercise proper control.

Before proceeding with the separate discussions of the two elements of the boiler unit, it is necessary to define clearly the lines of separation of the furnace and the boiler. It is desirable so to define furnace efficiency and boiler efficiency that

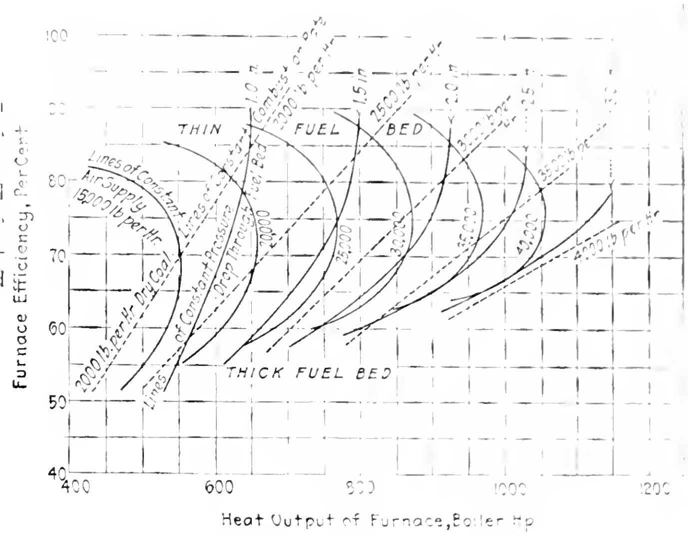


Fig. 2 Furnace-Operation Chart. Taylor Six-retort Stoker with Extension Grate

their product will be the overall efficiency of the unit. To this end boiler efficiency is taken as the ratio of heat absorbed to the heat available for absorption, *i.e.*,

$$E_B = \frac{\text{heat in steam}}{\text{heat in steam and sensible heat in flue gas}}$$

Furnace efficiency is defined as the ratio of heat available for absorption by the boiler to the heat in the coal, *i.e.*,

$$E_F = \frac{\text{heat in steam and sensible heat in flue gas}}{\text{heat in coal}}$$

and

$$E\,(\text{overall efficiency}) = E_F \times E_B$$

This method arbitrarily charges against the furnace all losses through the setting, such as radiation and leakage. Most of these losses do occur in the setting around the furnace and so this arbitrary classification is reasonable. It also charges against the furnace the loss in latent heat in the vapor of the discharged flue gases.

THE FURNACE

The ideal furnace for any form of fuel is one in which the three factors of combustion mentioned above,—amount and admixture of air, and time for completion of combustion, may be regulated independently. This furnace would have wide limits of efficient operation wherein it would be possible to attain at once both efficiency and capacity. Unfortunately the present status of the art, particularly in regard to coal-burning furnaces, falls far below this ideal.

The most important methods of firing coal employ the

[illegible] the underfeed and overfeed gravity stokers it [illegible] time of transit of coal decreases with [illegible] of load and forced-draft independent regulation, [illegible] it is impossible to regulate independently the amount and admixture of air. The [illegible] supply are controlled together by the amount of draft or pressure and by the condition of the fuel bed. These several inflexibilities are inherent in the present state of the art. They are serious disadvantages which can be [illegible], however, by introducing in other ways a large degree of flexibility.

Since regulation [illegible] by regulation of grate surface seems to be impracticable, the problem of furnace operation becomes simply the *problem of the air supply*, not merely [illegible] as a whole, but in its several parts separately. That flexibility of air supply will to some extent compensate for inflexibility in time of transit, may be illustrated by any of the underfeed gravity stokers. The grate areas of these stokers have been proportioned to give the proper time element for rated capacity.

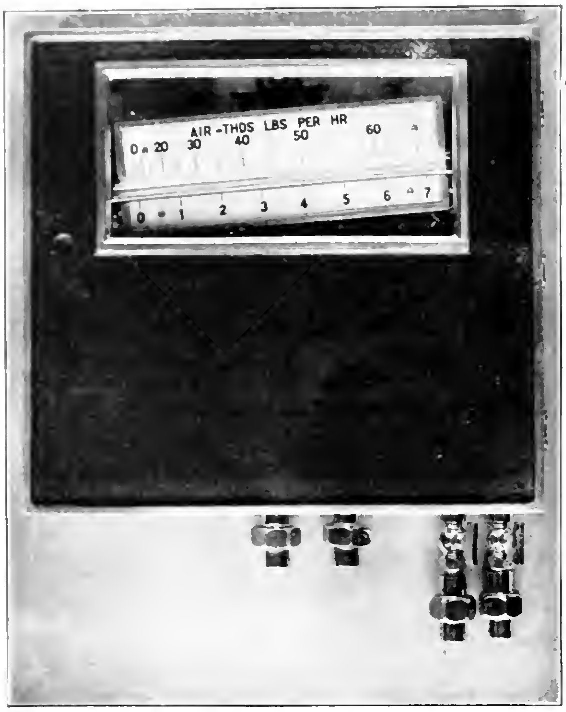


Fig. 3 Air Meter

For example, take the case of the Taylor stoker used in the equipment of the Cleveland Railway Company's plant which the writer tested. When the capacity is increased, the air supply on the lower or coking grates cannot be increased enough to burn the coal as fast as it is received from the upper grates. The result is a piling up of coke and ash on the dump and extension grates causing not only a large loss from carbon monoxide and coke to the ash pit, but perhaps serious clinker difficulties. A variable grate surface would eliminate this trouble. It could, however, be largely mitigated by flexible and independent air control for this section of the fuel bed. This is discussed further in the Appendix.

FUNDAMENTAL FACTORS OF OPERATION OF THE FURNACE

The operating variables of the furnace are simply the variables governing air supply. They are (1) thickness of fuel bed, (2) condition of fuel bed, and (3) pressure drop through fuel bed. These variables may be regulated differently in different parts of the furnace, but they are in all events the fundamental factors involved. They determine efficiency and capacity. In order to operate a furnace properly, the interrelations between efficiency and capacity and the foregoing variables must be established.

The validity of this principle has not been generally realized. Instruments for the indication of certain variables have been extensively used. Yet, either the number of instruments or the amount of rational interpretation has been insufficient. It is only in very special and limited cases that efficiency or capacity is indicated by a single variable factor such as carbon dioxide, or flue temperature.

Having defined the fundamental factors of operation, it now remains to select means of indicating these quantities to the fireman. The means of indication necessarily vary for different types of stokers and furnaces. With a chain grate the thickness of fuel bed may be readily measured and adjusted, and its condition is for the most part uniform. The draft in the combustion chamber constitutes the pressure drop through the fuel bed. Thus the chain grate readily lends itself to this system, and it is a simple matter to determine by tests

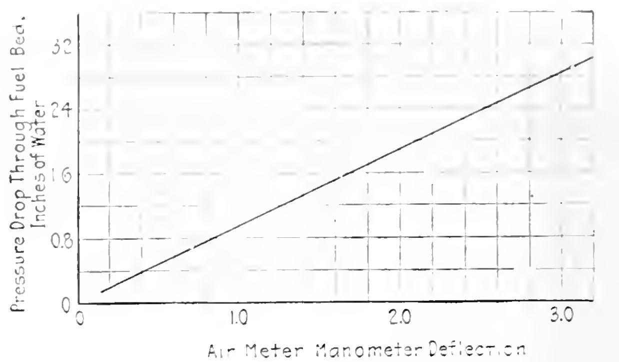


Fig. 4 Relation Between Pressure Drop Through Fuel Bed and Air Meter Manometer Deflection. Fuel Bed of Constant Thickness

the relation of furnace efficiency and capacity to the operating variables. In fact, the limits of expedient and efficient operation with the chain grate are not only narrow, but readily apparent. This is a salient feature of this type of stoker. On the other hand, the forced-draft underfeed stoker is not by any means so simple, and here intelligent control is not only effective but essential. In this case the thickness of fuel bed cannot be *directly* measured nor is its uniformity so much a matter of course.

The point of primary importance is the amount of air pushed through the fuel bed and the intimacy with which it is mixed with the volatile matter forming in the lower layers of green coal and the coke of the upper layers. Roughly speaking, this intimacy increases with the resistance to air flow. It is the condition and thickness of the fuel bed that determines both the amount and admixture of air. The pressure necessary to force up a certain quantity of air is both a simple and an effective indication of the mean condition and thickness of the fuel bed; in other words, an air-pressure gage and an air meter indicate the thickness of bed. In stokers of sufficient size to warrant the use of two air ducts, it is necessary to duplicate the air-measuring apparatus. By proper arrangement of the means of indication it now becomes

possible to gage the uniformity of the fuel bed by comparing the air indications to the two halves. Thus all the conditions governing air supply may be readily measured, and indicated to the fireman. In order that he may make proper use of these indications they must be related to the objects sought—efficiency and capacity.

As an illustration of the actual interrelating of the above indications, there is presented in Fig. 2 a chart showing graphically the results of the tests applying to the furnace.

It may be seen that this chart is a graphical representation of the principles outlined above. It shows how furnace capacity and efficiency are functions of extremely simple variables, and how any two of the variables fix conditions of operation. An analogy is a steam chart on which any two conditions, such as heat and pressure, or quality and temperature, determine a point from which the other corresponding conditions may be found. The chart brings out in conclusive manner the essential importance of the variables selected at the beginning of the discussion—thickness of fuel bed and pressure drop. So far as the furnace as a heat liberator is concerned, it establishes the conditions of maximum efficiency for each and every load.

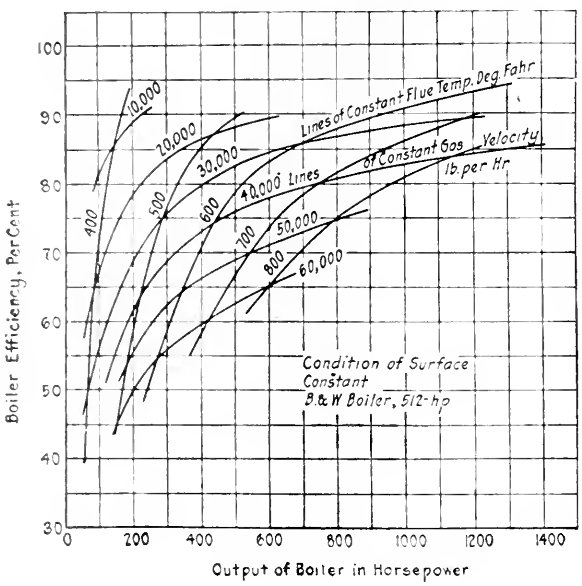


FIG. 5 THE BOILER AS A HEAT ABSORBER. BOILER-OPERATION CHART SHOWING INTERRELATION OF VARIABLES

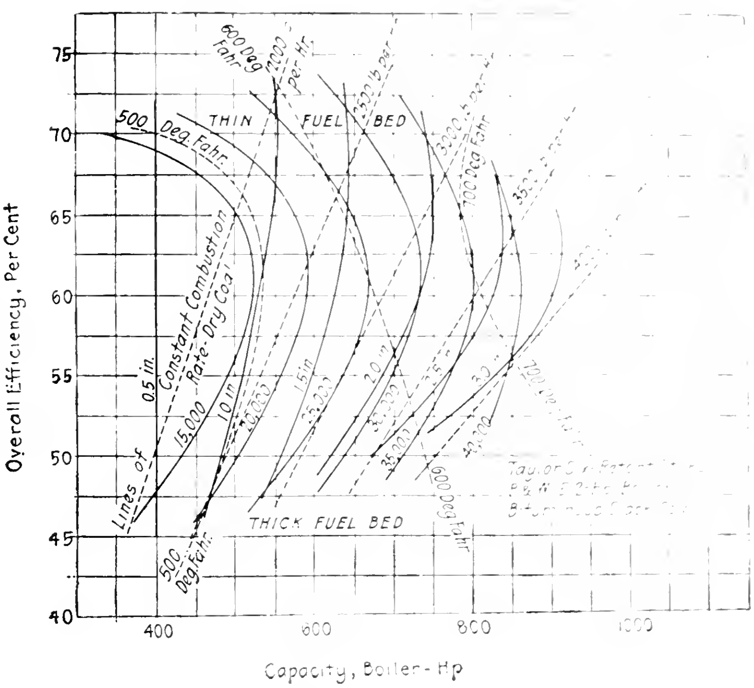


FIG. 6 OPERATIVE CHART, COMBINED BOILER UNIT

MEASUREMENT OF AIR SUPPLY

Of the instruments used by the writer in obtaining the results presented here, the apparatus for directly measuring the air supply, Fig. 3, merits perhaps a brief statement. It is quite possible to employ the pitot tube with close accuracy for measuring the air supply of forced-draft furnaces, and even where conditions are extremely unfavorable to obtain at least excellent relative results. The manometer used in connection with the pitot tube may be placed at a distance from the air duct, along with the other boiler instruments, without impairing its accuracy. When two manometers are necessary because of two air ducts the sloping tubes may be placed side by side and readings taken from a single scale. The only time that the liquid levels will not be side by side will be when the fuel bed is not uniform, a condition requiring immediate attention from the fireman. For example, a hole will cause a very marked difference in the two manometer level.

Another principle may be employed in connection with the form of air meter just described. The pitot tube manometers show deflections increasing as the square of the air velocities. Similarly, neglecting the relatively small amount of gas formed from the burning coal, the pressure drop through the fuel bed varies as the square of the air velocities. Hence, as is shown in Fig. 4, the relation between this pressure drop and the manometer deflection is a direct proportion. Utilizing this principle, another manometer tube[1] may be placed beside the other tubes for the measurement of pressure drop. By using liquids of the proper relative densities, or by introducing variation in the sectional area of the manometer, the levels can be set to move up and down together for the proper thickness of fuel bed; and a ready indication of amount of variation from the prescribed thickness is available. This last function is valuable in plants having short peak loads. The fireman may gage the amount by which he is building up his fuel preparatory to the short overload. Thus a single instrument has been made to indicate all the fundamental conditions of combustion—amount of air, pressure drop through the fuel bed, and thickness and uniformity of fuel bed.

THE BOILER

The performance of the boiler as an apparatus for absorbing heat is here analyzed in the complete paper along the same general lines as the furnace. The furnace produces heat which is available for absorption in the form of radiant energy and of hot gases, that is, the heat generated in the incandescent fuel bed is transmitted to the boiler surfaces by radiation and by convection. It is then transmitted from

[1] Not shown in Fig. 3 but exactly similar to the two tubes shown.

[illegible] to the inner surface, and to the water by conduction. The boiler involves, therefore, all three modes of heat transmission, and the variables of operation are those determining the effectiveness of each of these three modes. These variables are (1) temperature, (2) condition of surfaces and (3) gas velocity. Temperature is the predominant variable; it affects all three modes of transfer, in each case a temperature gradient being necessary. The condition of surfaces affects principally two modes of transmission, convection and conduction; while gas velocity affects simply convection.

BOILER-OPERATION CHART

Relations derived between the heat absorbed by the boiler, and the two variables, *flue temperature* and *gas velocity*, are combined into a single chart, Fig. 5, which is the boiler-operation chart, and corresponds to the furnace-operation chart previously shown. It expresses the relation of efficiency and capacity to the fundamental factors—temperature and velocity of the gases.

COMBINED BOILER-UNIT OPERATION CHART

Following this separate treatment of the two elements of the boiler unit—the furnace as a heat liberator and the boiler as a heat absorber—the paper here combines the results of the two analyses. As an example of such procedure there is presented in Fig. 6 the combined boiler-unit-operation chart.

It is evident that the factors governing furnace operation also determine the variables of boiler operation. The gas passing through the boiler is simply the air of combustion plus the weight of gasified coal (corrected, if necessary, for infiltration). The temperatures in the boiler are governed by the combustion conditions in the furnace. Hence, overall boiler efficiency and capacity are to be expressed simply in terms of the furnace variables—*thickness of fuel bed* and *pressure drop through fuel bed*. In the case presented here fuel bed thickness is indicated by weight of air and pressure drop, and these values therefore become the criteria of combined performance. The function of flue temperature is simply a check upon the condition of the heating surfaces. The combustion rate curves shown on the chart are of value only in assisting in the proper maintenance of fuel bed. However, this information is not necessary, since an insufficient fuel supply shortly disturbs the prescribed relation between air and pressure drop. Reference to the data shows very little variation in the character of the coal used in the tests, the results of which have been here presented.

The combined boiler-unit-operation chart brings out the essential importance of the variable factors which have been selected as determining performance. It supplies the information whereby the firemen may operate with maximum efficiency for each different load. It establishes the relation between efficiency and economy wherewith the economic policy of the boiler room may rationally be planned. Lastly, a study of the chart and of the reasons for its characteristics becomes a sound basis for improvement in design.

In conclusion the writer states clearly his position, which is not an unqualified acceptance of any single system of analysis, but rather the acceptance of the *principle* of systematic analysis. He believes there is no engineering problem which is immune to this principle.

An appendix describes the procedure for convection tests and for the determination of radiation heat, and discusses the furnace and stoker characteristics.

RADIATION ERROR IN MEASURING TEMPERATURE OF GASES

By HENRY KREISINGER, PITTSBURGH, PA.
Member of the Society

AND

J. F. BARKLEY,[1] PITTSBURGH, PA.

Of the errors entering into the determination of the average temperature of a stream of hot gases surrounded by colder or hotter surfaces, the radiation error is the most serious one and the most difficult to correct. Ordinary temperature measurements made with commercial devices under such conditions are from 5 to 25 per cent in error. If the surrounding surfaces are cooler than the gases, the temperatures indicated by the measuring instrument will be too low; or if the surrounding surfaces are hotter, as is the case in regenerating furnaces, they will be too high.

The object of this paper is to show primarily how large the radiation error may become under certain conditions of temperature measurements, and that judgment must be used in interpreting the accuracy and the value of temperature readings.

The radiation error is due to the fact that, to a large extent, gases are permeable to radiation. When a temperature-measuring instrument is immersed in a stream of hot gases surrounded by cooler surfaces, it absorbs heat from the gases by convection and its temperature rises. As soon as its temperature exceeds that of the surrounding surfaces, heat passes by radiation from the instrument to these surfaces through the intervening gases. Thus the instrument receives heat from the hot gases by convection, and gives off heat by radiation to the surrounding colder surfaces. The temperature of the instrument continues to rise with a decreasing rate, until the quantity of heat it gives off is equal to the quantity of heat it receives; the temperature then remains constant. Under these equilibrium conditions the temperature of the instrument is between that of the stream of gases and that of the surrounding surfaces; in other words, it is lower than the temperature of the gases which it is intended to measure.

In a similar way, when the instrument is inserted in a stream of gases surrounded by surfaces hotter than the gases, and when equilibrium conditions obtain, the temperature of the instrument is somewhere between that of the surrounding surfaces and that of the stream of gases; in other words, it is higher than the temperature of the gases which the instrument is supposed to measure. The difference between the temperature of the gases and that indicated by the instrument is the radiation error.

The magnitude of the radiation error depends on: (1) the size of the part of the instrument exposed to the gases and the radiation, and (2) the difference between the temperature of the gases and the temperature of the surrounding surfaces. The smaller the exposed part of the measuring instrument, the smaller the radiation error; also, the smaller the difference between the temperature of gases and the temperature of the surrounding surfaces the smaller the radiation error. In the measurement of the temperature of gases only the first-named factor can be controlled. The second factor is fixed by the kind of apparatus and its operation.

[1] Junior Electrical Engineer, U. S. Bureau of Mines.

For presentation at the Spring Meeting, Cincinnati, Ohio, May 1917, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. The paper is here printed in abstract form and advance copies of the complete paper may be obtained by members gratis upon application. All papers are subject to revision.

Of the instruments used in the measurement of temperature of gases, the thermocouple lends itself the best to the reduction of its size. It can be made so small that the radiation error is negligible for practical purposes. The correct temperature would be indicated only by a thermocouple having an exposed hot junction made of wires of zero diameter, which, of course, is a physical impossibility.

The effect of the size of thermocouples is shown in Fig. 1, which gives two sets of temperature measurements of the gases passing through a Babcock and Wilcox boiler fired with natural gas. One of these sets of measurements was taken with thermocouples having the hot junction made of wires 0.008 in. in diameter and the other made of tubes about 0.500 in. in diameter. This large couple is about the size of commercial instruments used for such purposes. Several thermocouples of each size were made and clamped together in pairs, each pair containing a large couple and a small couple, with their hot junctions about $1\frac{1}{2}$ in. apart. These pairs were placed at different points along the path of gases, indicated by the small circles and designated by the letters *A, B, C, D, E, F* and *G* in Fig. 2. All the couples were connected to a central switch and read in rapid succession with a portable potentiometer. While the readings were taken the furnace conditions were kept uniform, which was a comparatively easy task with the gas firing.

In Fig. 1 the abscissae are the approximate lengths of the paths of gases, measured from the position of the first pair of couples *A*. The full heavy curve connects the readings obtained with the large couples, and the full light curve the readings obtained with the small couple. The dotted curve above the full curves gives the probable true temperature of the gases, obtained by extrapolation from later curves. The curve near the bottom of the figure (drawn with dashes) gives the approximate velocity of the gases computed from the volume of gas burned, the chemical analysis of the products of combustion and the true temperature of the gases. The small black circle at the upper left hand corner gives the furnace temperature as measured with the Wanner optical pyrometer sighted through one of the gas burners, as shown in Fig. 2.

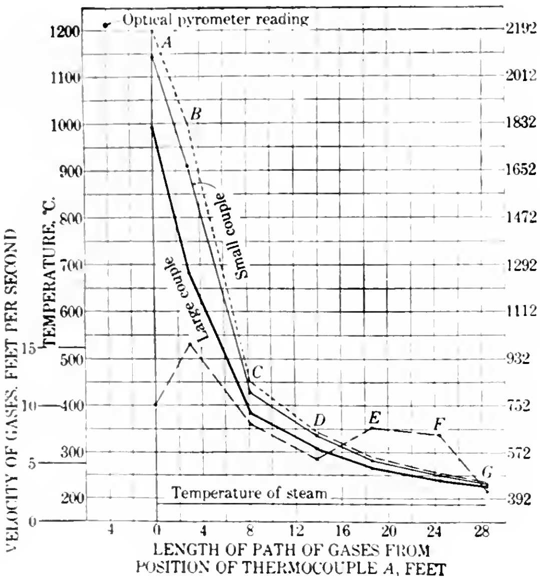


Fig. 1

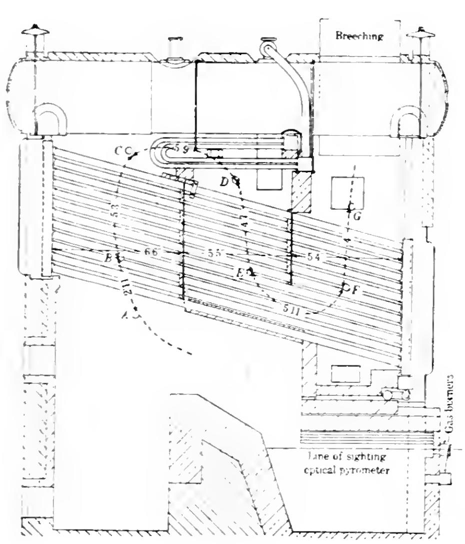


Fig. 2

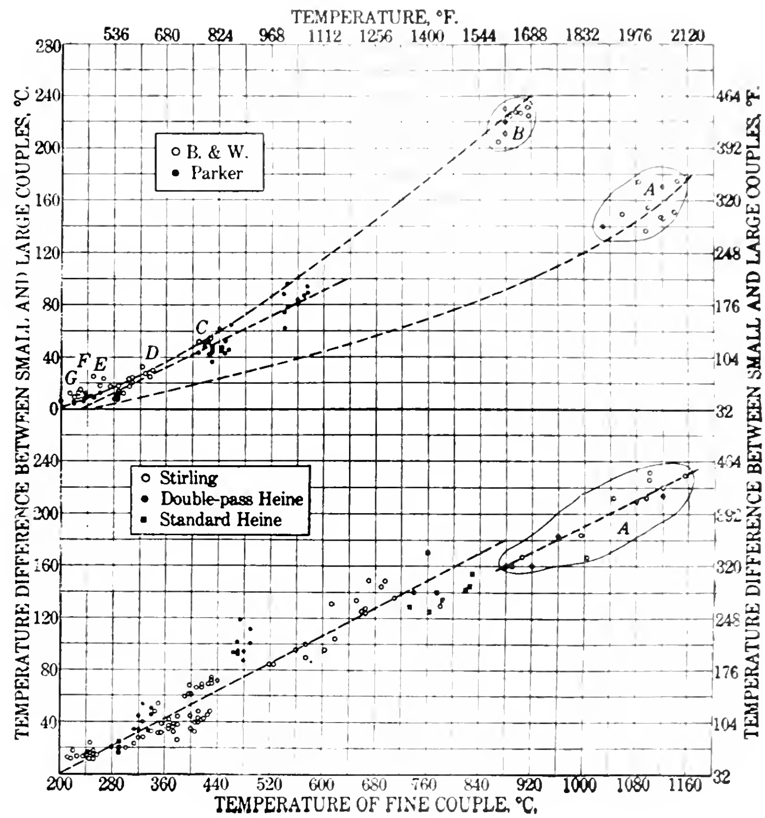


Fig. 3

Fig. 1 Temperature of Gases as They Pass Through Babcock and Wilcox Boiler

Fig. 2 Setting of Gas-Fired Babcock and Wilcox Boiler in Which the Measurements Were Made. Total Heating Surface, 3400 Sq. Ft.; Steam Pressure, 165 Lb. by Gage.

Fig. 3 Effect of Temperature of Gases on Radiation Error in Various Types of Boilers

The two full curves of Fig. 1 indicate that the small couples consistently showed temperatures considerably higher than the large couples, although the small couples themselves read somewhat too low. The difference between the readings of the two couples is nearly proportional to the difference between

[illegible] temperature of the gases and the temperature of the surrounding boiler surfaces, which was about 50 deg. higher than the temperature of steam in the boiler. The large couple at B shows a radiation error of about [illegible] deg. Fahr., whereas the small couple at the same place indicates an error of only 150 deg. Fahr.

Fig. 3 shows how much lower the large couples read than the small ones when the couples were placed in the boiler settings of five of the common types of water tube boilers. The readings were plotted on two charts to avoid crowding the points. With the exception of the groups marked A, all the readings were obtained with the thermocouples placed among the tubes, or in other places where they were almost totally exposed to the heating surfaces of the boilers.

The group A of the Babcock and Wilcox boiler was obtained with the thermocouple placed in position A, Fig. 2. In this position the thermocouples were exposed partly to the boiler tubes and partly to the brick walls and the clay-tile furnace roof, which latter surfaces were much hotter than the boiler tubes. Therefore the thermocouples did not lose as much heat by radiation as those couples which were completely surrounded by the boiler tubes, and their radiation error was smaller.

Group A of the lower half of Fig. 3 was obtained with the couples placed about 1 ft. above the arch and 1 ft. from the front nest of tubes in a setting of a standard Stirling boiler. They were therefore exposed partly to the boiler tubes and to some extent also to the hot brickwork of the furnace. Therefore the radiation error of these couples was somewhat smaller than the radiation error of the other couples completely surrounded by the boiler tubes.

Dotted curves were drawn through the groups of points representing readings of couples having nearly the same exposure to indicate that the radiation error is roughly proportional to the temperature of the gases.

The paper concludes with a determination of the nature of the relation between the radiation error and the size of the hot junction of a thermocouple.

DEVELOPMENT OF SCIENTIFIC METHODS OF MANAGEMENT IN A MANUFACTURING PLANT

By SANFORD E. THOMPSON, WILLIAM O. LICHTNER, KEPPELE HALL, AND HENRY J. GUILD [1]

THE development of scientific methods in manufacturing is being recognized almost universally as an essential to economical management. We say *recognized,* but this must be qualified by the acknowledgment that in the majority of concerns who accept this as a theory the treatment has been superficial instead of covering the development of plans which are accurate, exact, based on facts, and which account for all variable conditions. An encouraging feature of the situation lies in the fact that the most scientifically managed shops realize that they have by no means reached the ideal. In fact, a truly scientific development necessarily shows up the deficiencies as it proceeds. On the other hand, too many plants are settling back into self-sufficiency after establishing a so-called *efficiency department*—a most worthless piece of mechanism as ordinarily conducted—and a *cost system* which at best indicates how money is lost, and not how conditions can be improved.

SCOPE OF PAPER

A large proportion of the published matter relating to the application of scientific methods of management has pertained to the machine shop. In this paper it is the aim of the authors to present in considerable detail an outline of the development of scientific methods as applied to the ordinary manufacturing plant. At the same time, to make this more of a concrete illustration, the discussion will be centered in the plants known as the Eastern Manufacturing Company at Bangor and Lincoln, Maine, one of the largest concerns in the country manufacturing writing paper as its final product.

The development of scientific methods at these mills, however, is not, as one might assume, descriptive of simply a single and comparatively localized industry. As a matter of fact, the processes involved in pulp and paper making are similar in type, so far as management methods—not in specific technique—are concerned, to a vast number of industries. The treatment, for example, involves the scientific development and standardization of processes; the job analysis of hand and machine operations; the systematizing of stores, including supplies, raw materials and material in process; the introduction of planning methods to control very diverse conditions; the training of the worker; and the coöperation of the workers with the management through the Service Department, and personal relations.

In treating the subject, it is proposed after a brief summary and a statement of general principles to take up the plan of control of manufacturing and the methods adopted in the different processes to standardize practice.

INITIAL CONDITIONS IN THE PLANT

The plant at Bangor manufactures writing paper of high grade and also operates its own pulp mill, part of the product of which is for use in the paper and a part for sale. The Bangor mills employ some 800 people.

The individual processes group themselves into

1 manufacture of sulphite pulp from spruce wood
2 manufacture or making of paper from rags and sulphite pulp
3 finishing of the paper to produce the various finishes required for writing paper.

With the last is included the manufacture of the wooden boxes or cases for shipping the paper.

Before beginning the introduction of the more intimate analysis of the methods and processes, the plant had been brought during the previous two years to a stage much above the average plant of the old type of management in efficient operation. In 1914 it was decided by the directors to introduce scientific methods so as to go down to the bottom of things and develop standard methods of handling materials and labor.

RESULTS

The results secured by the scientific standardization of the various operations in combination with the routing system and bonus plan are briefly as follows

[1] Superintendent of Paper Mill, Eastern Manufacturing Co., Bangor, Maine. Other authors are members of the Society.

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a increase in production in the paper mill of 35 per cent
b increase in the pulp mill from 35 tons to 50 tons, or 42 per cent
c average increase in wages of 40 per cent
d reduction in cost per ton of paper production, notwithstanding increased wages, of about 25 per cent[1]
e saving amounting to several thousand dollars per month in materials
f control of production throughout the plant
g development of the spirit of coöperation between management and employees.

The reduction in cost in spite of the increase in wages is due to three things

1 fewer employees per unit of work
2 reduction of overhead costs through the increase in production with the same plant and non-productive help
3 savings in materials.

THE PROCESS OF PAPER MAKING

Paper making, today, both in method and machinery, is substantially the same as it was one hundred years ago. It has been carried on during all this time by using traditional methods transmitted from one generation to another.

The process consists in brief of beating the "furnish," that is, the raw materials, in a large tub or beating engine, passing this through jordan machines, and then on to the paper machine, after which it is cut and finished in a multitude of ways.

SCOPE OF DEVELOPMENT

Scientific management consists fundamentally in finding the best way of doing a thing and putting the plan into execution.

The logical process in the development of scientific methods is to begin with the handling, classification, and storage of the raw materials; next establish control of the manufacturing processes, and finally establish by scientific investigation standards of material and standard practice for operating the plant.

It is evident that there are two distinct features involved in this: *first,* the introduction of a system in management, and *second,* the establishment of standards. It must be recognized very clearly—and it is because of lack of appreciation of this point that scientific management is confounded with mere mechanism—that system alone is never in itself the goal. System is merely the tool and a necessary tool for control. It is the classification of facts, the job analysis, the intimate study of conditions, that produce the real results in output, in quality, in elimination of fatigue, in basic coöperation and pulling together between the men and the management.

These are principles of general application. The actual work to be accomplished presents in different manufacturing establishments problems singularly alike. The methods of procedure, for example, at the Eastern Manufacturing Company, were similar to those required in almost any plant operating under the ordinary type of management.

PLAN OF ORGANIZATION

The work was undertaken in accordance with the following plan

1 classify the product so as to eliminate the confusion caused by a multiplicity of trade names and designations for the same article, and permit of keeping a proper balance of stock of the various grades, weight, ream, size, and finishes for promptly filling orders.
2 develop a system of routing controlled by a central planning department that will
   - insure orders being filled in the proper sequence
   - designate the required material for every order
   - eliminate wasted time of men and machines by always having a definite job ahead of each operator and each machine
   - move materials promptly from one operation to another with a minimum amount of confusion and delay.
3 make scientific job analysis of every operation to establish standards of materials and practice with an increased output, and yet no undue exertion; and fix rates and bonuses based on these scientific studies that will permit of a largely increased wage to the worker and decreased cost of production.
4 develop the personnel of the whole organization—management and employees—to a point that will insure a large measure of coöperation by functionalizing duties, by training, by assuming responsibilities, by recognizing merit, and by encouraging any expression of thought which will facilitate the work in any way whatever.

CONTROL THROUGH THE PLANNING DEPARTMENT

The Planning Department, centrally located in the Finishing Department Building, now controls in complete detail the progress of each order through the mill. The advantages gained over the old method are manifold and obvious

a It has placed in the hands of the two men who are responsible for the filling of all orders—the Production Man of the Making Department (formerly Assistant Superintendent) and the Production Man of the Finishing Department (formerly Boss Finisher)—absolute control of the sequence in which they shall be run. They decide *when* the work is to be done, the one, when the paper is to be made, and the other, when it is to go through the finishing department.
b It affords these production men precise information as to the exact status of any order in the mill at any time without leaving the room.
c Each clerk in the planning department has some definitely specified duty to perform and detailed instructions as to just how to do it. There is thus a trained corps of men and women, each an expert on his own job, who are employed in planning in advance the details of each step of the foreman or of the workman himself after the job has been started.
d The condition of each department and of every machine or worker in that department as regards supply of work is shown by the planning department control board, and permits the shifting of employees from one department to another, in order to prevent congestion of work or lost time on machines.
e It is impossible for anyone to be out of work without the fact being known. In fact, conditions can be foreseen and provisions made to meet them.

FUNCTIONS OF PLANNING DEPARTMENT

The Planning Department performs the following functions

a receives all orders from the Sales Department and acknowledges them the day they are received with a promised date of shipment

[1] This applies to conditions before the recent increase in cost of raw materials.

[illegible] the sequence in which jobs are to be run

routes each individual order to the machines and work places at which the different operations are to be done, sometimes weeks ahead of the starting of the order

c makes out in advance the time tickets which will be given to the operators when they are assigned a job

keeps each machine and work place supplied with work

e directs and controls the moving of materials and orders from operation to operation

f transfers operators from one job to another so that every worker in the mill always has some defined task to work on.

PLANNING THE MAKING OF PAPER

The chief aims in routing the materials and planning the running of the different kinds of paper is to (1) produce uniformity of product, (2) reduce number of furnishes, (3) get the paper out on time, and (4) avoid changes on the machines by grouping orders. Careful planning of the runs avoids loss of time in shut downs, and also permits the arrangement of colors to avoid extensive washing up, so that whites can be runs consecutively, and when colors are run that the changes be made from dark to light instead of from light to dark; also changes in deckle width can be laid out to best advantage.

To accomplish these aims the production man of the making department accumulates the different orders, determines from his records, not merely by memory, the time required for each kind of paper, and plans out the dates when the various lots can be run to the best advantage, and from this order of work the production man prepares a schedule or running list for each of the three paper machines. The route sheets and "stores issues" are made, indicating the way each order is to be handled, and the material is to be used, and the individual time tickets are made out and posted.

ECONOMY AND QUALITY DUE TO UNIFORMITY IN BEATING

One of the fundamental processes of paper making is the treatment in the beating engines. The importance of uniformity in a process like this is little appreciated. The product must come up to a certain standard, and it is very necessary from the standpoint of cost, not merely that this standard be maintained, but also that material be not wasted by improper mixtures, and to provide for unnecessary variations.

STANDARDIZATION OF BEATING

The strength of the product resulting from the beating is dependent upon the length of time and manner of beating the fibers, which is controlled by the set of the beater roll. The variables which had to be considered and studied in the making of paper are

1 control of amount of bone dry stock put into beaters
2 control of density of stock, that is, percentage of water
3 development of proper method of beating for maximum strength, this being dependent upon set of beater roll at start and the varying of beater roll during the process of beating
4 development of proper methods of testing for
   a density
   b fiber length
   c fiber strength
   d slowness
   e set of beater roll
   f hand sheets
   g velocity of stock in beater
   h strength of each of the raw materials
5 determination of relation between proper method of beating and proper method of jordaning and of running on paper machine.

The investigations of these various conditions have been carried on so that at the present time it is possible to know what is going into each furnish, both as to percentages of raw materials and density, and to fix definite times of beating with certainty of uniform results in product. With the information already obtained it is now possible to continue the more intimate investigation with a view to even more definite control.

Through the investigations already made and the routing of the materials and labor, the saving in materials has reached a sum of several thousand dollars per month.

INCREASE IN OUTPUT OF PAPER MACHINES

During the period while the investigation was being made on the beaters it was found advisable to increase the output of the paper machines. This could be accomplished in three ways (1) by increasing the speed of the machines; (2) widening the sheet on the paper machine, or, as it is technically known, increasing the deckle width, and (3) reducing the number and length of shutdowns through better planning of the orders.

Investigation showed that the speeds of the machines for the same furnish at different times would vary as much as 50 per cent through variation in the condition of the stock and lack of uniformity. As a result of the studies definite speeds were established for each furnish and specified to the man on the machine with each order. It was found possible to increase the speeds materially over the average of the old speeds.

The output was further increased by increasing the deckle width of the paper from time to time. The number and length of the shutdowns were reduced through careful planning of the runs.

REDUCTION OF HOURS

The hours were reduced in the Finishing Department in January, 1916, from $55\frac{1}{2}$ to 50 per week. The bonus times were left the same and no piece rates were increased, so that the actual labor cost to the company was increased. However, a comparison of outputs in a single department indicated that the parties on piece work maintained the same production in the shorter day that they had been turning out in the longer day.

STANDARDIZATION IN THE SULPHITE PULP MILL

During the progress of the development in the paper mill, steps leading toward the standardization of methods in the sulphite pulp mill were in progress, and soon, as a result of the satisfaction with the bonus system in the paper mill, there was a demand on the part of the men for the introduction of bonuses in the pulp making.

The problem was of particular interest because, on account of the continuous process, the wood, after the preliminary treatment in the wood room, passed through to the finished pulp without handling. The output is chiefly controlled by the men handling the digesters which cook the chips. The results were accomplished by scientific studies of the different processes, which determined the standard methods to follow to produce the greatest uniformity. The cooks, for example, were given definite curves of temperature and pressure to follow, and

were given bonuses for keeping within the limits set. This resulted in a reduction in the time of cooking, a greater uniformity in product, and the development of initiative on the part of the workmen. A curve has been plotted giving a comparison of the cooking time before and after the establishment of standards, and shows how greater uniformity was obtained. As a result of this uniformity the time of cooking was reduced materially and the output largely increased.

CLASSIFICATION OF PAPER

In analyzing the affairs of any manufacturing establishment producing a great number and variety of articles, the lack of systematic classification of the product is evident. It frequently occurs that no list of the various items can be found, and that there are very imperfect records of the sales of each. This company makes a great variety of grades of paper in many different colors, sizes and weights, and it is necessary to standardize the names of the product before the product itself can be standardized. A mnemonic symbol system was devised and is now in general use. By means of the symbol which is composed of letters and figures, the grade, base weight, color, size and finish of any paper is clearly indicated.

As a result of the classification, it was found possible to reduce the number of grades and to clearly define the amount of stock to carry. With the aid, also, of the running inventory or balance sheets it is possible not merely to keep track of stock on hand but to know just when new stock in any grade should be made up.

PERSONNEL

Scientific management is essentially a system of development—development of methods, and a development of the individual. A man or woman must be trained in order to become an efficient and skilful worker and to demand and receive high wages. Furthermore, a personal development must be attained to give a broadening point of view, so that he may see and appreciate the values of sincerity and truth, health and right living, self respect and self expression.

To further these aims a Service Department was organized under the direction of a trained social worker. The functions of this department are to

a employ all help and to keep a set of employee's record cards

b maintain a library for free circulation of books

c maintain a dispensary for treatment and care of sick or injured

d operate a cafeteria at which wholesome food may be served to employees at cost

e inspect the factory and see that it is maintained at high standards as regards cleanliness, ventilation, sanitation, and safety

f hear all complaints of employees regarding wages, treatment or conditions: investigate every complaint and when necessary see that matters are adjusted so that justice is always done.

g hear all complaints of foremen and department heads regarding employees; investigate these thoroughly and concur in any discipline or discharge that may be administered

h coöperate with employees in furthering any suggestions offered in regard to activities of a recreative or social nature

i coöperate with all outside interests, municipal or private, that may have for their object the betterment of conditions in the community.

DISK-WHEEL STRESS DETERMINATION

By S. H. WEAVER,[1] SCHENECTADY, N. Y.

THIS paper describes and applies a simplified method for determining the centrifugal stresses in a disk wheel of given irregular shape of section. Stodola's disk theory is assumed, together with his formula for disks of hyperbolic-section profile. The formulæ are then transformed so as to give the tangential stresses at the inner and outer radii in terms of the radial stresses, ratio of radii and shape constant of disk section.

For a given disk with a single hyperbolic outline, the tangential stresses are expressed in terms of the radial stresses or loads; and if the latter are known, the stresses are determinate. In case the disk-section outline would require to be fitted by two hyperbolas meeting at the same thickness of disk, the wheel section can be divided at the meeting point of the curves into two imaginary rings. The rings at the meeting point, by the continuity of material and same thickness, are held together by a radial stress common to both and have the same elongation and tangential stress. One can then write the tangential stress of the other at their common radii, giving one equation with one unknown quantity, the radial stress common to both, and all stresses are determinate. Thus any irregular shaped disk can be fitted with n hyperbolas, divided into n imaginary rings, and $(n-1)$ equations written for the common meeting points of the curves with $(n-1)$ unknown radial stresses, and the stress problem is solvable.

The solution of the stresses is given by formulæ containing six coefficients whose values are given as functions of the ratio of radii and hyperbolic outline of disk section. These coefficients are laborious to calculate, but should be used for accurate results. For commercial work, approximate equations are given which cover the practical disk proportions, and within the limits shown have a range of error of less than one per cent.

As a further labor-saving device when a number of disks are to be estimated, the approximate equations can be placed in an alignment-chart form. An appendix gives the range and proportion of the five charts required, which experience has shown to be the most useful. The number and size of these charts for accurate reading do not permit of reproduction.

A practical example is given showing the actual application to the usual disk wheel.

Clinkers in Boiler Furnaces. During many years' experience in designing, testing, improving, and operating furnaces, used for many purposes, no branch of this subject has been found that requires more consideration than the troublesome formation of clinkers in the furnace and the formation and growth of clinkers on furnace linings. In a great majority of cases this trouble can be either greatly reduced or avoided, for clinkers are formed by the fusion of the ash and refuse from the combustion of the coal in the furnace.—*Elec. Wld.*, Feb. 10.

[1] General Electric Company.

For presentation at the Spring Meeting, Cincinnati, Ohio, May 21 to 24, 1917, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. On account of the mathematical nature of the paper its scope only is indicated here. Advance copies of the paper may be obtained by members gratis upon application.

AT the forthcoming Safety Session of the Spring Meeting, to be held under the auspices of the Society's Sub-Committee on Protection of Industrial Workers, will be presented and discussed a proposed code of safety standards for industrial ladders. This is one of a series of similar codes which the sub-committee has in preparation or in contemplation.

PROPOSED CODE OF SAFETY STANDARDS FOR INDUSTRIAL LADDERS

COMPILED BY THE SUB-COMMITTEE ON PROTECTION OF INDUSTRIAL WORKERS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The word "SHALL" where used is to be understood as mandatory and "SHOULD" as advisory.

DEFINITIONS

The term *Fixed Ladder* as used in these regulations means a ladder that is substantially fastened to a structure in a fixed position.

The term *Portable Ladder* as used in these regulations means a ladder with but one section, which is used transiently at various locations.

The term *Extension Ladder* as used in these regulations means a ladder consisting of two or more parallel sections traveling in guides or brackets so arranged that it may be adjusted to variable lengths.

The term *Portable Step Ladder* as used in these regulations means a ladder so constructed as to be self-supporting.

The term *Fire Ladder* as used in these regulations means a ladder used exclusively for fire purposes.

The term *Trolley Ladder* as used in these regulations means a ladder the movement of which is confined in permanent guides or ways at top or bottom, or both.

The term *Sectional Ladder* as used in these regulations means a ladder consisting of two or more sections so constructed that the sections will telescope into each other.

The term "*A*"-*Ladder* or *Scaffold Ladder* as used in these regulations means a ladder whose parts, each equivalent to a straight ladder, are hinged at the top to form equal angles with the base.

SECTION 1 GENERAL

a Where stairways are not provided, fixed ladders should be used for access to elevated positions; where fixed ladders are not suitable, portable ladders should be used.

b Ladders shall be numbered, or otherwise designated, and regular inspections shall be made of their condition.

c The use of broken or weak ladders, or ladders with missing rungs, is prohibited.

d When defects develop to such an extent that the ladder is to be permanently discarded, it shall be destroyed.

e Side rails, where wood is used, shall be straight-grained. Knots one-half (1/2) inch or less in diameter will be permitted when they are in the center of the rails. The following thoroughly seasoned woods should be used: Northern spruce, Oregon pine, Norway pine, yellow long-leaf pine, or Oregon fir.

f Rungs shall be inserted in holes in the side rails and kept from turning, and shall not exceed fourteen (14) inches in length at the top.

g Wooden rungs shall be straight-grained, free from splinters, and absolutely free from knots. The following woods should be used: White ash, white oak (3rd growth), or hickory.

h Steps, where wood is used, should be constructed of the following woods: Northern spruce, Oregon pine, Norway pine, or oak.

i Ladders shall have a uniform step or rung spacing of twelve (12) inches on centers. [Mason ladders having a uniform spacing on centers of ten (10) inches and fire ladders having a uniform spacing of fourteen (14) inches excepted.]

j Ladders shall be equipped with devices designed to prevent slipping. (Fixed ladders, portable step ladders, and "A"-ladders excepted.)

SECTION 2 FIXED LADDERS

Ladders designed to reach safety valves, cut-outs, etc., where speed of operation may mean a saving of life, should always be of a permanent type, securely fastened, and constructed of steel or iron.

a Ladders having side rails are preferred to the type made of U-shaped section embedded in wall or fastened to stack, etc.

b The pitch of ladders shall not be such that a man's position is necessarily below the ladder when climbing.

c Side rails, where metal is used, shall be not less than three-quarters (3/4) of a square inch in cross-section. A minimum size of two (2) inches by three-eighths (3/8) inch should be used. Where wood is used, they shall be not less than six (6) square inches in cross-section and shall be dressed on all sides. A section one and three-quarters (1 3/4) inches by three and three-quarters (3 3/4) inches (2 by 4 dressed) would be suitable for this purpose.

d Splice plates, where metal is used, shall be of the same size and material as side rails and shall be double-riveted or bolted. Bolts or rivets shall be countersunk on inside and shall be not less than one-half (1/2) inch nor more than five-eighths (5/8) inch in diameter, where cross-section does not exceed that of two (2) inches by three-eighths (3/8) inch. Where wood is used, there shall be splices on outside of side rails and joints shall be double-bolted. Carriage bolts shall be used. All splice pieces shall be chamfered at the ends.

e Rungs should be round. Where solid metal is used, they shall be not less than five-eighths (5/8) inch in diameter; where pipe is used, they shall be of equivalent strength; where wood is used, they shall not be less than one and one-half (1 1/2) inches in diameter and the tenon shall be at least one (1) inch in diameter or its equivalent in strength.

f Distances from front of rungs to nearest permanent object back of the ladder shall be not less than six and one-half (6 1/2) inches. There shall be a space clear of all obstructions in front of the ladder from bottom to top, of at least thirty (30) inches forward and of at least fifteen (15) inches either side of the center line of the ladder. [Ladders equipped with wells (cages) or their equivalent shall be excepted.]

g Ladders over thirty (30) feet in length should be pro-

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vided with wells, unless the ladder is built in zig-zag sections and provided with platforms between sections.

h Fastenings shall be made of material equivalent in strength to the rails. Fastenings shall be made to wall by building in, by through bolts, or by expansion bolts grouted or leaded. The maximum vertical distance between fastenings or braces shall not be in excess of ten (10) feet.

i Ladders to landing shall extend a distance of at least forty-five (45) inches above the landing, preferably being goosenecked. The rungs may be omitted above the roof. Where a man must step a greater distance than eighteen (18) inches from ladder to roof, tank, etc., a platform shall be provided.

SECTION 3 PORTABLE STRAIGHT LADDERS

a Ladders over thirty (30) feet in length should not be used.

b Side rails shall have a minimum cross-section equivalent in strength to a northern spruce side rail of the following dimensions:

Up to and including 10 ft.	$2\frac{3}{8}$ x $1\frac{3}{8}$ in.
Over 10 ft. up to and including 18 ft.	$2\frac{3}{4}$ x $1\frac{3}{8}$ in.
Over 18 ft. up to and including 26 ft.	3 x $1\frac{5}{8}$ in.
Over 26 ft. up to and including 30 ft.	$3\frac{1}{2}$ x $1\frac{7}{8}$ in.

c Side rails should be spread so that the width of the ladder at the bottom will be greater than the width at the top, preferably by a taper of one-quarter ($\frac{1}{4}$) inch per foot of length.

d Rungs shall be equivalent in strength and wear to an ash rung of the following dimensions:

	Diameter	Tenon
Up to and including 24 in. in length. .	$1\frac{1}{4}$ in.	$\frac{7}{8}$ in.
Over 24 in. up to and including 30 in. in length	$1\frac{3}{8}$ in.	$\frac{7}{8}$ in.

e Portable ladders should be fully protected at their bases to prevent slipping. For use on wood or earth the bases should be provided with case-hardened steel spurs; or a disk similar to the one furnished by the National Affiliated Safety Organizations, consisting of a case-hardened disk, held in position on dowel pins by springs, cotters and nuts, is recommended. These spurs shall be kept sharp. On concrete floors, pivoted shoes with lead or carborundum faces may be used.

f When used on iron floors an attendant should be placed at the foot of each ladder.

g Whenever possible to use ladders with a gooseneck or hook at the top, these should be provided, as forming the best protection against accident.

SECTION 4 EXTENSION LADDERS

a Table 1 should be followed in the construction of extension ladders.

b Ladders should be equipped with safety locks.

SECTION 5 FIRE LADDERS

a The construction, use and maintenance of industrial fire ladders shall conform to the specifications herein set forth covering portable straight ladders (Section 3, Par. *a* excepted).

b A uniform step or rung spacing of fourteen (14) inches shall be used.

c Fire ladders should be painted red and shall be plainly marked "For Fire Purposes Only."

d Fire ladders shall not be used for any other purpose than that for which they are intended.

SECTION 6 PORTABLE STEP LADDERS

a Ladders over twenty (20) feet in length shall not be used.

b Side rails shall have a minimum cross-section equivalent in strength and wear to a northern spruce side rail of the following dimensions:

Up to and including 12 ft.	$\frac{7}{8}$ x 3 in.
Over 12 ft. up to and including 16 ft.	1 x $3\frac{1}{2}$ in.
Over 16 ft. up to and including 20 ft.	1 x 4 in.

c Front and back rails shall be so spread when the ladder is open that the spread at the bottom, inside to inside, shall be greater than the spread at the top, inside to inside, by an amount equal to or greater than one and one-half ($1\frac{1}{2}$) inches per foot of length of ladder. Minimum width between side rails at the top step, inside to inside, shall be not less than twelve (12) inches, with a taper of at least one (1) inch per foot of length of ladder.

d Steps shall be equivalent in strength and wear to a northern spruce step of the following dimensions:

Up to and including 12 ft.	$\frac{3}{4}$ x $4\frac{1}{2}$ in.
Over 12 ft. up to and including 16 ft.	$\frac{7}{8}$ x $4\frac{1}{4}$ in.
Over 16 ft. up to and including 20 ft.	1 x $4\frac{1}{2}$ in.

e Steps shall be trussed and screwed or bolted to the side rails. Nails shall not be used as sole fastenings.

f An automatic locking device to hold the front and back rails securely in position shall be an integral part of each ladder.

TABLE 1 CONSTRUCTION OF EXTENSION LADDERS

SIDE RAILS:
Up to and including 44 ft. long: Material, Norway pine, clear and straight-grained, free from knots.
48 ft. to 60 ft. long: Material, Oregon fir, clear and straight-grained, free from knots.

RUNGS:
Material: Oak, ash or hickory, straight-grained, free from knots, and [illegible] and tough.
Dimensions: $1\frac{1}{4}$ in. diameter at center; taper to $1\frac{1}{8}$ in. diameter, straight-turn to $\frac{7}{8}$ in. diameter for holes in side rail.

LADDER DIMENSIONS

Length, ft.	Dimensions of side rails (cross-section same at both ends), in.	Distance between side rails, top section, in.	Distance between side rails, bottom section, in.	Vertical distance between rungs, in.
20, 22, 24, 26	$2\frac{3}{4}$ x $1\frac{1}{8}$	$12\frac{1}{4}$	$14\frac{3}{4}$	12
28	$2\frac{3}{4}$ x $1\frac{1}{4}$	$14\frac{1}{4}$	17	12
32, 36	$2\frac{3}{4}$ x $1\frac{3}{8}$	14	17	12
40	$3\frac{1}{4}$ x $1\frac{3}{8}$	$15\frac{3}{4}$	$18\frac{3}{4}$	12
44	$3\frac{1}{4}$ x $1\frac{5}{8}$	$17\frac{3}{4}$	$20\frac{3}{4}$	12
48, 52	$3\frac{1}{2}$ x $1\frac{1}{2}$	$17\frac{1}{2}$	$20\frac{3}{4}$	12
60	$3\frac{3}{4}$ x $1\frac{3}{4}$	18	$21\frac{3}{4}$	12

SECTION 7 "A" LADDERS OR SCAFFOLD LADDERS

a Ladders over twenty (20) feet in length should not be used.

b Side rails shall have a minimum cross-section equivalent in strength and wear to a northern spruce rail of the following dimensions:

Up to and including 12 ft.	$1\frac{1}{4}$ x $2\frac{3}{4}$ in.
Over 12 ft. up to and including 16 ft.	$1\frac{1}{2}$ x 3 in.
Over 16 ft. up to and including 20 ft.	$1\frac{1}{2}$ x $3\frac{1}{2}$ in.

c Side rails shall be so spread that the width of the ladder at the bottom, inside to inside, shall be greater than the width at the top, inside to inside, by an amount equal to or greater than one and one-half ($1\frac{1}{2}$) inches per foot of length of ladder.

d Supports shall be equivalent in strength and wear to an ash bearing one (1) inch by two (2) inches. They shall be straight-grained and absolutely free from knots, shall have tenons not less than five-eighths ($\frac{5}{8}$) of an inch by two (2) inches, secured in place with wire nails. They shall be not less than three (3) inches from the top of the side rails. They shall be eighteen (18) inches on centers, and shall be staggered. The tops of side rails shall be cut on a bevel to prevent them from spreading. Hinges shall be wrought or malleable iron, bolted or riveted to side rails.

SECTION 8 TROLLEY LADDERS

a Ladders shall be suspended from tracks fastened securely to the ceiling or to the framework with which the ladders are connected. Tracks should be of wrought iron or wood, and should be tested to double the maximum of load for marginal safety. Tracks shall be constructed so that it is impossible for the wheels to jump the track, by having the wheels in pairs situated on opposite sides of a vertical flange or by having the track so shaped that it completely encloses the sides of the wheels. The extreme front and back wheels shall have a horizontal distance of at least eighteen (18) inches between their centers.

b The track wheels shall be rigidly fastened to the top of the ladder with suitable steel or wrought-iron brackets. These brackets may be fastened to a bolt connecting the two side rails of the ladder or to the top step. In the latter case the top step shall be provided with extra metal braces to the side rails.

c Side rails shall have a minimum spread, inside to inside, of ten (10) inches.

d Side rails shall have a minimum cross-section equivalent in strength and wear to a northern spruce side rail three and one-half ($3\frac{1}{2}$) inches by seven-eighths ($\frac{7}{8}$) inch.

e Steps shall be equivalent in strength and wear to a northern spruce step four and three-quarters ($4\frac{3}{4}$) inches by three-quarters ($\frac{3}{4}$) inch.

f Steps, where metal is used, shall be flanged downward not less than two (2) inches at both ends and secured by two bolts or rivets to each side rail. Where wood is used, they shall be inset in the side rails one-quarter ($\frac{1}{4}$) inch, glued and nailed; all, or at least alternate steps, shall be braced to the side rails with metal brackets placed under the steps.

g The base of the ladder shall rest on two wheels or castors.

SECTION 9 SECTIONAL LADDERS

a The bottom section shall be six (6) feet in length and shall have a minimum spread between rails at the base, inside to inside, of twenty-one (21) inches.

b Sections (intermediates) shall be six (6) feet in length and shall have a minimum spread between rails at the bottom, inside to inside, of thirteen (13) inches.

c The top section may converge with a minimum spread between rails at the bottom, inside to inside, of thirteen (13) inches.

d Side rails shall have a minimum cross-section equivalent in strength and wear to a northern spruce side rail of the following dimensions:

Up to and including 5 sections	$2\frac{3}{4}$ x $1\frac{1}{8}$ in.
Over 5 sections	$3\frac{1}{8}$ x $1\frac{1}{8}$ in.

e Rungs shall be equivalent in strength and wear to an ash rung one and three-sixteenths ($1\frac{3}{16}$) inches in diameter with seven-eighths ($\frac{7}{8}$) inch tenon.

SAFE PRACTICES

Use care in placing portable ladders before using them. If there is danger of ladder's slipping, have some one hold it. Do not place ladders too straight or at too great an angle, or they may fall, break or slip.

Never place ladders in front of doors opening toward the ladder.

Ladders should never be placed against window sashes. Screw a board across top of ladder to give bearing at each side of window.

Step ladders should be fully opened and locked in all cases before any one steps on them.

Always face ladder when ascending or descending.

Do not go up or down a ladder without free use of both hands. If material has to be handled, use a rope.

Never slide down a ladder.

Never use broken or weak ladders or ladders with missing rungs.

When defects of construction develop to such an extent that the ladder is discarded, it should be destroyed.

Ladders withdrawn from service for repairs should be sent to the repair shop or tagged as "Dangerous—DO NOT USE."

See that ladders you use have safety feet, and, where necessary, safety hooks at top.

Short ladders should not be spliced together, as they are not strong enough to be used as long ladders.

Safe practice demands that ladders be numbered, classified, and subjected to careful and periodic inspection. Ladders should be kept clean and free from dirt or splashings of paint or material. Imperfections or defects are not readily observed unless ladders are kept in good condition.

Iron and steel ladders should be coated with a preservative paint or composition. Wooden ladders, if used out of doors, should also be carefully treated with a suitable preservative.

A satisfactory practice is the storing of ladders upon brackets by arranging them against wall in such manner as to permit inspection without moving ladders.

Storage of ladders involves a separate problem. Shelter should be provided in all cases. If placed upright, 75 degrees will afford a safe angle; if racks are used, place the ladder on edge rather than flat; this will prevent trouble and danger of accident in withdrawing the ladder for use.

Safety bolts and hooks should be provided when the character of the work demands the attention of the workman or constitutes an element of danger.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

Reply to Comments on Welding Paper

To the Editor:

In reply to the several persons who entered into the discussion of my paper on welding by the metal-pencil electric-arc method, printed in the April issue of The Journal, I do not think that the term *autogenous* applies to this particular form of welding, because it so closely follows the cycle of conditions of ordinary forge welding, whereas in autogenous welding, fluidity is a necessary condition. The pencil form is the last form developed and ought to be differently named, since it actually is in the added metal the lowest-temperature weld of the newer forms.

In reply to Mr. McCabe, the temperatures in question are estimated from the color. In the metal-pencil electric-arc welding, watched through colored glasses, just the same putty-like condition occurs as in the ordinary forge welding. The estimate may be either above or below the actual temperature; it is used, more than for any other reason, to direct notice to the fact that fluidity is not a condition present in this last-developed form of spot welding, except that known as the Quasi Arc.

As to the elimination of the possible stresses set up in the weld, the figures as quoted by Mr. McCabe cannot apply to this form of welding. In this case the area is very much less, and being free from the highly expanded condition of fluidity (in many cases almost reaching vaporization), the differential for each degree of temperature is different and the internal stress less. However, no attempt is made to eliminate internal stresses, nor is this necessary, because these stresses are at a maximum only when new, and are constantly changing as time elapses. This is true of any of the later forms of welding wherein the bulk of the work is always cold and the part worked on made hot. The point to recognize here, and this is fairly well explained in my paper, is that in this form of welding these internal stresses are the least of any and consequently more readily and sooner neutralized. With this consideration, therefore, no differential per degree of temperature can be used.

The determining of the safety of a vessel by the electrostatic test is new to me. What I am familiar with is the hydrostatic test, and this is perfectly trustworthy when accompanied by hammering while the test is on, the test being applied to the customary amount, that is, one-half more than the running pressure under which the vessel is to work.

It is to be expected that the welding material would vary widely in any form of welding except the approved form of welding, which may vary some, but not widely, and except the form that my paper defends, and Mr. McCabe is justified in his conclusion regarding this, but I would suggest that the metal-pencil form of electric-arc welding should not be made to carry the burden of the failures of autogenous welding generally, since this form places the art on a newer and entirely different and safer basis.

In reply to Mr. Bierbaum, the disturbance of the adjacent metal is dwelt upon in my paper and was shown in the lantern slides used at its presentation, and these ought to be a conclusive answer. It is true that in all other forms of welding wherein fluidity is resorted to, the disturbance is considerable, and one slide used by Mr. Armstrong in further discussion of my paper shows the adjacent metal practically destroyed. I wish to dwell strongly on the fact that in this metal-pencil electric-arc method no such condition exists, and the adjacent metal is not disturbed to a fraction of the extent of that which takes place in gas and carbon-arc welding and in the approved form of welding embodied in the A.S.M.E. Boiler Code and entitled Forge Welding, and this is due to the extremely localized character of the process and also its great rapidity of action,—it does not have time enough to overheat so as to create the disturbance referred to.

In reply to Mr. Armstrong, his discussion practically embodies a paper in itself and describes a further improvement in this particular form of welding, viz: the metal-pencil electric arc, but wherein fluidity obtains as a condition; but this occurs to a degree beyond which it does not go and is controllable to a nicety, approaching as is described in my paper an automatic action, which can be depended upon to prevent vaporization or any carelessness regarding overheating exactly in the way I have described, and altogether analogous thereto. In analyzing this extended discussion, however, in his references to the chemistry of these welds Mr. Armstrong refers to the oxidizing which occurs around the crater when the metal pencil is fused. Now to obtain fusion a high voltage must be used with electrodes of this character, and the arc maintained abnormally long. In his slides this is shown, and he states "about 1/8 in." as the length of such arc, but it is safe to say that it must be more since the slides themselves show dimensions as practically full size, as in Fig. 3 and Fig. 4, page 315 of the April issue of The Journal.

While these metal arcs require more voltage than the arcs obtained otherwise, the voltages used with the pencil arcs are normally low, from 60 to 70, and with such voltages an arc cannot be held with a wire in size equal to 0.161 in. diameter or No. 8 B.W.G. more than about 1/16 in. Therefore, fusion under such conditions cannot take place, and the piece of plastic putty-like metal flies for the plate, being constantly pulled into it, and consequently does not have time to become fused and the oxide does not amount to enough to deserve any considerable attention. However, the little that is present in what Mr. Armstrong terms the *bare wire* is almost entirely absent in the slag-covered wire, and though a predetermined limited amount of fusion occurs, the deposited metal shown in the slides shows a remarkable similarity to the metal of the plate it joins. These slides also show the least disturbance of the adjacent metal and the added metal is as he says, "just the same as ingot steel." Taking his discussion in a general way, it is a strong vindication of the supremacy of the metal-pencil electric-arc method of welding, showing a remarkable and highly efficient improvement in the art.

Mr. Armstrong introduces for the first time the question of

[illegible] been corroded with [illegible] consider [illegible] upon it. In this regard I wish to say, however, [illegible] many pieces of torch welding wherein no corrosion has yet appeared. Iron and [illegible] are in evidence, such, [illegible] instances in plants, where there are innumerable things [illegible] occurrence, pieces wherein this claim is absolutely absent. Test pieces which I have furnished the Society and which have now been in their possession about a year, welded with the electric method, show absolutely no indication of corrosion. However, I claim that in the several other methods of welding referred to in this discussion, wherein fluidity takes place, disturbances are set up which produce conditions where the question of corrosion may be a consideration, but not under the form of welding in my paper, nor is it present in the perfected form of welding which Mr. Armstrong advocates, nor in the approved form of welding in the A.S.M.E. Boiler Code.

In reply to Mr. Mauck if he means that the metals "in all processes of welding" have to be raised to the point of fusion and no more, that is, just a plastic condition, then his discussion is not a criticism of the metal-pencil electric-arc welding, since that is just what takes place therein.

If there are no leaks when a moderate hydrostatic test to $1\frac{1}{2}$ times is applied, it shows that there are no porous or spongy places,—that the joint is solid. Then why a higher test? I do not think it necessary or advisable to carry the testing pressure to extremes and so unduly strain the vessel.

In conclusion, let me say that with the knowledge we have in our possession, derived from much investigation, many experiments and tests, all reduced to tables and curves, we now know just the right voltage to use, just how much current to have, just what are the right size pencils, together with proper direction of current, and the knowledge also which enables us to utilize other factors such as magnetism, slag protection and purifying agents. The process now contains nothing haphazard or problematical: it has been reduced to an exact science, and, therefore, belongs in the list of things that have become considered as settled.

E. A. WILDT.

Scranton, Pa.

WORK OF THE BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

Below are given the interpretations of the Committee as approved by the Council on April 20, 1917, in Cases No. 136 to 139, 141, 142, 144 and 145. In this report, as previously, the names of inquirers have been omitted.

CASE No. 136

Inquiry: Is it the intent that no pressure shall again be allowed on a boiler on which a crack has been discovered in a longitudinal seam, and that the boiler cannot be patched and again used, or may such a boiler be again put in commission after being patched and after passing a prescribed test?

Reply: It is the intent of Par. 384 to permanently discontinue the use of the shell or drum of a boiler, for steam boiler purposes, should a longitudinal joint crack be discovered in any plate or course of the shell or drum.

CASE No. 137

Inquiry: Is it permissible under Part 1, Section 2 of the Boiler Code, to use a smaller size of safety valve than is there specified, where a heating boiler is operated on the vapor system with open vents to the atmosphere?

Reply: It is not expedient to modify or amend the Code in the nature you request. Par. 348 and 358 cover your case, and refer to the boiler and not to the system.

CASE No. 138

Inquiry: Is it permissible in a superheater constructed with steel return bend headers to electrically weld the tubes into the headers?

Reply: Autogenous welding of superheater tubes to headers is not permissible under the Boiler Code if the strength of the weld be depended upon to resist the pressure tending to drive the tube out of the header. It is permitted for the sake of the tightness, but the strength of the weld at the joint must not be taken into account.

CASE No. 139

Inquiry: Is it possible to secure a smaller A.S.M.E. Boiler Stamp than the present $\frac{3}{4}$ in. stamp that is furnished to meet the requirements of Par. 332 of the Boiler Code? It is difficult to stamp thin plates with the present $\frac{3}{4}$ in. stamp on account of the rebound.

Reply: A new stamp will be provided, $\frac{1}{2}$ in. size, hammer type, and with the top end square, so that it can be either used as a hammer stamp or struck with a sledge.

CASE No. 141

Inquiry: Is there any objection to drilling and tapping holes in the shell of a boiler if they are properly reinforced?

Reply: It is the opinion of the Boiler Code Committee that there are no objections to drilling and tapping holes in the shell of a boiler if the same are properly reinforced according to the Code.

CASE No. 142

Inquiry: In a design of horizontal return tubular boiler, with a manhole located in the front head below the tubes, is it permissible under Par. 218 to insert tubes on either side of the manhole instead of through stays?

Reply: Tubes on each side of a manhole cannot be used in place of the through stays specified in the last sentence of Par. 218.

CASE No. 144

Inquiry: What are the requirements for the design of reinforcing liners for the inside of the cylindrical shell of a boiler?

Reply: Where reinforcement is necessary for openings which are not intended for pipe threads, the requirements of Par. 261 of the Boiler Code are to be followed.

CASE No. 145

Inquiry: Is it not better practice under Par. 316 of the Boiler Code to discharge feed water in the waterleg of a vertical firetube boiler about half way between the mud ring and the bottom head, than to discharge it against the tubes midway between the bottom head and the lowest water level?

Reply: It is the opinion of the Boiler Code Committee that Par. 316 does not permit of discharging the feed water in the waterleg of a vertical firetube boiler.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

THE officers of the Society are trying to make every member feel that this is a national society of the engineering profession. President Jacobus, last year, and President Hollis, this year, have made great sacrifices of their time and energy in order to visit the Sections, and I have supplemented their trips and have just returned from as far west as Oklahoma City.

The first place I visited was Cincinnati, where I met the Local Committee, who are arranging for the Spring Meeting. If they carry out the program they have planned, the Meeting will be the most complete I have known of, not only of this Society but of any other.

From Cincinnati, I went to Chicago to attend a conference on Engineering Coöperation, called by Dr. F. H. Newell, Mem.Am.Soc.M.E. An account of this conference appears elsewhere in this issue of The Journal. As I have lived a number of years in the West, I appreciate the point of view of a man who lives away from the headquarters of the national societies.

The theory on which these organizations, of which there is a large number, representative of the smaller societies as well as the larger societies, have gotten together, is that the engineering profession owes a duty to society and ought to take a part in public affairs, and the members of these organizations are correspondingly dissatisfied with the attitude of the National Engineering Societies in what they regard as an ultra-conservative policy.

Is it a proper ambition for an engineering society to aspire to such a position with relation to civic affairs that engineering matters coming up in the administration of communities be referred to the society? If so, how can it be fulfilled? This is a broad question which should be thought about carefully. Should engineering societies take a part in public affairs? What part should they have in public affairs?

Our Council is laboring with this problem sincerely, and is trying to strike the happy medium between avoiding taking sides on political and economic questions and giving engineering advice on matters which we do know about.

From Chicago, I went to Madison to the Student Branch there. We have forty-four Student Branches in the Universities and are getting the young men interested in engineering societies. They have their own societies and presiding officers. They have outside lecturers and papers presented by their own members. They learn how to speak in public before their mates. We are supplying, through the activities of the engineering societies, a feature which is not supplied by the majority of colleges in their regular curricula.

From Madison I went to Milwaukee, where we had a splendid meeting with members of the local committee of the Milwaukee Engineering Society, which is the nucleus about which the locals of the national engineering societies there gather. Then I returned to Chicago, where I met the Chicago local committee.

I then went to the Student Branch of the State College of Iowa and to the University of Kansas Student Branch, where they had an Annual Meeting which lasted all day, all arranged for by the students themselves and being addressed by outside lecturers. From there I went to the University of Oklahoma, just outside Oklahoma City, and in one of the coming states of the United States.

Just before I left New York on this journey, the Military Engineering Committee wrote to the presidents of each of the National Engineering Societies, suggesting that the ex

FELLOW MEMBERS

It is not necessary to call the attention of the Society to the unprecedented crisis before this country, because we all, as American citizens, know well that our country has embarked upon an undertaking fateful to the freedom of the individual.

The word "Democracy" does not express fully all that would be in store for us if we, as a nation, failed to do our duty by humanity, and by our country. Happily every member of our Society can assume that every other member is eager to make his contribution. I have been struck with that in the great amount of correspondence I have had during the past month, always asking the question, "How can I serve my country?"

The Society as a whole is doing all it can to coöperate effectively with the National Research Council, with the Council of National Defense, and with the War and Navy Departments, in the appointment of representatives to assist and coördinate the work of all engineering societies. Two of our members were selected for the National Research Council, two for the Council of National Defense, two for work with an Army Board on guns, and doubtless others will come forward, or be brought forward as the exigency arises.

As good citizens we should truly awake to the necessity of a well-trained army. We, as engineers, can help in this, not only by offering ourselves to the War Department and to the Navy Department, but also by assisting unselfishly in the industries, and in the promotion of increased farm production.

In our democracy we can best raise an army by sharing alike in its hardships, not trusting that the noblest and best of our young men will come forward to enlist for service, but putting the responsibility on all alike through some kind of universal service.

I have no permission to speak for the whole Society, but as its President, I urge every member to search his own conscience seriously for some method by which he can serve. The country depends upon us and we must respond.

IRA N. HOLLIS

[illegible] Committee be reconstructed and authorized to get out a complete set of instructions as to what a man should do who wished to serve his country. The Committee is now [illegible] the Joint Committee on National Defense and has, during the past month, prepared two circulars to send out to the membership with instructions as to how to join the Army and the Navy. We will send these out shortly.

A number of our members have responded to the call for national service, as the "Roll of Honor" published this month shows. This list will be supplemented from month to month by the names of members as they are enlisted. This first list [illegible] the particulars of commissions received by members in the Engineer Officers' Reserve Corps, the War Department having at this date issued a list of accepted commissions to March 15 only. Members who have accepted commissions in the Corps subsequently to this date, and any other members entitled to have their names inserted in the Roll of Honor, should notify me immediately.

The National Research Council has solicited the nomination of two of our members for their Engineering Committee and the Council of National Defense has advised us that they similarly will request us to nominate members for their Engineering Committee.

Calvin W. Rice,
Secretary.

Council Notes[1]

At the meeting of the Council on March 16 the following members were present: Ira N. Hollis, *President*, John H. Barr, C. H. Benjamin, R. H. Fernald, Arthur M. Greene, Jr., W. B. Gregory, F. R. Hutton, W. B. Jackson, D. S. Jacobus, C. T. Main, H. de B. Parsons, John A. Stevens, Wm. H. Wiley, *Treasurer*, and Calvin W. Rice, *Secretary*.

A.S.M.E. Boiler Code. The Chairman of the Committee proposed changes in the Code, together with interpretations in cases Nos. 140 and 143, which were approved and ordered published in The Journal. They appeared in the April issue.

Engineering Coöperation Conference. Paul P. Bird, H. C. Gardner, and Calvin W. Rice were appointed to represent the Society at a conference on Engineering Coöperation to be held in Chicago, March 28 and 29.

Military Engineering Committee. It was voted that the Committee on Engineer Officers' Reserve Corps of The American Society of Mechanical Engineers, which is part of a joint committee, coöperate with the other engineering societies and the United States Government, so that there will be one central committee of the engineering profession which shall assist the Government, and that the committee has power to select a suitable name, also to add to its membership, and that The American Society of Mechanical Engineers will be willing to assume its proportionate share of the expenses of a comprehensive work of advancing the preparedness for national defense.

Standardization Committee. C. F. Hirshfeld was appointed on this committee in place of H. G. Stott, deceased.

Student Branches. A student branch at the University of Oklahoma, Norma, Oklahoma, was approved.

Calvin W. Rice
Secretary.

On page 370 of the April issue of The Journal it was stated that the price of the book on The John Fritz Medal is $4.00. This is erroneous. The price is $2.50.

[1] The April Journal went to press before the March Meeting.

Past Presidents' Return from the Orient

Dr. Brashear, Mr. Swasey and Mr. Freeman have returned safely from their extended tour of the Orient, and were entertained at luncheon at the Engineers' Club of San Francisco on April 3. Vice-President Dickie has sent us a first-hand account of the reception, which is well worth reproduction in full:

It was no ordinary occurrence that brought out one hundred and seventeen of the best-known engineers of San Francisco on Tuesday April 3 to luncheon at the Engineers' Club. It is not often possible to have as guests at one time, three ex-presidents of one of the national societies, but fortune favored the engineers who practice their profession in the city of the Golden Gate. For in through that Western Gateway there floated three wise men from the Far East, such men as the engineer, be he civil, electrical, or mechanical, delights to honor—Dr. Brashear, Mr. Swasey, and Mr. Freeman.

Mr. C. T. Hutchinson, president of the club, and Mr. Shreve, chairman of the entertainment committee, secured the three noted engineers, who were seeking rest rather than excitement, and brought them to the club rooms, where they were received with manifest tokens of good will and respect and at 12.30 all proceeded to the dining room. Mr. Dickie acted as chairman, and after luncheon, with a few remarks appropriate to the occasion, introduced first Dr. Brashear who, in a beautiful address, carried these hard-working sober engineers up with him on angels' wings so that they might gaze for a while on the very heaven of heavens, and feel what engineers seldom feel—the bliss of wings and the glorious vision of distances that can only be measured in terms of light years. But after a hearty luncheon neither the doctor nor his audience could stay long up where he had drawn them, so gradually he let them down and talked awhile about the common things of the engineer's checkered career. This fifteen-minute address was a gem and will be long remembered by those who had the privilege to hear it.

The chairman then called upon Mr. Swasey for a few words, which resulted in a very helpful address on the growing importance of the engineer in the work of the world. Mr. Swasey said that while this old, selfish world was rather slow in acknowledging its great debt to the engineer, it has at last found out that it cannot even fight to any purpose without the engineer—and so he encouraged the young engineers before him, with the thought that their profession was a militant one, and that the future would become brighter for the engineer as the years rolled by.

Mr. Freeman spoke on the outlook of the Panama Canal, giving his experience as a member of the commission appointed by the President to investigate the effect of the landslides on the security of the canal as a reliable passage for shipping between the two oceans. Mr. Freeman, in a lucid address, cleared away any doubts that might be in the minds of his hearers, and what he said will always be referred to when the subject is under discussion.

The meeting with these three typical men in our profession will not soon be forgotten by those, especially the younger members, who had the rare opportunity to hear them; and it should also be noted that Dr. Brashear, Mr. Swasey and Mr. Freeman expressed their delight in having the opportunity to meet so many of the engineers of San Francisco.

If the student of engineering gets his training in the English classroom only, it is, at best, artificial: at worst, only speaking pieces. For training of this sort there is opportunity (and it is being taken advantage of) in engineering "topics" classes; but the best place is in the engineering society. If this is a student organization with faculty assistance and if students who really know something of some particular engineering problem and practising engineers make up the program, in the discussion of which all take part, such a society can accomplish more in training students to speak effectively than an unaided English teacher ever could.—*Engineering Education*, February 1917.

THE ENGINEERING SOCIETIES IN NATIONAL DEFENSE

THE JOURNAL takes great satisfaction in announcing the active participation in national affairs by members of the Society as fully set forth in the Society Affairs and Engineering Survey sections of this number.

The Society has been honored by the election of Prof. W. F. Durand, former president of the International Engineering Congress, to the National Academy of Sciences. This is in keeping with the announcement last year of the intention of the Academy to create a division of engineering coördinate with other divisions of the Academy, and from time to time to elect engineers to membership.

Mr. John R. Freeman has been elected a member-at-large of the National Research Council of the Academy of Sciences. Mr. Freeman, and Dr. W. F. M. Goss, already a member of the Research Council, have been designated as the Society's representatives on that body.

At the meeting of our Council on April 20, President Hollis reported that he and Dr. D. S. Jacobus had been selected by the Secretary of War as representatives of the Society on a special engineers' commission to serve with officers of the Army and Navy in determining gun mounts.

The following nominations were also made in response to invitations received from the National Research Council and the Advisory Committee of the Council of National Defense:

For membership on the Engineering Committee of the National Research Council, of which committee Mr. Gano Dunn, Mem.Am.Soc.M.E., is chairman, Prof. W. F. Durand and Charles D. Young.

For appointment on an Engineering Societies' Section of the commission of the Advisory Commission of which Dr. Hollis Godfrey, Mem.Am.Soc.M.E., is chairman, Dr. Ira N. Hollis and Calvin W. Rice.

In response to the request of the Director of the Bureau of Mines, the Council has nominated its Research Committee as a special advisory committee to the Bureau, and has also authorized the President to appoint two sub-committees, one on fuels and another on mine equipment. Prof. O. P. Hood, Mem.Am.Soc.M.E., and mechanical engineer at the laboratories in Pittsburgh, has been designated by Director Manning as secretary of the advisory committee of the engineering societies to the Bureau.

Mr. Frank A. Scott, vice-president and treasurer of The Warner and Swasey Company, has been appointed head of the General Munitions Board, as is noted in the Engineering Survey Section in this issue. Mr. Scott's appointment is one of the evidences of the helpfulness of the Society in the present crisis.

At the request of THE JOURNAL, the following letter has been prepared by Mr. Dunn, in which is clearly explained the relations of the engineering societies to the various agencies of national defense.

Letter from Mr. Gano Dunn, Chairman Engineering Committee, National Research Council

TO THE EDITOR:

The engineering profession, which has been so prompt to volunteer its professional and military services to the Government in support of national defense, is now in contact with the various government agencies, as follows:

First, through the Naval Consulting Board and its formerly existing Committee on Industrial Preparedness, with the origin and organization of which board the engineering profession is already familiar. Each of the national engineering societies, and certain other societies, by contributing two members to the Naval Consulting Board, has afforded the Navy and War Departments and the Council of National Defense a highly expert board for passing upon inventions and developing them in the new Government Laboratory that has been organized.

ENGINEERS' RESERVE CORPS

Second, in a more or less informal way, through the joint Committee on Engineers' Reserve Corps and the Military Engineering Committee of New York, the military services of engineers are being organized and offered to the Government, and an Engineers' Regiment is recruiting in New York.

The constitutions of the national engineering societies were found to contain such limitations that these societies could not take formal action in military matters. A little over a year ago the Military Engineering Committee organized itself through the spontaneous action of a group of leading engineers, including a number of presidents, past-presidents and other prominent officers of the national engineering societies, to an extent that gave the committee a character representative of those societies, although this character has only recently been confirmed by the action of the societies themselves.

NATIONAL RESEARCH COUNCIL

Third, through the National Research Council, created at the request of President Wilson by the National Academy of Sciences, "to bring into coöperation existing governmental, educational, industrial, and other scientific and research organizations, with the purpose of encouraging investigations of natural phenomena, the increased use of scientific research in the development of American industries, the employment of scientific methods in strengthening the national defense, and such other applications of science as will promote the national security and welfare."

The work of the National Research Council, the offices of which adjoin the offices of the Council of National Defense, is carried on through the agency of central committees covering each of the physical sciences and chemistry, mathematics, medicine, hygiene, agriculture and other subjects, including a Committee on Engineering. To this Committee on Engineering, each of the national engineering societies has contributed two representatives, and stands ready to contribute others as called for. With the engineers who are members of the National Research Council, these constitute the Engineering Committee.

The representatives so far named from the American Society of Civil Engineers are George F. Swain, Edgar C. Marburg and Clemens Herschel; from the American Institute of Mining Engineers, Pope Yeatman, Albert Sauveur, Charles F. Rand and George K. Burgess; from The American Society of Mechanical Engineers, W. F. M. Goss, John R. Freeman, C. D. Young, Wm. F. Durand, John A. Brashear, Hollis Godfrey, Howard E. Coffin and Ambrose Swasey; from the American Institute of Electrical Engineers, Frank B. Jewett, Clayton H. Sharp, Gano

[illegible] J. Skinner, Michael I. Pupin, [illegible] W. Stratton, Elihu [illegible] and John J. Carty from the American Institute of [illegible] Engineers, Lewis B. Stillwell.

The Engineering Committee, under formal request of the Council of National Defense, in a resolution dated February [illegible] 1917, addressed to the National Research Council, brings [illegible] the Council of National Defense, directly through [illegible] services of engineers in the realm [illegible] research, and it constitutes the connection between the Council of National Defense and the various national engineering societies, through which services offered by [illegible] to the President of the United States may be [illegible] of problems in scientific and engineering research.

In addition to supporting the Government in engineering research, the committee also brings to the aid of the Government, through the National Research Council, such general engineering services as are auxiliary to research where those services are needed by any of the other committees of the Council, as incidental to research problems on which they are at work.

The national engineering societies have a further relation to the National Research Council through the Engineering Foundation which those societies established to administer the munificent gift of Ambrose Swasey for the fostering of research in science and engineering. Through the action of the engineers, the whole available income from this gift is now devoted to the organization and operation expenses, but not the research expenses, of the Council.

As has been stated, the contact of the engineering profession with national defense, through the Engineering Committee of the National Research Council, covers only those services involved in science and engineering research, with the addition of such general engineering services as are auxiliary.

Other or general services in the engineering field are articulated with the national defense, as follows:

COUNCIL OF NATIONAL DEFENSE

Fourth, through an Engineering Section of that committee of the Advisory Commission of the Council of National Defense, which is under the direction of Dr. Hollis Godfrey, to whom the Defense Council has assigned supervision of general engineering matters, including education.

Dr. Godfrey is now in course of completing the formation of this committee by calling upon each national engineering society, and certain other engineering societies, to contribute two representatives whom he may appoint members of the Engineering Section of his committee, so that services needed by the Council of National Defense in the realm of general engineering may be placed at its disposal, either by the individual members of the committee or through them by other members of the engineering societies upon whom the Council of National Defense may call.

The above four channels indicate the broad extent to which the members of the engineering profession, in patriotic response to the country's need, have come forward to render services.

Yours truly,

[illegible], *Chairman, Engineering Committee, National Council.*

[illegible] is the text of letters received from the National Research Council and the Advisory Commission of the Council of National Defense inviting nominations from our Society on the Engineering Committee of the former and on the Engineering Societies' Section of the latter:

FROM ADVISORY COMMISSION OF COUNCIL OF NATIONAL DEFENSE

The American Society of Mechanical Engineers tendered its services to the President of the United States in support of the National Defense, and these services were accepted by the President who referred further relations with The American Society of Mechanical Engineers to the Council of National Defense.

As the member of the Advisory Commission of the Council of National Defense charged with matters pertaining to engineering, and authorized by virtue of my appointment by the President and by Act of Congress to appoint Committees for the purpose of assisting the Council of National Defense with advice on the carrying out of its plans, I desire to ask if you will designate two representatives from The American Society of Mechanical Engineers whom I may appoint members of an Engineering Section of my Committee, which representatives will be the means of putting The American Society of Mechanical Engineers into relations with the Council of National Defense so that the services offered by your Society may be available to the Council.

Upon the completion of the formation of the Engineering Section of my Committee, I desire to ask the representatives of the National Engineering Societies to meet me for a conference in Washington to make further plans by which the Government may derive the greatest benefit from the services those Societies have so patriotically tendered.—HOLLIS GODFREY, *Member Advisory Commission Council of National Defense.*

FROM THE NATIONAL RESEARCH COUNCIL

The National Research Council to increase its means of serving the Government in support of National Defense by enlisting through an Engineering Committee the services of a group of distinguished engineers drawn from the field of engineering research in each of the four main divisions of civil, mining, mechanical and electrical engineering.

In addition to services in the field of engineering research the Council has need of some general engineering services auxiliary to problems of research, and desires to be in a position to enlist such services in support of the general objects of the Council.

These objects are, to bring into coöperation existing governmental, educational, industrial and other research organizations with the purpose of encouraging the investigation of national phenomena, the increased use of scientific research in the development of American industries, the employment of scientific methods in strengthening the national defense, and such other applications of science as will promote the national security and welfare.

The relation of the National Research Council to the Council of National Defense is indicated by the following resolution, passed on the 21st of February, by the latter:

> RESOLVED, that the Council of National Defense, recognizing that the National Research Council, at the request of the President of the United States has organized the scientific forces of the country in the interest of national defense and for national defense, and to this end the Council of National coöperate with it in matters pertaining to scientific research for national defense and to this end the Council of National Defense suggests that the National Research Council appoint a Committee of not more than three, at least one of whom shall be located in Washington, for the purpose of maintaining active relations with the Director of the Council of National Defense.

The Executive Committee of the National Research Council would appreciate if on behalf of The American Society of Mechanical Engineers, you would designate two engineers skilled in engineering research, whom the Committee may appoint members of the Engineering Committee of the National Research Council, to render the services outlined in this communication and to serve as a means of calling upon other members of The American Society of Mechanical Engineers, for services that the National Research Council may need in support of the National objects herein referred to.—GEORGE E. HALE, *Chairman, National Research Council;* JOHN J. CARTY, *Chairman, Executive Committee;* GANO DUNN, *Chairman, Engineering Committee.*

ROLL OF HONOR

Members of The American Society of Mechanical Engineers Enlisted in the National Service

(First List)

ADAMS, CARROLL E., Private, Battery A, Rhode Island National Guard.

ADAMS, WALTER H., Captain, Engineer Officers' Reserve Corps*

ALLEN, WALTER C., Captain, Engineer Officers' Reserve Corps.

ALLISON, JOHN F., First Lieutenant, 3d Regiment, Penn Machine Gun Company, Fort Bliss, Texas.

ALLYN, ROBERT S., Major, 9th Coast Defense Command, C. A. C., National Guard, New York.

BEHR, F. J., Captain, Coast Artillery Corps, U. S. A., Hammond Radio Research Lab., Gloucester, Mass.

BELCHER, P. WILLIAM, First Lieutenant, Engineer Officers' Reserve Corps*

BENEDICT, B. W., Captain, 1st Illinois Field Artillery, commanding Battery F.

BERLINER, R. W., Captain, Engineer Officers' Reserve Corps.

BETTS, PHILANDER, Major, Engineer Officers' Reserve Corps.

BILGER, H. E., Captain, Engineer Officers' Reserve Corps*

BILLMYER, CARROLL D., Corporal, First Company, Coast Artillery Corps, National Guard of Virginia.

BIRNIE, ROGERS, Colonel, Sandy Hook Proving Ground, Fort Hancock, N. J., and Governor's Island, N. Y.

BOETTGER, ROBERT, First Lieutenant, Engineer Officers' Reserve Corps.

BRENNAN, JAMES, Captain and A.D.C., 7th Division, U. S. A.

BURROUGHS, JOS. H., JR., First Class Private, Company B, Engineer Battalion, National Guard, Pennsylvania.

BUSH, HAROLD M., Major, Ohio Battalion of Artillery, National Guard.

BUYERS, A. S., First Lieutenant, Coast Artillery Corps, U. S. A., care of Adjutant-Gen'l, U. S. A., Washington, D. C.

CAMPBELL, E. D., Captain, Engineer Officers' Reserve Corps*

CARLSSON, CARL A. V., Ordnance Engineer, Navy Dept., Ordnance Office, Navy Yard, Washington, D. C.

CATTELL, WILLIAM A., Major, Engineer Officers' Reserve Corps*

CHURCH, ELIHU CUNNINGHAM, Seventh Infantry, New York.

CLUETT, SANFORD L., Major, Signal Corps, New York National Guard.

COMSTOCK, CHARLES W., Second Lieutenant, Field Artillery, National Guard, Colorado.

COOKE, STANLEY S., Private, Troop D, 1st Squadron Cavalry, Colorado National Guard.

COYLE, A. M., Mechanical Engineer, Coast Defense, Board of Engineers, U. S. A.

CRUIKSHANK, BARTON, Captain, R. L., First Cavalry, National Guard, New York.

CURTIS, GREELY S., Lieutenant, Junior Grade, 10th Deck Division, Massachusetts Naval Militia.

DAVIS, FRANCIS P., Second Lieutenant, Coast Artillery Corps, New York National Guard. Assigned to [illegible] Co., 8th C. D. C.

DAVIS, JAMES H., Second Lieutenant, Coast Artillery Corps, New York National Guard. Assigned to 33d Co., 8th C. D. C.

DELEMOS, SIDNEY R., Captain, Engineer Officers' Reserve Corps.

DEWOLF, ROGER D., Lieutenant, 7th Division, 3d Battalion, Naval Militia, New York.

DOTY, PAUL, Commissary General, rank of Brigadier General, Minnesota National Guard.

DOTY, PAUL, Major, Engineer Officers' Reserve Corps.

DOYLE, M. A., Second Lieutenant, Engineers, U. S. Coast Guard.

EATON, P. B., Second Lieutenant, Engineers, U. S. Coast Guard.

ELMES, CLYDE C., Captain, Engineer Officers' Reserve Corps.

FITZGERALD, EDWARD T., Captain, 2d Battalion, Naval Militia, New York.

FRY, ALFRED BROOKS, Captain, Naval Militia and Engineers' Reserve List, U. S. N.

FULLER, RAY W., Captain, Company A, Engineers, U. S. and Penna.

GILLIS, H. A., Major, Engineer Officers' Reserve Corps.

GREEN, F. W., Captain, Engineer Officers' Reserve Corps.

GREGORY, WILLIAM B., Major, Engineer Officers' Reserve Corps.

GUNBY, FRANK M., Captain, Artillery Engineer, C. A. C., Massachusetts National Guard.

HALL, HARRIS F., Captain, Company M, 6th Infantry, Illinois National Guard.

HERBERT, J. S., Captain, Engineer Officers' Reserve Corps.

HILL, FRANCIS L., Company H, First Virginia Regiment Volunteers.

HOLMES, URBAN T., Commander, U. S. N., Navy Department, Washington, D. C.

HOLMGREN, F. C., Automobile expert, Rock Island Arsenal, Rock Island, Ill.

HUBBELL, LYMAN P., Captain, Quartermaster Corps, 74th New York Infantry, National Guard.

HUNT, LEIGH, Lieutenant, Machine Gun Company, 1st Kansas Infantry, Eagle Pass, Texas.

HUTCHENS, EDWARD, Captain, Engineer Officers' Reserve Corps*

INGHAM, HOWARD M., [illegible] 1st M[illegible] of Englewood, N. J.

IRELAND, MARK L., Captain, [illegible]

JAMIESON, CHAS. C., Major, [illegible] U. S. Army [illegible]

JENKS, GLEN F., Major, [illegible] U. S. A., [illegible] Ordnance Depot, [illegible]

JOHNSTONE, EDWARD J., Lieutenant, Junior Grade, Naval Militia.

JUNKERSFELD, PETER, Major, Engineer Officers' Reserve Corps*

KATTE, E. B., Major, Engineer Officers' Reserve Corps.

KESSLER, ARMIN GEORGE, Lieutenant, Senior Grade Naval Militia, Erie, Pa.

KILPATRICK, JOHN D., Major, Quartermaster Corps, N. J.

KING, CHARLES G. A., Lieutenant Commander, Illinois Naval Reserve.

KINGSTON, ARTHUR, Lieutenant, 4th Regiment, U. S. Marine Corps.

KRAUS, SIDNEY M., Lieutenant (J. G.), U. S. N., U. S. S. Sampson.

LAMONT, CLARENCE B., Captain, Engineer Officers' Reserve Corps.

LARSEN, CHARLES, First Lieutenant, Engineer Officers' Corps*

LINCOLN, PAUL M., Captain, Engineer Officers' Reserve Corps.

McLEAN, ROBERT W., First Lieutenant, Engineer Officers' Reserve Corps.

McMUNN, WILLIAM N., Commander, Illinois Naval Reserve.

MANSFIELD, JULIAN B., Captain, Infantry and Artillery, Reserve.

MARTIN, KINGSLEY G., Private, Class B, Depot Battalion, 22d Regiment of Engineers.

MAXFIELD, HOWARD H., Captain, Engineer Officers' Reserve Corps.

MERSHON, R. D., Major, Engineer Officers' Reserve Corps.

MILLER, MARTIN NIXON, Chief Building Inspector, Frankford Arsenal, Ordnance, War Dept., U. S. A.

MOON, HARTLEY A., Major, Infantry, 4th Battalion, 3d Regiment.

NEWCOMB, ROBERT S., Captain, Coast Artillery Corps, New York National Guard.

NEWTON, GUY D., Major, Engineer Officers' Reserve Corps*

NORRIS, ALEX. MURDOCH, Ensign, Engineer Duties, Maryland Naval Militia.

OATLEY, HENRY B., Naval Militia.

OHMER, JOHN F., JR., First Lieutenant and Battalion Adjutant, 3d Ohio Infantry.

OSGOOD, WENTWORTH H., Lieutenant, U. S. N., U. S. S. Chester.

OTTO, HENRY S., Private, Squadron A, New York National Guard.

PARKER, CHARLES H., Captain (retired), Massachusetts Naval Militia.

PELLY, JOHN F., Battery A, First Field Artillery, Pennsylvania National Guard.

PELLY, JOHN F., Corporal, Battery A, First Field Artillery, Pennsylvania.

PELOT, JOSEPH H., Major, Ordnance Dept., U. S. A., Frankford Arsenal, Philadelphia.

RATHJENS, G. WILLIAM, Captain, Engineer Officers' Reserve Corps*

REIMER, ARTHUR A., Captain, Engineer Officers' Reserve Corps.

RICHARDSON, EDWARD BRIDGE, Captain, Battery A, Massachusetts Field Artillery.

ROBINSON, WILLIAM, Second Lieutenant, Engineer Officers' Reserve Corps*

SANDSTROM, C. O., Captain, Company L, 3rd Regiment, Mo., Laredo, Texas.

SCHLANK, ELIAS, Private, Sanitary Division, 7th N. Y. Infantry, National Guard.

SCHNEIDER, G. A., First Lieutenant, Engineer Officers' Reserve Corps.

SCOTT, ROSSITER STOCKTON, Corporal, Battery A, Maryland National Guard.

SIMPSON, COLIN C., JR., Private, Depot Battalion, 7th New York Infantry.

SMITH, ALBERT S., Captain, Engineer Officers' Reserve Corps.

SMITH, WILLIAM WALKER, Lieutenant, U. S. N., Pittsburgh, Pa.

STARK, W. E., Second Lieutenant, Engineer Officers' Reserve Corps.

STEEL, REGINALD A., Corporal, Company A, 22nd Corps of Engineers, National Guard, New York.

STRAHLMANN, O. E., Aeronautical Engineer, U. S. Army Signal Corps.

SUMMERS, DANIEL, Second Lieutenant, Engineer Officers' Reserve Corps*

SUTTON, FRANK, Major, Engineer Officers' Reserve Corps.

SWAN, JOHN J., Captain, Engineer Officers' Reserve Corps.

SWIFT, JOHN B., Lieutenant, Company E, 1st Battalion, Illinois Engineers.

TAYLOR, DONALD F., Private, Squadron A, Machine Gun Battery, New York Division.

TAYLOR, L. B., Torpedo Engineer, U. S. Naval Torpedo Station, Newport, R. I.

TOLTZ, MAX, Major, Engineering Corps, Minnesota National Guard.

TREAT, SIDNEY W., Sergeant, 7th Infantry N. G. U. S.

TRUSCOTT, HAROLD S., Captain commanding Co. I, 3d Batt., 4th Inf. Reg., National Guard of Hawaii.

TURNER, ROBERT T., JR., Gunner, N. Y. Training Battery.

VIETS, HARRY A., Sergeant, 13th Coast Defense Command, National Guard, New York.

WAGNER, CHARLES FRANCIS, Captain, Engineer Officers' Reserve Corps.

WAITT, ARTHUR M., Major, Engineer Officers' Reserve Corps.

WESTERVELT, W. I., Major, U. S. A., U. S. Government, Washington, D. C.

WHITLEY, FREDERIC N., Major, First Battalion, New York Engineers.

WHITLOCK, E. H., Major, Engineer Officers' Reserve Corps*

WHITNEY, HERBERT A., Assistant Battery Commander, Coast Artillery, National Guard.

WHITTED, T. B., Captain, Engineer Officers' Reserve Corps*

WILDER, C. W., First Lieutenant Engineer Officers' Reserve Corps.

WILSON, HENRY C., Major, 8th Coast Defense Command, National Guard, New York.

WOOD, HORATIO N., First Lieutenant of Engineers, U. S. Coast Guard, U. S. Cutter Morrill, Detroit, Mich.

WOODRUFF, CLARENCE A., Second Lieutenant, Connecticut Coast Artillery Corps.

YORK, HERBERT W., Lieutenant Commander, Naval Militia, New York.

ZIMMERMAN, OLIVER B., Captain, Engineer Officers' Reserve Corps.

* Acceptance of commission pending at date of latest list from War Department

THE SPRING MEETING AT CINCINNATI

THE record of the Spring Meetings of the Society brings back the most pleasant recollections of good fellowship, inspiration and renewed interest in the affairs of the Society to those who have been fortunate in being present at these meetings. It also calls to mind many gracious hospitalities extended to the Society by friends of engineers in every part of the country in which these meetings have been held.

The entertainment part of the program ot the Spring Meeting of The American Society of Mechanical Engineers, to be held in Ohio, May 21 to 24, if carried out as it has been planned by the Cincinnati Local Committee, will make this meeting the most enjoyable one ever held by the Society. The Committee has excelled itself in providing novel and attractive features for this part of the program.

In this anticipation of the good time in store for members and guests attending the meeting, we must not lose sight of the fact that there are serious matters to be considered, and that some of the topics to be presented and discussed at the professional sessions are of vital national importance at this time. The Technical Section of this issue of The Journal is devoted to the papers to be given at these sessions.

A complete program of the meeting is published below. Full information was given in the last issue of The Journal regarding transportation and fares and hotels, and nothing remains now but for members to complete their own arrangements for being present with their guests at the Hotel Sinton, in Cincinnati, on the morning of Monday, May 21.

Below are also given brief biographical notes of the authors of the papers.

Authors of the Papers

J. F. Barkley has been connected with the U. S. Bureau of Mines for about four years, working on fuel problems concerning boiler-room practice, particularly the transmission of heat from the gases of combustion to the boiler water. He has also spent some time with the Westinghouse Electric and Manufacturing Co., partly on heat problems. There are several government publications along the lines of his paper.

Harry L. Coe is vice-president of Harpham, Barnes, Stevenson & Coe, Inc., production engineers of Boston. For the past ten years he has specialized in general production engineering work, factory organizations, types of management and machine production. He has had charge, for the past two years, of the projectile departments of the Vermont Farm Machine Company and the Consolidated Car-Heating Company, manufacturing 3-in. shrapnel.

Adolph L. De Leeuw speaks from a very extended experience, having been designing engineer with the Niles Tool Works Company, mechanical engineer with the Cincinnati Milling Machine Company, and at present is mechanical engineer with the Singer Manufacturing Company. He has written quite a number of papers on the important subject of metal cutting and metal cutters.

John R. Du Priest is at present head of the Mechanical Engineering Department of the University of Idaho, Moscow, Idaho. He is a specialist in gas-engine work, having served as chief engineer with the Columbus Machine Company where complete power plants for pumping, lighting and manufacturing were turned out under his direction. He is the inventor of various new designs in gas and oil-engine machinery.

Otto P. Geier became associated with The Cincinnati Milling Machine Co. three years ago to organize an Employee's Service department. He was formerly superintendent of the Department of Charities and Correction at Cincinnati, and has given a great deal of attention to the problems of public health work. He is chairman of the section on Preventive Medicine of the American Medical Association, and chairman of the Health Service Section of the National Safety Council.

Henry J. Guild is superintendent of the paper mills of the Eastern Mfg. Company, Bangor and Lincoln, Maine. He has been associated with the development of scientific methods from the beginning and is continuing this development.

Harry V. Haight is at present chief engineer of the Canadian Ingersoll-Rand Company, Ltd., Sherbrooke, Quebec, having for many years served in a similar capacity with the Canadian Rand Drill Company. He has made a specialty of compressed-air machinery, including designing of air compressors, rock drills, coal cutters, compressed-air locomotives, haulage plants and general pneumatic tools.

Keppele Hall has made an intensive study of the Taylor system and in practice as a consulting engineer, associated with Sanford E. Thompson, Mem.Am.Soc.M.E., specializes in the same subject. In this particular line of work he has been employed for the last three years as a resident engineer of the Eastern Manufacturing Company's paper mill.

Arthur L. Humphrey is at present vice-president and general manager of the Westinghouse Air Brake Co. He has had a very wide experience in railroad engineering, having held executive positions with the Union Pacific, Southern Pacific, Colorado Midland, Colorado Southern and other railroads. He has made a specialty of improved shop facilities and modern appliances for economical manufacturing operations.

Horace Judd has been connected with The Ohio State University for the past fifteen years. From 1902 to 1910 he was assistant professor and since 1910 has been associate professor of experimental engineering. During that time his work has been chiefly along the lines of gas, hydraulic, and steam engineering, with more attention during the past few years to hydraulic subjects, especially to the flow of fluids through pipes and orifices.

F. G. Kent is at present works manager of the Lodge & Shipley Machine Tool Company. He was formerly for four years general superintendent of manufacturing with the Pierce-Arrow Motor Car Company. Before that he was associated with The Goodman Manufacturing Company, manufacturers of electrical mining machinery, as works manager. He has a wide and varied experience in machine shop practice, and is a specialist on the subject of organization.

Henry Kreisinger has been connected with the Government fuel investigation for the last thirteen years. He has made a large number of steaming tests of many kinds of fuels and with various boiler equipments. He is now in charge of the fuel-efficiency laboratory of the U. S. Bureau of Mines. His interest is principally given to the study of combustion of coal and heat transmission in engineering problems. He is a co-author of a number of government publications on these subjects.

William O. Lichtner is a member of the firm of Thompson & Lichtner, Consulting Engineers. He specializes in advice on management conditions and on the introduction of scientific methods of management in construction and industrial operations.

Charles Edward Lucke has carried out a great variety of investigations, both scientific and commercial, and has published numerous papers and books on engineering subjects, especially gas-engine design. As head of the mechanical-engineering department at Columbia University he organized new courses and developed new methods of instruction. He has also acted as consulting engineer to various important industrial concerns.

[illegible] W. M[illegible] [illegible] professor of [illegible] engineering at the Ohio State University. Previous to that [illegible] for six years a member of the staff of the Engineering Experiment Station of the University of Illinois. In both of these positions he had devoted [illegible] time to [illegible] study, largely experimental, of [illegible] and [illegible] machinery.

Charles M[illegible] has been connected with the Cincinnati Planer Company for the past [illegible] years, serving the first eleven years as chief designer and superintendent and the last five [illegible]. He has specialized in the [illegible].

Charles B. N[illegible] has been connected with Robert W. Hunt & Co. for the past seven years, having charge during the latter four years of the inspection of general engineering materials. He has given particular attention recently to the inspection and testing of [illegible] classes of artillery, equipment and other important munitions [illegible] supplied the European Governments by this country.

[illegible] E. Otterson is at present first vice-president and general manager of the Winchester Repeating Arms Company, New Haven, Conn. He graduated from the Naval Academy and served as an officer in the Navy. He was also graduated as Master of Science by Massachusetts Institute of Technology and served as Naval Constructor in the United States Navy.

Victor B. Phillips has been connected since 1911 with The Cleveland Railway Company which has studied very thoroughly the matter of power policy. The company has investigated at great length questions of purchased-power rates and the rehabilitation of old plants or the construction of new plants, and as a result enjoys the lowest purchase rates for steam-generated power known in this country. As assistant to the Superintendent of Power, Mr. Phillips in the last two years has devoted himself almost entirely to the above problems.

Herman Schneider is Dean of the College of Engineering, University of Cincinnati. He devised and put into operation the coöperative scheme of education whereby students spend alternating bi-weekly periods in seventy-five industrial, construction, and transportation concerns, and at the Engineering College of the University of Cincinnati. The course has been in operation eleven years, and there are five hundred students enrolled in the work.

Sanford E. Thompson is a consulting engineer and member of the firm of Thompson & Lichtner, Consulting Engineers. He has advised on many projects both in lines of construction and investigation and shop management, acting at the present time as consulting engineer in the introduction of scientific methods of management for various concerns.

Frederick A. Waldron has had experience with the Brown & Sharpe Manufacturing Co., Beaman & Smith, and the Yale & Towne Manufacturing Co. With the last mentioned company he worked his way up to the position of superintendent. He has been practising as an industrial engineer for some years, and is chairman of the Sub-Committee on Industrial Buildings of the Society.

Edward T. Walsh has had experience as construction engineer and as mechanical engineer of the Workmen's Compensation Service Bureau. He has been engaged in industrial engineering for more than ten years. He is at present chief engineer of the Canadian Car and Foundry Company, Ltd., in which capacity he has been brought in close touch with the Russian Technical Bureau and Russian Inspection.

S. H. Weaver has been connected with the Schenectady works of the General Electric Company for the past thirteen years. For the greater part of that period he has supervised the mechanical-stress calculations for the varied electrical apparatus that company produces.

Frank O. Wells has been connected with Wells Brothers Co. since 1876, and has been president of the Greenfield Tap and Die Corporation since its organization. He has devoted a great deal of his time during the past several years towards instituting the United States Standard thread in place of the so-called V-thread. Such success as has been achieved towards this end is largely due to the efforts of Mr. Wells, not only in his individual capacity on many occasions, but also as Chairman of the Sub-Committee of the A. S. M. E., to which Committee was referred the matter of standardization of screw thread tolerances. As a step towards preparedness, the Government, at the suggestion of Mr. Wells, and through his personal efforts and the information he placed at their disposal, has done a great deal to standardize and equip private plants with all gages necessary to manufacture munitions and arms.

Lucien J. Yeomans is practising in Chicago as an industrial engineer and is also a patent attorney. He has had wide experience as a production engineer, and specializes in shop organization and methods of cost reduction. He is manager of the Amalgamated Machinery Corporation and patentee of the machine tools manufactured by them.

John Younger is chief engineer of the Truck Division of the Pierce-Arrow Motor Car Company, and has been so for the past five and one-half years. He has specialized in motor-truck design, motor-truck and road-vehicle transportation for the past twelve years.

Enlargement of Engineering Survey Section

In the Engineering Survey Section of this issue of The Journal is taken another step in the policy of the Publication Committee to develop The Journal along lines of increasing usefulness.

From now on the Survey will review important engineering events, as well as the leading articles in technical periodicals, which has heretofore been its distinguishing feature. The new department will be devoted exclusively to professional matters and will include reports of the meetings of other engineering societies, synopses and lists of researches conducted by various laboratories, besides brief articles and items having a more strictly news value.

Engineers are busy men. Few have time to more than keep in touch with the developments in their own specialized fields, and too often in respect only to trade conditions. It is hoped by the Publication Committee that the new development in the Engineering Survey will enable its readers to follow more readily the progress in the various fields in which they may be interested.

Request for January Issues

The demands for copies of the January 1917 issue of The Journal, which contains a full account of the 37th Annual Meeting, have now exceeded the supply, and this issue is temporarily out of stock. Requests for copies are still being made, however, and members who do not desire to preserve permanently their copy of the January Journal are requested to return it to the Secretary, who will remit postage and cost.

Presentation of John Fritz Medal

The John Fritz Medal was awarded in January, 1917, to Dr. Henry Marion Howe, for his "investigations in metallurgy, especially in the metallography of iron and steel."

The presentation ceremonies will take place in the Auditorium of the Engineering Societies Building, at 8:30 p. m., on May 10.

Ambrose Swasey, chairman of the John Fritz Medal Board of Award, will preside and addresses will be delivered by Dr. Rossiter W. Raymond, secretary emeritus of the American Institute of Mining Engineers, Dr. Ira N. Hollis, Presi-

SPRING MEETING PROGRAM

Cincinnati, May, 21-24, 1917

Monday, May 21

10.00 a.m. Opening of headquarters and registration at Hotel Sinton.
2.00 p.m. Council Meeting.
During the afternoon there will be trips to the shops of the city and an inspection visit to the hospital
8.00 p.m. Informal Reception.

Tuesday, May 22

10.00 a.m. Business Meeting, followed by Professional Sessions.

MACHINE SHOP SESSION

A Foundation for Machine Tool Design and Construction, A. L. DeLeeuw.
Machine Shop Organization, Fred G. Kent.
Metal Planers and Methods of Production, Charles Meier.

GENERAL SESSION

Tests of Uniflow Steam Traction Engines, F. W. Marquis.
Relation of Efficiency to Capacity in the Boiler Room, Victor B. Phillips.
Radiation Error in Measuring Temperature of Gases, Henry Kreisinger and J. F. Barkley.
Development of Scientific Methods of Management in a Manufacturing Plant, Sanford E. Thompson and Associates.
Disk Wheel Stress Determination, S. H. Weaver (by title only).

Excursion for the ladies to Rookwood Pottery and the Art Museum.

2.30 p.m. Joint Session with National Machine Tool Builders' Association, with two addresses:
The Trend in Engineering Training, Dean Herman Schneider.
The Human Potential in Industry, Dr. Otto P. Geier.

Trolley ride for the ladies to Fort Thomas.

8.15 p.m. Smoker for members of the Society and of the National Machine Tool Builders' Association.
Reception for the Ladies.

Wednesday, May 23

10.00 a.m. FIRST MUNITIONS SESSION.

Opening remarks by Major E. D. Bricker, Ordnance Department, Frankford Arsenal, and Lieutenant T. S. Wilkinson, Jr., U. S. N. Bureau of Ordnance.
Munitions Contracts and Their Financing, Frederick A. Waldron.
Organizing for Munitions Manufacture, Arthur L. Humphrey.
Organization for Munitions Manufacture, Harry L. Coe.
Procuring Special Machines for Munitions Manufacture, H. V. Haight.
Practical War-Time Shell Making, Lucien I. Yeomans.

Trip for ladies through leading stores and visit to skyscraper.

2.00 p.m. Boat ride to Fern Bank Dam or Water Works.
8.30 p.m. Informal Dance.

Thursday, May 24

10.00 a.m. Simultaneous Sessions.

SECOND MUNITIONS SESSION

The Design of Munitions for Quantity Manufacture, J. E. Otterson.
Procuring Materials for Munitions, C. B. Nolte.
Limits and Tolerances for the Manufacture of Munitions, A. W. Erdman.
Gages and Small Tools, F. O. Wells.
The Importance of Intelligent Inspection in Munitions Manufacture, E. T. Walsh.

GAS POWER SESSION

The Problem of Aeronautical Engine Design, C. E. Lucke.
Test of a Motor Fire Engine, Horace Judd.
Design of Motor Truck Engines for Long Life, John Younger.
Relation of Port Area to the Power of Gas Engines and its Influence on Regulation, J. E. DuPriest.

INDUSTRIAL SAFETY SESSION

Proposed Code of Safety Standards for Industrial Ladders.

In the afternoon, Motor Car Ride to Mt. Storm, U. C. Observatory, Ault Park, visits to Machine Plants.
On Friday, for those who remain over, there will be an opportunity for trips to Fort Ancient, Mammoth Cave or to Lexington.

dent of our Society, and Judge Elbert H. Gary, chairman of the Board of the United States Steel Corporation.

Professor Albert Sauveur, chairman of the Board at the time the award was made, will present the medal and the ceremonies will conclude with the response of Dr. Howe.

The John Fritz Medal is awarded from time to time for notable scientific or industrial achievement, and is provided for in a fund subscribed in memory of the great engineering pioneer, John Fritz. The award of the medal is made by a permanent Board of Award composed of four members from each of the four societies: the American Society of Civil Engineers, the American Institute of Mining Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers.

The members of the board for 1917 are:

A. S. C. E.	A. I. M. E.
George F. Swain	E. Gybbon Spilsbury
Charles Warren Hunt	Charles F. Rand
Charles D. Marx	Christopher R. Corning
Clemens Herschel	Benjamin B. Thayer
A. S. M. E.	**A. I. E. E.**
Ambrose Swasey	C. O. Mailloux
John A. Brashear	Paul M. Lincoln
Frederick R. Hutton	John J. Carty
John R. Freeman	Harold W. Buck

Members of the engineering societies and others interested, including ladies, are cordially invited to be present at the presentation ceremonies.

Committee of Arrangements
C. O. Mailloux,
Charles Warren Hunt,
John R. Freeman,
E. Gybbon Spilsbury, *Chairman.*

Fares to Spring Meeting

Members of the Society and their friends visiting Cincinnati to attend the Spring Meeting from California, Nevada, Washington, Oregon and British Columbia may avail themselves of the nine-months' excursion fares which are in effect daily from these States to Chicago, St. Louis, Memphis, New Orleans and other eastern terminals of transcontinental lines. They can then rebuy tickets to their final destination, at fares in effect from Transcontinental Passenger Association Eastern Terminals. Thus, nine-months' excursion fares approximate two cents per mile in each direction, or about one fare and 1/3 for round trip.

Full particulars of these reduced fares may be obtained from the Transcontinental Passenger Association, 608 South Dearborn St., Chicago, Ill.

Death of Mr. James Forrest

Mr. James Forrest, honorary secretary of the Institution of Civil Engineers of Great Britain, died on March 1, 1917.

Mr. Forrest was born in London Nov. 30, 1825. In his sixteenth year he was articled to Edward and John Manby, civil engineers, in Westminster. Later he became associated with Charles Manby, secretary of the Institution of Civil Engineers. About 1852, after an interim of a few years on railway construction, he became assistant secretary to the Society of Arts under Mr. George Grove. He returned again to the staff of the Institution of Civil Engineers, and in 1860 was appointed secretary. Following his appointment the Institution immediately took on new life, for during his tenure of office both the roll of membership and the income increased tremendously. To perpetuate the memory of his long service for the Institution an endowment fund was raised by the members in 1891 and, in accordance with Mr. Forrest's wish, was devoted to the founding of the James Forrest Lectureship.

His death is mourned by members of kindred societies on both sides of the Atlantic, and many of our members will long cherish memories of the unfailing courtesies and attentions paid them by Mr. Forrest when they visited the headquarters of the Institution in London.

Spring Meeting of New Haven Section

The Spring meeting of the New Haven Section on April 19 was a successful and well-attended affair. As is the custom with this Section, two sessions were held, in Mason Laboratory, Sheffield Scientific School, dinner being served in the interval between at the Yale Dining Club.

Henry B. Sargent, Mem.Am.Soc.M.E., Chairman of the New Haven Section, presided at the afternoon session, when Herbert C. Nickerson, Chief Engineer of Pumping Stations, New Haven Water Company, presented an interesting paper on Water Works Pumping Engines, in which he gave particulars of the various types of plants that had been installed by the company since its organization in 1861. Following this, excursions were made by automobile to the large pumping stations at Lake Whitney and Lake Saltonstall, where opportunity was afforded to inspect all but the earliest engines described by Mr. Nickerson.

At the evening session, J. Arnold Norcross, Mem.Am.Soc.M.E., who acted as chairman, voiced the regret of the Section and its guests at the inability of Dr. Ira N. Hollis, President Am.Soc.M.E., to be present and address them, owing to exigencies arising from the war situation. He then introduced F. F. Nickel, Mem.Am.Soc.M.E., of the engineering department of Henry R. Worthington, Harrison, N. J., who read a paper on The Development of the Centrifugal Pump, which was profusely illustrated with lantern slides, and which dealt with the various types of pumps of this class, their special uses and advantages, the interpretation of their characteristics, and with methods employed to obviate end thrust, and other design problems. Some interesting points on fire pumps were brought out in the limited time available for the discussion of the paper.

The second paper of the evening, by H. M. Chase, Mem. Am.Soc. M. E., of the engineering department of the Deane Works, Holyoke, Mass., on Pumping Machinery for Industrial Purposes, was devoted to the reciprocating type of pump, its mechanisms, and its adaptation to the special requirements of a wide range of industries. This paper was also abundantly illustrated.

Among the audience were many members of the Winchester Engineering Club, which society had postponed a meeting of its own in order to take advantage of the program offered by the New Haven Section.

The Hardness of Metals. Sir Robert A. Hadfield, Mem.Am. Soc.M.E., has placed in the hands of the British Institution of Mechanical Engineers a sum, the interest on which may be awarded as a prize for the description of a new and accurate method of determining the hardness of metals, especially of metals of a high degree of hardness.

Particulars regarding the competition may be obtained by addressing the secretary of the Institution, Great George Street, Westminster, London.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER JUNE 10, 1917

THE American Society of Mechanical Engineers is an organization for mutual service of over 7800 engineers and associates coöperating with engineers. The membership of the Society comprises Honorary Members, Members, Associates, Associate-Members and Juniors, all elected by ballot of the Council. Application for membership is made on a regular form furnished by the Secretary which provides for a statement of the standing and professional experience of the applicant and requires references from voting members personally acquainted with the applicant. The requirements for admission to the various grades will be furnished upon request.

Below is the list of candidates who have filed applications for membership since the date of the last issue of The Journal. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate-Member or Junior, and those in the third under Junior grade only. Applications for change of grading are also posted.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by June 10, 1917, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about July 15, 1917.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

California

BOND, JOHN M., Assistant Plant Engineer, The Holt Manufacturing Co., Stockton

GOESER, EDWIN W., Chief Engineer, Union Tool Co., Torrance

Connecticut

BUXBAUM, WILLIAM, Production Superintendent, Tool Department, Winchester Repeating Arms Co., New Haven

FRAUENBERGER, CARL F., Planning Supervisor, Winchester Repeating Arms Co., New Haven

KENYON, FREDERICK G., Group Head, Tool Designing Department, Remington U. M. C. Co., Bridgeport

McQUILLAN, JOHN, Mechanical Engineer, Remington Arms U. M. C. Co., Bridgeport

VAN YORX, JOHN H., JR., Manager of Foundry, Bullard Machine Tool Co., Bridgeport

WILSON, HOWARD B., Efficiency Engineer, New Departure Mfg. Co., Bristol

District of Columbia

GILLIS, IRVIN V., Commander (retired) U. S. Navy, Representing Bethlehem Steel Co. in China

Illinois

KNAPP, LELAND G., Efficiency Engineer, Emerson Co., Efficiency Engineers, Chicago

PITT, ALMA A., President, The Pitt Engineering Co., Chicago

Indiana

BURRELL, BENJAMIN S., Master Mechanic, Inland Steel Co., Indiana Harbor

COREY, DAVID A., Executive Engineer, S. F. Bowser & Co., Inc., Fort Wayne

NOLAND, RALPH W., Instructor in Machine Design, Purdue University, Lafayette

Maryland

FOX, HARRY K., Chief Draftsman, Motive Power Department, Western Maryland Railway Co., Hagerstown

Massachusetts

COGSWELL, LESTER W., Engine Designer, Kinney Manufacturing Co., Boston

DAVIS, SIDNEY L., Production Engineer, Bausch Machine Tool Co., Springfield

KNIGHT, FREDERICK D., Superintendent of Construction, Stone & Webster Engineering Corp., Boston

MONTGOMERY, WILLIAM J., Instructor in Machine Work, Brockton High School, Brockton

WILLARD, FRANK H., Assistant General Manager, Graton & Knight Manufacturing Co., Worcester

Michigan

GALLAGHER, WILLIAM H., JR., Electrical-Mechanical Engineer, Wolverine & Mohawk Copper Mining Co., Kearsarge

ROWEN, JOHN H., Commander (Retired) U. S. Navy, and Member of Faculty of Engineering College, University of Michigan, Ann Arbor

SINTZ, CLAUDE, Engineer, Detroit

Minnesota

POLLARD, LAWRENCE E., Sales Engineer, L. E. Pollard Co., Minneapolis

RUFF, DE WITT C., Vice-President, Fire Brick Construction Co., Minneapolis

New Jersey

KOTTENBASH, ERNEST E., Chief Engineer, Schafer Ball Bearings Co., Inc., Hawthorne

MATTHEWS, JOHN B., Marine-Power Engineer, Samuel L. Moore Sons Corp., Elizabeth

MOUNT, RALPH H., Manager, The Okonite Co., Passaic

New York

ABELS, ALOYSIUS J., President, A. J. Abels Co., Inc., Buffalo

BALDWIN, ARTHUR J., Publisher, Vice-President, McGraw-Hill Publishing Co., Inc., New York

CONNER, WILLIAM W., Engineer, Eastman Kodak Co., Rochester

CORLISS, WILLIAM J., State Locomotive Boiler Inspector, Public Service Commission, Albany

DIETER, WILLIAM, Torpedo Engineer, E. W. Bliss Co., Brooklyn

DIVINE, BRADFORD H., President, Divine Brothers Co., Utica

KEARFOOT, WILLIAM D., Marine Engineer, New York

LACY, ROBERT, Estimating Engineer, Otis Elevator Co., New York

MOEN, LECLANCHE, President, C. W. Hunt Co., Inc., New York

WATKINS, ARTHUR M., Secretary, Inter-Continental Machinery Corp., New York

North Carolina

HARDESTY, GEORGE H., Engineer in Charge, State Hospital, Goldsboro

Ohio

BICKETT, CHARLES A., President, The Bickett Machine & Mfg. Co., Cincinnati

CHRYST, WILLIAM A., Chief Engineer, Dayton Engineering Laboratories Co., Dayton

JUPP, ALFRED J., Sales Director, The Lunkenheimer Co., Cincinnati

LYON, GEORGE R., Vice-President, The Power Equipment Co., [illegible]

STONE, JULIUS F., President, The Seagrave Co., Columbus

WALTER, FRANK L., Master Mechanic, Dayton Engineering Laboratories Co., Dayton

Pennsylvania

BRESSLER, J. WALTER, Metallurgist, Tacony Steel Co., Tacony

DUNN, J. JAY, General Superintendent, Shelby Steel Tube Co., Ellwood City

FORREST, JAMES, Assistant General Foreman, Baldwin Locomotive Works, Philadelphia

McNARY, JAMES E., Staff Engineer, Lubrication Division, The Texas Co., Pittsburg

SAYLOR, JOHN R., Proprietor, Pottstown Machine Co., Pottstown

[illegible] Field Engineer,
[illegible] Philadelphia
WANDLESS, [illegible] W., [illegible] Supervisor,
[illegible] Co., Eddystone

Tennessee

CAROTHERS, [illegible] G., Senior Mechanical Engineer,
Interstate Commerce Commission,
[illegible] Chattanooga
DANIELS, [illegible] H., [illegible]
Walsh & Weidner Boiler Co., Chattanooga

Wisconsin

MANHEKE, [illegible]
[illegible] Engineering & Mfg. Co., Milwaukee
MILBRATH, [illegible] Engineer,
[illegible] Mfg. Co., Milwaukee
ELVERT, [illegible], Assistant Engineer,
[illegible] Mfg. Co., West Allis

Canada

JOHNSON, [illegible], Assistant General Sales Manager,
Armstrong Whitworth of Canada, Ltd., Montreal
KINGSTON, JAMES S., Heating and Ventilating Engineer,
Department of Public Works, Ottawa

Italy

FERRERO, MICHELE, President of
Società Italiana Macchine Utensili, Milano

Scotland

MITCHLEY, JOHN W., Mechanical and Chemical Engineer,
Ministry of Munitions, Dornock, N. B.

FOR CONSIDERATION AS ASSOCIATE MEMBER OR JUNIOR

Alabama

ROBERTS, ARTHUR M., Assistant Superintendent,
Alice Furnace, Tennessee Coal, Iron & R. R. Co., Birmingham

California

LAMB, HAWTHORNE M., Senior Mechanical Engineer,
Interstate Commerce Commission, San Francisco

Illinois

DRAKE, ROBERT W., Steam and Electrical Engineer,
International Harvester Co. of N. J., Chicago
GOENSCH, OTTO, Department Head,
Western Electric Co., Inc., Chicago
STUEBING, ALBERT F., Western Mechanical Editor,
Railway Age Gazette, Chicago
WHITESIDE, VICTOR, Testing Engineer,
Western Electric Co., Chicago

Massachusetts

PETRIE, ELMER H., Mechanical Engineer,
Fred T. Ley Co., Inc., Springfield
WILKINSON, JAMES, Consulting Engineer,
General Electric Co., Pittsfield

Montana

WOHLENBERG, WALTER J., Assistant Professor of Mechanical Engineering, University of Montana, Bozeman

New Jersey

STERN, JOSEPH H., Assistant Engineer,
Aeolian Co., Garwood

New York

BEINECKE, FRITZ W., Supervisor of Automobile Equipment,
The Texas Co., New York
CHANDLER, HEMAN W., Draftsman Maintenance Department,
American Locomotive Co., Dunkirk
HILDRETH, KENNETH E., Chief Electrician,
New York & New England Cement & Lime Co., Hudson
HINRICHSEN, ARTHUR F., Works Manager,
Slocum, Avram & Slocum Laboratories, Inc., New York
LEACH, EDGAR J., Engineer,
Curtiss Aeroplane & Motor Corp., Buffalo
LEISENRING, FRANK S., President,
Mechanical Specialties Co., New York
RAMSEY, JAMES F., Lubricating Engineer,
Vacuum Oil Co., New York
WACHENBERG, LEWIS, Technical Assistant to Superintendent,
Arbuckle Bros., Brooklyn
WELSH, MILFORD G., Superintendent,
Mohawk Gas Co., Schenectady

North Carolina

SHEARER, DAVID R., Consulting Engineer, Shulls Mills

Ohio

BRUSSEL, JOHN W., Supervisor of Machining,
Dayton Engineering Laboratories Co., Dayton
HASKELL, ALLAN G., Sales Engineer,
Champion Spark Plug Co., Toledo

Oklahoma

WOOBANK, WILFRED, Sales Engineer,
Worthington Pump & Machinery Corp., Tulsa

Canada

BROOKS, CHARLES E., Superintendent Motive Power,
Grand Trunk Pacific Railway, Transcona, Manitoba
SEALEY, WILLIAM G., Mechanical Superintendent,
British Cordite Co., Nobel, Ont.

FOR CONSIDERATION AS JUNIOR

California

BERG, HENNING J., Engineering Department,
Standard Oil Co. of Cal., Corcoran
LILLA, HERBERT L., Machinist's Mate, United States Navy,
U. S. S. Huntington, c/o Postmaster, San Francisco

Connecticut

BARNETT, SYDNEY A., Engineering Draftsman,
Hugh L. Thompson, Consulting Engineer, Waterbury

Illinois

STUERMAN, ROBERT V., Superintendent Heating Department,
Springfield Gas & Elec. Co., Springfield

Kentucky

SEATON, EDWARD W., Engineering Department,
Ashland Iron & Mining Co., Ashland

Maryland

LEDNUM, JAMES M., Junior Engineer,
Davison Chemical Co., Curtis Bay
NELSON, ROBERT W., Foreman Shrapnel Shop,
Bartlett Hayward Co., Baltimore

Massachusetts

BAKER, CHARLES H., JR., Member of Firm,
Norton Co., Worcester
BARRY, EDWARD H., Sales Engineer,
The Elliott Co., Boston
CHURCHILL, F. LORING, Instructor in Mechanic Arts & Drafting,
High School, Quincy

Michigan

COTTRELL, HOLMES A., Carburetor Engineer,
Detroit Lubricator Co., Detroit
MOSES, CARL A., Insurance Engineering, Detroit

New Jersey

ILIFF, WILLIAM L., Sales Engineer,
Hyatt Roller Bearing Co., Newark
RAUSCH, ROSWELL H., Engineer,
Niles-Bement-Pond Co., Plainfield
ROSS, JOSEPH M., Mechanical Engineer,
Thomas A. Edison, Inc., Silver Lake

New York

BUSHNELL, BURDGE O., Mechanical Engineer,
New York Quebracho Extract Co., Brooklyn
DERRY, GARDNER C., Sales Engineer, Rochester
ENGESSER, BENJAMIN M., Apprentice Engineer,
Pierce-Arrow Motor Car Co., Buffalo
MINOTTY, JOSEPH P., Mechanical Draftsman,
Combustion Engineering Corp., New York
MURPHY, AMBROSE E.,
With Remington Typewriter Co., Ilion
OUTTERSON, CHARLES R., Sulphite Superintendent,
Carthage Sulphite Pulp & Paper Co., Carthage
WEBER, ROBERT L., Jr., Draftsman,
Combustion Engineering Corp., New York

Ohio

HODOUS, LOUIS W., Construction Supervisor,
The Canfield Oil Co., Cleveland
LANEY, THOMAS G., Jr., Student, Lima

Pennsylvania

CARVIN, FRANK D., Engineer of Tests,
Schaum & Uhlinger Co., Inc., Philadelphia
PARK, JOHN F., Jr., with
Dodge Sales & Eng. Co., Philadelphia
WORTH, PAUL, Mechanical Engineer,
Heine Safety Boiler Co., Phoenixville

Tennessee

LYLE, ALEXANDER B., Superintendent,
Stickney & Montague Co., Chattanooga

Texas

BLAKESLEE, WALTER A., Instructor in Mechanical Engineering,
Rice Institute, Houston

Washington

DONOVAN, PHILIP L., Purchasing Agent,
Bloedel Donovan Lumber Mills, Bellingham

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE MEMBER

New Jersey

KNIGHT, WILLIAM, Assistant Mechanical Engineer,
Crocker-Wheeler Co., Ampere

Pennsylvania

McGRAIL, FRANCIS J., Foundry Superintendent, Struthers-Wells Co., — Warren

Canada

STENBOL, CARL, Superintendent Steel Department, Canada Cement Co., — Montreal

PROMOTION FROM JUNIOR

Indiana

BARRETT, WALTER A., Mechanical Engineer, The Bass Foundry & Machine Co., — Fort Wayne

Massachusetts

CARROLL, M. B., Commercial Engineer, General Electric Co., — Lynn

New Jersey

ROYLE, VERNON E., Mechanical Engineer, John Royle & Sons, — Paterson

New York

HORTON, CHARLES M., Industrial Writer, — New York

Ohio

MANLEY, SUMNER M., Mechanical Engineer, The Proctor & Gamble Co., — Ivorydale

MAROT, EDWARD H., Sales Engineer, Hyatt Roller Bearing Co., — E. Cleveland

Tennessee

ALLEN, WHARTON H., Secretary-Treasurer, Allen-Scales Engineering Co., — Nashville

South America

NELSON, ERNEST B., Assistant Engineer, Andes Copper Mining Co., — Chanaral, Chile

SUMMARY

New applications	116
Applications for change of grading:	
Promotion from Associate-Member	3
Promotion from Junior	8
Total	127

NECROLOGY

ARTHUR BEARDSLEY

Arthur Beardsley was educated as a civil engineer at Rensselaer Polytechnic Institute, and was graduated in 1867 with the degree of Civil Engineer. Following his graduation, he was employed for one year as assistant engineer at the Hoosac Tunnel. In 1868, he entered private practice as a civil engineer and architect. In the following year, he was appointed instructor in civil engineering, physics and industrial mechanics at the University of Minnesota, and in 1870 was appointed to the chair of Civil Engineering and Industrial Mechanics at the University. In 1872, he was called to the chair of Mechanics and Engineering at Swarthmore College.

Mr. Beardsley was elected a life member of the Society in 1883, three years after its organization. He died on January 22, 1917.

J. ANSLEY HARTFORD

J. Ansley Hartford was born in Pittsburgh, Pa., on October 17, 1871. He received his early education in the public schools of Pittsburgh, and was graduated from the Pittsburgh Central High School at the age of 16. He served a four-years' apprenticeship as machinist at the Black Diamond Steel Works. He spent the next five years with the Westinghouse Electric and Manufacturing Co., entering as a machinist and being promoted through the tool-making division to the position of outside construction engineer, working on some of the largest power installations in the country.

In the meantime he had studied mechanical and electrical engineering at night, and was given charge of the electrical equipment of the Westinghouse Machine Company at East Pittsburgh. He remained at Pittsburgh eleven years in the capacity of factory engineer responsible for all service machinery. He designed the switchboard in use at the Pittsburgh plant. He represented the company in its joint betterment work with the Westinghouse Electric Co., organizing the Casino Technical Night School, Casino Restaurant and Library.

In 1910 he accepted the position of superintendent of design and manufacturing of the tractor works of the Smith Manufacturing Co., of Chicago. Later he designed the Breese motor plow and became secretary and general manager of the company organized to manufacture it. In February, 1916, he accepted the position of experimental and productive engineer with the Garford Motor Truck Co., which he held at the time of his death.

Mr. Hartford became an Associate of the Society in 1914. He died at Lima, Ohio, on March 17, 1917.

ALBERT C. STEBBINS

Albert C. Stebbins was born on September 19, 1845, in Monson, Mass., and received his education in the Monson Academy. When 19 years old, he came to New York City and worked for William Soules in the wool and flax business. Feeling the necessity of taking up a trade, he apprenticed himself as machinist with Lucius W. Pond, Worcester, Mass., from 1865 to 1870. In 1870 he went to New York as representative of Mr. Pond. Five years later, when the business changed hands and Mr. Pond's son, David W. Pond, took charge, Mr. Stebbins went back to Worcester as superintendent. In 1886, when the Pond Machine Tool Co. was established, Mr. Stebbins was made vice-president, and went to Plainfield, N. J., where he built the plant and had it running in the spring of 1888. In 1898, on the formation of the Niles-Bement-Pond Co., Mr. Stebbins was made vice-president and manager of the Pond works and continued in this capacity until the time of his death. He was also vice-president of the Pratt & Whitney Co., director of the Ridgway Machine Co. and vice-president of the Plainfield Savings Bank. He became a member of the Society in 1904. He died in Plainfield, N. J., February 28, 1917.

SILAS E. WEIR

Silas E. Weir was born on May 16, 1869, in Cookstown County, Tyrone, Ireland. He was educated at the Guilds Schools in London and served his apprenticeship with Coombe, Barboure and Coombe, Belfast, Ireland. Following this training, he went to British India to take charge of the installation and operation of a tea-drying plant located northwest of Calcutta. He had to give up this position, however, owing to illness, and he returned to Ireland for a period of about five years. He then came to the United States and worked for several firms—as general master mechanic with the Griffin Wheel Company, general superintendent with the Triumph Electric Company and works manager with the American Blower Company, retaining the last position until the time of his death. He became a member of the Society in 1914. He died in Detroit, on February 13, 1917.

WILLIAM C. WILLIAMSON

William C. Williamson was a member of the Society of long standing, having been elected to membership in 1882. He was a member of the firm of Williamson Bros. Company of Philadelphia. He died on February 12, 1916.

AMONG THE SECTIONS

THERE are several cities where the number of members of the Society is not as yet sufficient to warrant the establishment of a Section, but where a local organization exists which serves as a medium for bringing together the engineers of the locality. With the Section's reports will be listed in the future, therefore, reports of meetings of such organizations.

The Engineering Society of Nashville, Tenn., has opened its new headquarters at Room 109, Commercial Club Bldg., with secretary's office and technical reading room. The association holds a luncheon each Monday at 12.30 o'clock, with the exception of the first Monday of each month, when the meeting is held at 6.30 p. m., at which a set program is provided. Visiting engineers are always welcome at these events and at the association's quarters.

A Southwestern Society of Engineers has recently been formed at State College, New Mexico. This includes all branches of the profession. Until there are a greater number of engineers in any one branch than there are at present in a given locality, this organization will serve the purpose for which Sections in more thickly populated districts are established. The first convention was held on March 8, 9, and 10 and was a complete success. The papers presented would have done credit to the general meetings of some of the national societies.

ATLANTA

March 8. The Section was called to order for the election of officers for the ensuing year, and the following were elected: Oscar Elsas, chairman; Cecil P. Poole, secretary; Robert Gregg, J. N. C. Nesbit and Earl F. Scott.

Methods of interesting the members were discussed, and a trip was planned to the Atlantic Steel Co.'s plant. It was decided that such visits to industrial plants would be made periodically, and that at occasional meetings a paper prepared and read by one of the members would be the most effectual method of maintaining the interest of the members.

March 16. The Section visited the Atlantic Steel Company's works, and inspected with much interest the plant and equipment.

EARL F. SCOTT,
Section Chairman.

BIRMINGHAM

May 16. The Annual Meeting of the Birmingham Section will be addressed by Dr. Thornwell Haynes, President of Birmingham College.

April 11. This was one of the best meetings ever held by the Birmingham Section. It was addressed by Prof. M. Thomas Fullan, of Alabama Polytechnic Institute, on the subject of Technical Writing. Professor Fullan emphasized the fact that engineers should do more writing and the results would be profitable to both themselves and their readers. His clear and forceful description of the method of writing papers was much enjoyed and appreciated by his audience.

PAUL WRIGHT,
Section Secretary.

BOSTON

April 4 and 5. A two-day Joint Meeting of the Section and the American Institute of Electrical Engineers was held on these dates. The first session was held at the Engineers' Club on the evening of April 4. A buffet supper preceded the technical session, which was devoted to the general subject of Recent Developments in Steam Generation.

At this first session, Frederick Ewing presented a paper on Developments in Fuel Oil vs. Coal. This was followed by a paper on Up-to-Date Stoker Practice, by Sanford Riley, Mem. Am.Soc.M.E. High Pressures and Temperatures in a Modern Station was then discussed by I. E. Moultrop, Mem.Am.Soc.M.E. Prof. L. S. Marks, Mem.Am.Soc.M.E., reviewed the recent work of Messrs. Kreisinger, Ovitz and Augustine of the U. S. Bureau of Mines, on Combustion in Hand-Fired Boilers. The evening was closed by a paper entitled High Temperature Insulation of Boiler Settings, by P. A. Boeck.

The program for April 5 covered Isolated Plants and Central Stations, at the afternoon session, and Developments of Prime Movers, Condensers, Auxiliary Equipment, etc., at the evening session. Mr. Walter N. Polakov, Mem.Am.Soc.M.E., opened the afternoon session with a paper on Principal Factors in the Selection of Sources of Power. This was followed by a paper on Interesting Isolated Power Plants, by A. R. Meek, and by a second paper on An Isolated Power Plant in Connection with a Factory near Boston, read by William G. Starkweather, Mem. Am.Soc.M.E. Engineering Features and Results at the Holyoke Municipal Plant was presented by John J. Kirkpatrick, and W. F. Schaller closed the session with a paper on Coöperation between Isolated Plants and Central Stations, by Percival R. Moses and himself.

Following the afternoon session a dinner was served, at which brief addresses were made by several of the members and guests. Mr. Charles F. Weed, president of the Boston Chamber of Commerce, gave figures and statistics to show the almost incomprehensible amount of munitions being used in the war and compared this with the present quantity of munitions in this country. President Hollis outlined what the mechanical, electrical, civil and mining engineering societies are doing in assisting the Government to carry out its military and naval program. Prof. A. L. Williston, Mem.Am.Soc.M.E., and Dr. Frederick R. Hutton, Mem.Am.Soc.M.E., also spoke.

At the evening session, John A. Stevens, Mem.Am.Soc.M.E., gave a brief address upon the discussion of engineering subjects by engineering societies. R. A. Langworthy presented a paper on Engineering Features of Combined Heat and Power Distribution. Some remarks on turbine development in recent years were made by Dr. L. C. Loewenstein, Mem.Am.Soc.M.E., in the absence of Richard H. Rice, who was to read a paper on the Development of Steam Turbines. The meeting closed with a paper by Charles H. Bromley, entitled Recent Developments in Condensers and Modern High Vacuum.

WILLIAM G. STARKWEATHER,
Secretary.

BUFFALO

March 14. Before the Engineering Society of Buffalo, Karl W. Zimmerschied, of the General Motors Co., talked on the necessity of standardization as a measure of industrial preparedness, laying stress upon the standardization of detail. Mr. Zimmerschied said that efficiency is the great slogan of the times, but that it should be in evidence all along the line, as there is just as much efficiency in seeking facts which are of value and then utilizing them as there is in anything else. He also spoke of the adoption of the metric system, which he thinks is assured in machine-shop practice and engineering design, stating that the United States Government has recognized its value by adopting it in the aviation service.

April 4. Arthur S. Hurrell, superintendent of education in Indianapolis, Ind., spoke on Vocational Training, describing a survey prepared a short time ago which made clear the needs of industry and the wants of young men who proposed to enter mechanical occupations. He thought this would be of great value in the development of vocational education in other cities as well as Indianapolis.

Dr. George Smith, head of the Buffalo vocational-education department, and other educators commended the idea of the survey as a good thing for Buffalo and agreed that one of the needs in this city, if vocational training is to come into its greatest community influence, is public interest and support.

LOUIS J. FOLEY,
Assistant to Secretary.

CHICAGO

May 18. O. B. Zimmerman, Mem.Am.Soc.M.E., will present a paper on Small Internal Combustion Engines. The meeting will be held in the Hotel La Salle.

April 4. With an attendance of 125 at the regular dinner meeting, J. Philip Furbeck, of the Oxweld Railroad Service Co., gave a talk on Oxy-acetylene Welding. Mr. Furbeck limited his remarks to the practical application of oxy-acetylene welding in manufacturing, maintenance of equipment and machinery, reclamation work and the cutting of steel and wrought iron. A large number of lantern slides showed a great variety of work that had been done successfully at a cost considerably below that entailed by other methods.

This address was followed by a spirited discussion, joined in by a large number of those present. A nomination committee was selected, consisting of Messrs. C. C. Brooks, G. F. Gebhardt and Lewis M. Ellison, to present at the next meeting the names of candidates for the offices of the Section.

T. Wilson,
Corresponding Secretary.

MERIDEN

April 12. At the monthly meeting of the Meriden members E. P. Bullard, Mem.Am.Soc.M.E., president of the Bullard Machine Tool Company, gave a talk on the new Bullard employment plan which has been adopted by his company. Each person present at the meeting was given a pamphlet outlining the several branches of the plan, and Mr. Bullard then explained the workings in detail. He stated the workmen no longer asked for promotion or increased pay, as under the system this was taken care of automatically. A bonus is given if the men make full time all week, vouchers for this being paid after 30 days if the men are still in the company's employ, and a premium is paid for production above the standard amounts. The employees are insured without a medical examination. The workmen's welfare is looked after, and this is not confined to the shop, help being given in case of sickness in the home. Wages are higher under this system and the cost of production has been reduced, both workmen and company being benefited. Mr. Bullard said that while they were formerly much troubled with the constant loss of help, and the consequent necessity of breaking in new men, practically no such trouble exists under the new plan. In March only four men left the employ of the company out of something over 1,100 on the payroll. The company has an average of 1,500 applications for work per month and has closed its employment office.

C. K. Deckard,
Chairman.

MILWAUKEE

March 21. Capt. W. A. Moffat, U.S.N., commandant of the Navy Training Station at Great Lakes, Ill., addressed the Section.

Captain Moffat, who is an authority on naval matters, advocated the building of sea giants, volcanoes of power, by the United States, that would place the superdreadnoughts of foreign navies in the has-been class and would not necessitate the constant building of new ships. He considered it of little value to be continually building vessels which in a few years are out of date and go to the scrap-heap. The size of battleships, he said, should only be restricted by the limitations of the Panama Canal.

Capt. Moffat declared that a fleet of ships as large as it is possible to build would provide far greater protection and prestige to a nation than would a fleet of ships which are constantly being exceeded in size by those of other nations. He proposed ships of 60,000 tons displacement 250,000 hp., 995 ft. long and with a speed of 36 knots.

F. R. Dorner,
Section Secretary.

NEW ORLEANS

April 2. Preparedness was the subject of a paper by A. M. Lockett, Mem.Am.Soc.M.E., before the joint meeting of the Section and the New Orleans Association of Civil Engineers. The speaker told of the many and important ways in which the people of New Orleans may aid the nation in time of war, and his paper was discussed by Commodore V. S. Nelson, Major J. L. Schley, Major Richard C. Moore, Captain H. A. Drum, Lieut Moses, General Perrillat and Prof. Williamson.

Mr. Lockett said that the United States was now in the position of a contractor who had been awarded a large contract and must assemble men, material and equipment to carry it to completion. The engineers and chemists of the country have already aided in this work by making an industrial inventory of equipment. He pointed out that a contractor having both skilled and common labor at work on a job would not set a mechanic to do the work of the water boy nor the common laborer to do the work of a mechanic, neither should the Government use the engineers for other work than that for which they are especially fitted, but should place each man where his knowledge would be most valuable.

In discussing the paper, Commodore Nelson spoke of the need of the Navy for more men, and explained what enlistment in the Navy and Naval Reserve entails and the different grades of service. He also pointed out the need of men on shore, such as radio operators, electricians, mechanics for machinery and ship-repair men for operating mine layers and mine sweepers, and the great need of men in the flying corps.

Major Schley said that the engineers were especially suited for the work of "apostles of preparedness," as they took a matter-of-fact view of things and knew something of the number of men and quantities of material required to accomplish large undertakings.

Major Moore, of the U. S. A. Engineer Corps, spoke of the need of both material and men. Satisfactory arrangements for the first have been made, but there is need of many men both in the ranks and as officers. Captain Drum, of General Pershing's staff, who has recently come here to create interest in the army training camp, described the object of training camps and the advisability of universal military training and service, as this would give us an army of men "whose interest is for peace, whose hopes are for peace and who will vote for peace with honor." He urged the citizens of Louisiana to attend the camp to be opened at Alexandria, and carefully explained the requirements for such attendance.

Lieutenant Moses, U. S. N., gave specific advice as to how the organizations in New Orleans could join in the work of aiding the Government, and suggested that the Association of Commerce establish and maintain a perpetual stock-card system showing material actually on hand and ready for immediate delivery to the Navy Yard, and that the merchants coöperate to develop a transportation system to insure this delivery. Suggestions were also made as to the facilities for motor-boat repair at the mouth of the river and the building of submarine chasers as well as plans for medical attention at that point.

General Perrillat pointed out that the country now has in hand a gigantic work, and cited Great Britain's mistake in taking men from the munitions factories for the front and then having to recall them. He considered it advisable to have a census of men made and their abilities listed. Professor Williamson followed with the same thought as to the census.

In conclusion, the President of the Louisiana Engineering Society was asked to appoint a committee to take up the work of making the roster of the members of the Society.

H. L. Hutson,
Section Secretary.

NEW YORK

May 8. Siegfried Rosenzweig, Mem.Am.Soc.M.E., will speak on The Development of the Poppet-Valve Steam Engine With Special Reference to Its Present Status in the United States.

April 10. The following Committee was elected to nominate officers for the coming year: George S. Humphrey, chairman, Philander Betts, F. R. Low, W. W. Macon and Edward Van Wrinkle.

Secretary Rice described in detail his trip to the various Sections which had taken him as far west as Oklahoma City. He also outlined the work which engineers are doing in the present crisis, and told the members present how best to offer their services to the Government.

The paper of the evening was presented by Earle Buckingham, Mem.Am.Soc.M.E., and was entitled Standards of Business Success. Mr. Buckingham said that we are living in an age of combinations

[illegible] and it has been rather generally assumed and accepted that there was no limit to the profitable increase of a large concern. He then presented accessible figures to show what happens to several departments of a concern when it very largely increases the amount of business transacted. For the purchasing department he showed that, in every line of business he had examined, the cost of materials showed an increase disproportionate to the growth of the business. He said that, from experience, a growing firm's sales costs would increase faster than the gross amount of business increase. In like manner there can be no question that the cost of credits will increase faster than the costs of the business. Cost of production involved labor and overhead charges and the complete showing of the production end of American business could not be ascertained at present.

A. D. Blake,
Section Secretary.

MINNESOTA

[illegible] A banquet and entertainment was tendered Dr. Ira N. Hollis, President Am.Soc.M.E., at the Hotel Dyckman in Minneapolis. The guests present were addressed by Dr. Hollis, Dr. G. E. Vincent, President of the University, and Dr. Marion L. Burton, President-elect of the University. Dancing and a general get-together followed.

March 10. A symposium on steam locomotives was held at the Main Engineering Building of the University of Minnesota. Seven papers were read and many of them discussed, and an address was made by Dr. Hollis.

J. V. Martenis, Mem.Am.Soc.M.E., gave the opening paper, on Historical Development of the Locomotive. Locomotive Improvements, by Max Toltz, Mem.Am.Soc.M.E., was read by C. F. Shoop, Mem.Am.Soc.M.E. This was followed by Modern Methods of Locomotive Operation, by T. A. Foque, Mem.Am.Soc.M.E., and Historical Development of the Superheater on the Locomotive, by Geo. L. Bourne, Mem.Am.Soc.M.E., read by R. M. Ostermann, Mem.Am.Soc.M.E. A paper on the Use of Pulverized Fuel for Locomotives was read by J. E. Muhlfeld, Mem.Am.Soc.M.E., and papers on Economy of the Locomotive Superheater by R. M. Ostermann, and Feed Water Heating by George M. Basford, Mem.Am.Soc.M.E.

D. M. Forfar,
Section Secretary.

PHILADELPHIA

May 22. A joint meeting with the Engineers' Club and Affiliated Societies at Drexel Institute will be addressed by Willard Behan on Engineering of Men.

March 27. A joint meeting of this Section and the Philadelphia Chapter of the American Society of Heating and Ventilating Engineers was addressed by Walter J. Kline, of the American District Steam Heating Co., on District Heating.

Mr. Kline gave much thought to the design and financing of various systems, emphasizing the desirability both from the producers' and consumers' standpoint of the installation and use of meters.

March 30. The Engineers' Club of Philadelphia celebrated its fortieth anniversary by a banquet at the Bellevue Stratford Hotel. Patriotism and loyalty were the keynotes of the evening, and much was said of the part played by the engineer in construction and destruction in time of war.

References to salient points in the history of the Club were made. The Club was organized in December, 1877, with nineteen members, at whose residences the meetings were held for the first few months, after which the Club opened its own headquarters. After several changes it took possession of its present quarters at 1317 Spruce Street in 1907. Among receptions tendered by the Club to visiting engineers and engineering societies were one to Count Ferdinand de Lesseps in 1880, and one to the delegates from the Society of Engineers of France to the Chicago World's Fair in August 1893.

Following proceedings inaugurated in 1913, affiliation was effected in 1915 between the Club and the Philadelphia Sections of the American Institute of Electrical Engineers, The American Society of Mechanical Engineers, American Society of Civil Engineers, Illuminating Engineers, Technology Club of Philadelphia, Massachusetts Institute of Technology, Society of Automobile Engineers and American Society of Heating and Ventilating Engineers.

By a whirlwind campaign in the latter part of 1915, the club membership was increased within a few days from 524 to 2336, an increase of nearly 350 per cent.

W. R. Jones,
Section Secretary.

PROVIDENCE

May 21. Subject: Time and Motion Study.

February 28. An open meeting to which ladies were invited was addressed by M. R. Hutchison, Mem.Am.Soc.M.E., engineering advisor to Thomas A. Edison and a member of the Naval Consulting Board, on Edison, His Life and Achievements. Mr. Hutchison illustrated his lecture with lantern slides and moving pictures of interest.

March 28. The Providence Engineering Society held a very largely attended meeting, at which Dr. Ira N. Hollis, President Am.Soc.M.E., George H. Pegram, President Am.Soc.C.E., and Harold W. Buck, President Am.Inst.E.E., spoke on The Engineer and Organization.

Dr. Hollis pointed out the relations between the engineer and democracy, dwelling on the fact that the spread of democracy seems to have run parallel with the growth in engineering achievements from the time of James Watt, inventor of the steam engine, down to the present. The speaker said that it was the duty of engineers to stand for the principles of democracy and use their influence to have trained men picked for high offices in the government; and in order to do this the coöperation of engineers throughout the land is necessary.

Mr. Buck dwelt on the fact that all engineering problems are coöperative, and asked for coöperation between the engineer and the scientist, instancing Faraday's work which a century ago was looked upon by engineers as fanciful and pretty but which today forms the basis of great electrical attainments.

Mr. Pegram suggested that if our Government had a department of public works there might be improvement in the handling of many problems. The Government has but recently officially recognized the engineer, but without his services it is doubtful how much progress could be made.

Following these addresses General Abbot, of the Rhode Island National Guard, spoke on coöperative work among the engineers necessary in time of war. Dr. Faunce, of Brown University, also emphasized the necessity for coöperation, and Major Buxton, of the National Guard, advocated compulsory military training.

A. E. Thornley,
Corresponding Secretary.

ST. LOUIS

The St. Louis Section sends in a description of the organization and work of the Engineers' Club of St. Louis, which, in its reincorporated form, includes the Club and the Local Sections of the National Societies of Civil, Mechanical and Electrical Engineers and of the American Society of Electrical Contractors. The description was given in a recent paper by Mr. F. G. Jonah, presented before the third conference on Engineering Coöperation.

The Club maintains permanent quarters, containing the office of a secretary, who devotes his whole time to Club affairs, a fairly good reference library, a reading room supplied with all the technical journals, and an auditorium equipped with a motion-picture machine.

Meetings are held weekly during the season and papers for presentation are arranged for by the various Sections in turn. The Club publishes a bi-monthly journal in which papers and discussions are printed, and issues a bulletin monthly, devoted to general news.

The Club has attempted in a dignified manner to influence the solution of public questions involving engineering and scientific consideration and maintains, among others, the following standing committees: Civic, City Plan, City Building Code, Quantity Surveying, and Good Roads. These committees watch legislation in city and state, and are frequently requested to coöperate with the municipal authorities.

STUDENT BRANCHES

Members of Student Branches are requested to notify the Secretary of any change in address as promptly as possible, in order to facilitate delivery of The Journal.

THE University of Cincinnati Student Branch extends an invitation to the Student Sections in the vicinity of Cincinnati to visit that city at the time of the Spring Meeting of the Society during the week of May 21. This, the Semi-Annual Meeting of the Society, offers to Student Members the opportunity to become better acquainted with the manner of conducting the work of the Society. Students are invited to attend the professional sessions and hear the discussions of engineering problems of the day.

One of the important features of the Spring Meeting will be the visits to industrial plants, of which there are a number in Cincinnati. Invitations will be extended to Student Members to accompany the parties on the various trips of inspection arranged to these plants, and also to the places of interest scheduled on the program, and in all probability students will be invited to attend the social affairs.

Plans are well under way for a big Joint Meeting of the Student Branches to be held at the University of Cincinnati. It is hoped that a goodly number will go to Cincinnati, and that this Joint Meeting of Student Sections will be a record breaker. This meeting will afford an excellent opportunity for the men from the colleges to become acquainted. The University of Cincinnati men are looking forward to this Joint Meeting with a great deal of anticipation.

On April 13, a convention of Student Members was held at the Engineering Societies' Building, New York, and delegates of the following branches participated: Columbia University, Lehigh University, New York University, Polytechnic Institute of Brooklyn, Rensselaer Polytechnic Institute, Stevens Institute of Technology and Syracuse University.

The meeting was divided into two sessions, the first of which was addressed by Prof. Lionel S. Marks, Mem.Am.Soc.M.E., on The Explosion Process in Gas Engines, by Prof. Arthur M. Greene, Jr., Mem.Am.Soc.M.E., on Pumping Engines, and Prof. Charles E. Lucke, Mem.Am.Soc.M.E., on Surface Combustion. Prof. F. R. Hutton, Mem.Am.Soc.M.E., opened the meeting with an introductory address in which he outlined the rapid development of the Student Branches of the Society, and spoke of the great benefit derived from joint meetings of branches.

Following the professional session, those present were shown through the Engineering Societies' Building, after which supper was served. In the evening a Smoker was held, at which Mr. "Jack" Armour, of *Power*, entertained and made a decided hit. All present joined in patriotic and college songs and Prof. William Kent, Mem.Am.Soc.M.E., spoke on the opening days of the war and compared them with the days of '61. A collation closed the meeting.

The Committee on Student Branches consists of Frederick R. Hutton, chairman, George M. Brill, William Kent and George A. Orrok; and John L. Kretzmer and James G. Manning, of Columbia, George H. Hauser, Jr., and Joseph Gilman, of N. Y. U., Arthur A. Bielek, chairman, and Frank R. Stamer of Poly, and Sprague Hazard and Alvin G. Searles of Stevens formed the committee on arrangements for the joint meeting.

ARMOUR INSTITUTE OF TECHNOLOGY

March 14. Mr. S. W. Thal gave an elaborate illustrated lecture on Automobile Ignition, followed by G. M. [illegible] talk on Walter Tractors.

March 28. After the regular business Mr. [illegible] talk on Thermit Welding. R. E. Marks spoke on Motion Pictures and G. M. Fritze discussed Trackless Trains thoroughly [illegible] interesting manner.

April 1. G. W. Jewell, of the Builders Iron Foundry, [illegible] illustrated lecture on the Venturi Meter, Its History, [illegible] and Uses. The lecture was followed by discussion.

Abe J. [illegible]
Branch Secretary

BUCKNELL UNIVERSITY

April 9. This was the first meeting of the Spring Term. C. D. Maurer, '17, gave an instructive talk on Power Plants, in which he described the equipment of the Shamokin Power Plant.

He was followed by Prof. F. E. Burpee, Mem.Am.Soc.M.E., who spoke on the Engineer Officers' Reserve Corps, and announced that he had offered the services of himself and the graduating class to the War Department.

C. M. Kriner,
Branch Secretary

CASE SCHOOL OF APPLIED SCIENCE

April 10. Advertising was the subject of an address by C. H. Henderson, of the Cleveland Twist Drill Co. The talk was full of snap, and contained much advice for the young engineer in business.

Alexander Trenhoft,
Branch Secretary

UNIVERSITY OF CALIFORNIA

March 24. The banquet held jointly with the Student Branch at Leland Stanford University was a great success. After many interesting addresses and excellent music, a number of the members of this Branch attended a theatre party.

April 3. William A. Doble, Mem.Am.Soc.M.E., read an interesting paper on the new Doble steam engine for automobiles, pointing out the principles upon which it is based. It was of timely interest and was much appreciated.

John H. Fenton,
Branch Secretary

CARNEGIE INSTITUTE OF TECHNOLOGY

March 21. W. O. Renkine, who is connected with A. M. Byers Co., addressed the Branch on the subject of powdered coal.

Mr. Renkine said that although powdered coal as a fuel had been experimented with as far back as a hundred years ago, the first practical application of it was not made until 1894 and was monopolized by the cement industry. Due to the high cost of oil and scarcity of natural gas it was found necessary, about two years ago, to experiment with powdered coal in the production of iron and steel.

In his talk Mr. Renkine described the various stages of pulverizing, storing and burning powdered coal, and the obstacles met with during the experimental development of the processes.

James H. Davis,
Branch Secretary

UNIVERSITY OF CINCINNATI

March 23. An interesting talk was given by Calvin W. Rice, Secretary Am.Soc.M.E., on the work that engineering societies are doing for the nation in regard to national defense. He described the formation of the Naval Advisory Board, the Munitions Standardization Committee and the Committee on Industrial Preparedness. He advised all students to participate in all student activities and to strive for responsible positions on committees that serve the business world. He also urged the students to make use of the free service of the Engineering Societies' Library.

[illegible] A. M[illegible], Mem.Am.Soc.M.E., depicted part of a [illegible] concern in the [illegible] explaining systems for numbering parts and [illegible] work throughout [illegible]. This was followed by [illegible] and employment problems. [illegible] devoted to the design of new [illegible] buildings. Location, light, sanitation and pleasant surroundings were mentioned as requisites for a satisfied working force.

Henry A. Wo[illegible],
Branch Secretary.

COLORADO AGRICULTURAL COLLEGE

[illegible] 3. A lengthy discussion regarding the process of manufacture of ball bearings was given by Prof. L. D. Crain, Mem.Am. Soc.M.E. The talk was well illustrated with slides from the S. K. F. Ball Bearing Co., and chief topics of the discussion were the various operations of manufacture, kinds of material used and the extensive application of ball bearings.

E. C. Johnson,
Branch Secretary.

UNIVERSITY OF COLORADO

April 10. At the regular meeting of the Branch, Prof. J. A. Hunter, Mem.Am.Soc.M.E., reported on the convention of the oil men called by the U. S. Bureau of Standards, at Washington, D. C., for the purpose of establishing standards by which gasoline and oils might be more uniformly classified. His report was supplemented by a description of the oil-testing equipment used in the Bureau, and a discussion followed.

W. S. Beattie,
Branch Secretary.

COLUMBIA UNIVERSITY

February 28. The United Engineering Societies of Columbia University were addressed by Charles Ferguson, who had accompanied Colonel House on a trip through Europe, and who, on his return, presented a report on industrial conditions there to President Wilson.

Mr. Ferguson said that he considered the engineer to be the dominant factor in the future regulation of society, and emphasized the importance of the engineers' viewpoint on vital matters. He said that those who conquered in the struggle of business competition would be better fitted to control the workings of the state than any other group of men, and the engineer is the man to develop the great business system to its fullest measure.

John L. Kretzmer,
Branch Chairman.

CORNELL UNIVERSITY

March 26. What is a Ship was the subject of an address by Prof. G. R. McDermott, naval architect and head of the ship-design department of Sibley College.

Professor McDermott pointed out that the developments of the modern day have made it necessary to include in the name *ship* airships and submarines. He explained the advantages of each of the different classes of ships. He described the problems of building and launching, and called attention to the fact that every branch of engineering is made use of in the construction of all vessels.

S. M. Barr,
Branch Secretary.

STATE UNIVERSITY OF IOWA

March 29. F. M. Kolar gave a talk on High Speed Steel, dealing with the annealing, hardening and tempering of it.

C. L. Severin,
Branch Secretary.

UNIVERSITY OF KANSAS

April 3. The Ninth Annual Meeting of the Branch was held in three sessions, with Dean P. F. Walker, Mem.Am.Soc.M.E., H. A. Fitch, W. C. Baxter, Mem.Am.Soc.M.E., Calvin W. Rice, Secretary Am.Soc.M.E., A. Hurlburt, Mem.Am.Soc.M.E., R. A. Rutledge and W. W. Walford as the speakers.

As a departure from the usual program, three illustrated lectures were given by S. K. F. Co., on the Present-Day Application of Ball Bearings; by the Lodge and Shipley Machine Tool Company, on the Manufacture and Testing of Lathes, and by the National Tube Co., entitled From Ore to Finished National Pipe, respectively. Dean Walker made the opening remarks, and Mr. Fitch spoke on Industrial Development in the Southwest. Mr. Baxter, who is connected with the Wichita Pipe Line Co., discussed Natural Gas Engineering, and he was followed by Mr. Rice, who spoke on the Engineer in Public Service. Mr. Hurlburt's topic was Engineering in Public Utilities.

At the afternoon session and the banquet in the evening Mr. Rutledge, Chief Engineer of the Santa Fé Railroad, gave an address on Qualifications for an Engineer, and Mr. Walford, head of the advertising department of this road, addressed the Branch on A Tour Through the Southwest.

April 12. Mr. L. H. Chase, head of the farm-machinery department, gave a very interesting talk on Agricultural Engineering and Its Importance.

Harlan A. Russell,
Branch Secretary.

STATE UNIVERSITY OF KENTUCKY

March 17. The Branch was most fortunate in securing Samuel Rea, President of the Pennsylvania Railroad, to speak at its meeting.

Mr. Rea related in an informal way some of the tremendous problems involved in operating the great system of which he is head, discussing these problems from both financial and engineering standpoints. He referred to the expansion of the system, telling how it was found necessary to build the two tunnels under the Hudson River between New York and New Jersey in order to meet the conditions of growing traffic.

By way of advice to the students present, he said that the man without a technical education cannot hope to compete in the field of engineering or other professions requiring technical knowledge with one having the advantages of such a training. He considered conditions in the profession were now more exacting than when he entered it, and stated that although he himself had been charged with supervisory responsibility for more than nine years he would not undertake the engineering details of some of the works which the Pennsylvania Railroad had undertaken in its tunnel construction.

April 8 to 15. Prof. F. Paul Anderson, Mem.Am.Soc.M.E., and Prof. W. E. Freeman, conducted the senior class on an inspection trip to Chicago and vicinity. The party paid visits every day to various industrial plants and points of interest.

D. S. Springer,
Branch Secretary.

LEHIGH UNIVERSITY

March 22. W. P. Berg, '17, and H. E. Kantner, '17, were the speakers. Mr. Berg gave a talk on the Manufacture of Paper from Wood Pulp, describing how the paper is prepared from chemically treated wood pulp, obtained from the wood either by the soda or bisulphate process, and so on through the various stages to the finished product. Mr. Kantner spoke on Present-Day Applications of Ball Bearings, bringing out the points in their manufacture, design and uses by means of a large number of lantern slides.

F. M. Porter,
Branch Secretary.

LELAND STANFORD JR. UNIVERSITY

March 24. The Branch joined with the University of California Branch in a banquet at the Engineers' Club of San Francisco. Dr. W. F. Durand, Mem.Am.Soc.M.E., acted as toastmaster, introducing as speakers W. K. Potts, C. E. Grunsky, Prof. H. B. Langille, Mem.Am.Soc.M.E. and G. W. Dickie, Mem.Am.Soc.M.E. The evening was greatly enjoyed by those present, and it is hoped to make this an annual event of the two Branches.

The form of program was somewhat original, showing a curve

on which the readings indicated the periods during the evening at which the various entertainment features would take place.

A. L. Morgan,
Branch Secretary.

LOUISIANA STATE UNIVERSITY

March 14. E. C. Freeland read a paper on Burning Bagasse, in which he compared the fiber content of the cane at various stages of the process of sugar manufacture. He illustrated the processes of burning bagasse.

J. A. Nadler,
Branch Secretary.

RENSSELAER POLYTECHNIC INSTITUTE

March 5. Dr. Ira N. Hollis, President Am.Soc.M.E., spoke on The Engineer and the National Crisis. Dr. Hollis, referring to the adage that "history repeats itself," gave illustrations in the present events; he also described what he considered efficiency and the attitude of the people toward the government, impressing upon the minds of those present that it was the duty of the engineer to increase the efficiency of the government.

H. M. Hammond,
Branch Secretary.

SYRACUSE UNIVERSITY

It has been the practice of the Student Branch to have as many good talks as possible given by men experienced in the engineering field at their meetings held every other week, and a debate between the mechanical and electrical Student Branches was a feature of the year.

R. M. Milford,
Branch Secretary.

UNIVERSITY OF MAINE

March 21. N. A. Robbins, Mem.Am.Soc.M.E., chief engineer of the Orono Pulp and Paper Co., outlined the growth of the power plant of this company and described the problems which have come up for solution in connection with it from time to time. The plant is a modern one in every way and furnishes a good example of an up-to-date power plant in a present-day manufacturing establishment.

R. E. Fraser,
Branch Secretary.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

March 23. John A. Stevens, Mem.Am.Soc.M.E., was the speaker at the smoker held by the Branch on this date. Mr. Stevens spoke of the value of the man to the company employing him and related many of his sea experiences while chief engineer of the S.S. St. Paul. K. C. Richmond, '16, spoke on Rock Tunnel Construction, describing the machinery used and stages in the work.

March 30. Patent Law was the subject of an address by a member of the class of '88, Odin Roberts, Mem.Am.Soc.M.E., a prominent patent attorney. Mr. Roberts gave examples illustrating the salient points of our patent law as it stands today.

E. P. Warner, '17, followed with a talk on The Stresses Developed in Aerial Propellers, illustrating his talk with plots and diagrams and a full-sized propeller to show sections and angles.

May 6. J. A. Moyer, Mem.Am.Soc.M.E., spoke on Steam and Gas Tnrbines, illustrating his talk with lantern slides. The speaker answered many questions about both types of turbines, materials used, efficiencies, etc. H. M. Brayton, '17, spoke on Engineering Charts.

Edward W. Rounds,
Branch Secretary.

NEW YORK UNIVERSITY

It was decided to replace the April meeting by the courses given especially for mechanical engineers at the Brooklyn Navy Yard. Passes were obtained for each member, and instruction was given on board the U.S.S. New Jersey under the supervision of a lieutenant detailed on this ship. Three courses were being given, Ordnance and Gunnery, Electrical and Steam Engineering, and Signaling and Navigation, but with the declaration of war these were discontinued. However, a course of signaling is being established at the University under the supervision of Prof. C. P. Bliss, and it is expected that most of the members will attend.

Joseph Gilman,
Branch Secretary.

OHIO STATE UNIVERSITY

March 21. Prof. John R. Allen, Mem.Am.Soc.M.E., gave an interesting lecture on Engineering in Turkey, in which he described the manner in which construction work is done there and the difficulties encountered. He urged the engineers to become proficient in foreign languages, as it is impossible to do an export business in one language. He stated that the American exporter through his shortsightedness, loses his greatest opportunity in the line of raw materials, by having to sell his goods through European salesmen who are able to speak the required language.

F. E. Smyser,
Branch Secretary.

OREGON STATE AGRICULTURAL COLLEGE

Mrch 15. Mr. Graf described the interesting things seen by him on his trip East. Mr. Goldman read a paper on The Engineer in Practice, in which he called attention to the opportunities open to the engineer.

April 5. After the transaction of the regular business, Mr. Peaslee gave an informal talk on the Engineer Officers' Reserve Corps and the Opportunity in It for Engineers, and Mr. Orr gave an informal talk on Plant Operation.

Arthur O. Leech,
Branch Secretary.

UNIVERSITY OF PITTSBURGH

April 12. Mr. Goldberg read a paper on the Uniflow Engine, treating of its economy, problems of design and development. The paper was discussed by Messrs. Noss and Lynch. At this meeting plans were talked over regarding the part to be taken by engineers in the Preparedness movement.

March 15. Mr. Hutcheson read a paper on Superheaters, which dealt with the progress and history of superheated steam. The paper was discussed by Mr. Wachter and Mr. Russo.

F. C. Noss,
Branch Secretary.

PURDUE UNIVERSITY

March 15. Mr. Hannun, of the mechanical department, spoke on the uniflow steam engine. His discussion dealt primarily with the type of uniflow engine manufactured by the Skinner Engine Co., with which he was formerly connected, and with the Stumpf engine.

March 27. Prof. L. W. Wallace, Mem.Am.Soc.M.E., talked along the lines of locomotive engineering, devoting special attention to the advantages of the superheater engine over that using saturated steam. The talk was based upon data derived from tests in the Purdue Locomotive Laboratory and that of the Pennsylvania Railroad, and was illustrated with many photographs.

W. G. Schutt,
Branch Secretary.

THROOP COLLEGE

March 5. A most successful joint meeting of the mechanical and electrical Student Branches was held, with Earl Ovington as the speaker.

Mr. Ovington, who is a pioneer in aviation, being the first man to fly a monoplane in the United States and the winner of several big races in exhibition flying, held the attention of his audience with descriptions of his wide experiences which he illustrated with lantern slides.

Reginald Coles,
Branch Secretary.

VIRGINIA POLYTECHNIC INSTITUTE

April [illegible]. The King of the Rails was the subject of a motion picture of much interest. The film was furnished through the courtesy of the General Electric Co.

April 19. G. F. Minor gave an interesting lecture on the Pelton Water Wheel, which was illustrated with slides supplied by The Pelton Water Wheel Co.

G. F. MINOR,
Branch Secretary.

UNIVERSITY OF WASHINGTON

March 9. The Branch held a meeting in Engineering Hall, when the object of the organization was outlined and plans for future meetings and trips were formulated. The following officers were elected: Chairman, Philip G. Johnson; Secretary, Claire L. Egtvedt, and Treasurer, Thomas P. Evans.

March 22. The accurate determination of secondary stresses in complicated steel castings, particularly truck frames and body bolsters of freight cars, was the subject of the lecture before the Branch by George B. Floyd, of the American Steel Foundry Co., of Chicago.

Mr. Floyd recited the advantages of the Berry extensometer in the determination of the weak parts in castings, and described in detail, with the aid of blue prints, the results of extensive experiments conducted by his company with this apparatus.

WALTER HENRY KURTZ,
Branch Secretary.

UNIVERSITY OF WISCONSIN

March 15. At the regular semi-monthly meeting of the Branch, A. G. Hoppe presented a paper on Advertising, in which he dealt with fake advertisements of an engineering nature found in non-technical journals, using an example from a current magazine.

March 26. The first annual banquet was held, with Calvin W. Rice, Secretary Am.Soc.M.E., as the guest of honor; Prof. G. L. Larson, Mem.Am.Soc.M.E., as toastmaster, Dean F. E. Turneaure and Prof. J. G. Callan as speakers.

As his message to the Branch, Dean Turneaure emphasized the value of Outside Activities for the Student and the Engineer. Mr. Rice urged the technical student to consider how he could best serve his country in the present crisis, suggesting that the trained man should not rush into private enlistment but hold himself in readiness to be placed where he can do the greatest amount of good. Professor Callan spoke upon the Broader Engineering Education, and commended the present tendency of engineering schools to broaden their training by the addition of cultural courses. A. E. Kelty, president of the Branch, gave the response.

March 29. Mr. Grant described the various methods he had tried in analyzing the vibration of an automobile engine. Magazine reviews were given by J. M. Wood, on the manufacture of steel balls; Mr. Roberts on the characteristics of the 1917 automobile, and Mr. Seelbach on the conference of motor-boat manufacturers with Secretary Daniels regarding small speed power boats for the Navy.

JOHN M. WOOD,
Branch Secretary.

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping anyone desiring engineering services. The Society acts only as a clearing house in these matters.

POSITIONS AVAILABLE

In forwarding applications, stamps should be enclosed for transmittal to advertisers; applications from non-members should be accompanied by a letter of reference or introduction from a member, such reference letter to be filed with the Society. Copy for notices must be in hand by the 15th of the month.

ESTIMATOR. Plant in Western New York manufacturing steel-plate tanks and receptacles, desires the services of estimator. In first letter state age, experience, training, single or married, salary, present employment. 634.

HEATING AND VENTILATING ENGINEER, young technical graduate, three or four years' experience. Location Ohio. 665.

SUPERINTENDENT for automobile-tire factory, man who understands compounding, and knows machinery and installation. Location Minnesota. 666.

PLANNING DEPARTMENT AND TIME-STUDY MEN. Well-established firm offers exceptional opportunities for effective and interesting work to engineering graduates with substantial experience with modern industrial accounting with special reference to time study, determination of standard tasks and planning and scheduling production. State age, education, experience, present and expected salary. 679.

DRAFTSMEN, experienced, preferably not over 30. Permanent employment and advancement to capable men. 751.

POWER ENGINEER for large industrial corporation operating own steam and electrical power plants. Young man with executive ability, mechanical or electrical-engineering graduate, experienced in power plant and power distribution, design, and operation. State age, school, year of graduation, detailed experience, salary expected. Location Michigan. 763.

PRODUCTION MANAGER, 30 to 40, married preferred, clean-cut, aggressive, of generous build. Technical graduate preferred. Must have had practical experience in every branch, such as shop work, drawing-room work, tool designing; must also have had successful experience of at least five years; must be thoroughly informed in modern cost and planning-department methods. Electrical manufacturing experience preferred, though not absolutely essential. Location vicinity of New York. Salary $3,000 to $4,000. 890.

ENGINEER for clock company in New England. Experience in handling men, up to 500, engaged in manufacture of woodworking parts from raw timber through to highly finished exterior, and supervising of numerous small parts in clocks. Must be capable of improving quality and increase output. 917.

THREE DRAFTSMEN, pipe work; steam, hydraulic, water, and air piping. Also MACHINE DESIGNERS and plant layout men. Also first-class STRUCTURAL STEEL and POWER-PLANT man. Location Ohio. 927.

DRAFTSMAN familiar with valve detail and design and experienced in estimating and layout work. Excellent opportunity for competent man. State age, experience in detail, references and salary expected. Location New York State. 928.

RECENT TECHNICAL GRADUATES for shop positions with company manufacturing recording meters, with opportunity to advance in other lines of work as business expands. Location Boston. 933.

YOUNG TECHNICAL GRADUATE with one or two years' experience in steam engineering, for testing work. Location New Jersey. State age, experience and salary expected. 939.

INSPECTOR, experienced in expediting machinery deliveries. Giving particulars, experience, etc. 942.

DRAFTSMAN on design of new machinery, equipment, general work in connection with plants of a steel and wire company. 945. American Steel & Wire Co., Mr. P. Morrison, Ch. Draftsman, Trenton, N. J. Telephone 3225.

THREE HIGH-GRADE ENGINEERS, thoroughly conversant with application of all phases of production and cost work, able to carry through alone handling of contracts. Essential qualifications, pro-

nounced power of observation and analysis, ability to plan and organize, practical type of mind, tact and sound judgment in dealing with clients. Headquarters New York. 946.

FACTORY ENGINEER, technical graduate, with successful record as assistant superintendent or superintendent for concern manufacturing polishing and bufing wheels, and employing 150. Must be conversant with scientific management and able to secure, retain and handle successfully both men and women. Give age, experience, education, and salary expected. Permanent position with splendid future for right party. 948.

DRAFTSMAN experienced in factory design and installation of elevator and conveying machinery in general cement-plant work. Location Pennsylvania. 949.

RECENT ENGINEERING GRADUATE to take up economy studies in pole-line and cable-plant construction. Man having some experience in estimating cost of such construction given preference. State experience and salary desired. New York. 952.

MAN to run COST OFFICE. One with practical machine-shop experience, and who understands theory of cost accounting, and has had experience in instructing clerks. Employ about 475 in diversified work with foundry, pattern and machine shop. Salary $25 a week. Location Massachusetts. 953.

ENGINEER. Young technical graduate to engineer, design and take charge of production of electro-mechanical devices, and to conduct performance tests on standard and special designs. Salary to start $100. Location Middle-West. 954.

CHIEF ENGINEER for industrial power plant operating 10,000 boiler hp. and 5,000 electrical. Must be well up on combustion and plant maintenance. State salary. Location North Carolina. 956.

ENGINEER on design and experimental work. Good personality. Salary to start $1200. Location Elizabeth, N. J. 957.

COMPANY with factory in western Maryland desires man with technical training, in the capacity of assistant designer and works manager. To assist in designing special machinery and developing ideas; analyze machine operations, prescribe equipment and devise means to effect speedy and economical production; superintend manufacturing such machinery. Requires ability of thoroughly practical master mechanic with original ideas as to methods, knowledge of modern shop practice, familiarity with design and application of time-saving fixtures, executive ability and diplomacy necessary to successfully direct manufacturing plant. No question of salary if right man applies. In first letter state full particulars and experience from technical degree which will be held confidential. 958.

SALESMAN, steam power-plant specialties. College graduate preferred, and, if possible, having experience in similar line of work in Philadelphia. Should be capable of taking charge of office eventually. 959.

DRAFTSMEN (three or four) experienced in plant layouts and special-machinery design. 963.

PRODUCTION ENGINEER to take charge of cost-reduction work in Canadian shop manufacturing air compressors, rock drills. State age, experience and salary expected. 974.

INDUSTRIAL PLANT ENGINEER. Mechanical engineer, preferably college graduate, with several years' all-round experience which would fit him to take charge of design, construction and maintenance of factory buildings and equipment. Good opportunity with large growing company, desirably situated. Location New York. 977.

PRODUCTION ENGINEER, must have thorough factory experience on motor-truck construction, organization, production, equipment and accounting. Live wire. State age, experience and salary desired. 988.

DRAFTSMAN, technical graduate, familiar with design of power-station installations, steam piping and fair amount of structural work. State age and experience. Location Brooklyn, N. Y. 990.

MECHANICAL ENGINEER having had technical education and at least five years' experience in plants manufacturing chemicals. Work mainly advisory engineering work in connection with manufacture of chemicals. Address, E. I. duPont de Nemours & Company, Engineering Department, Wilmington, Del. 991.

DRAFTSMAN wanted immediately by Chicago rubber works. Ingenuity is prime requisite. To work from rough sketches of labor-saving appliances. Permanent. Salary $25 for six months, $35 for next six months, future advances contingent on ability. Describe physical condition and education, state months on previous jobs and approximate hours per month in each kind of duty. 992.

MEN AVAILABLE

Only members of the Society are listed in the published notices in this section. Copy for notices should be in hand by the 15th of the month, and the form of the notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

ENGINEER desires position in connection with maintenance or production of railway rolling stock and equipment or production incident to national defense. At present employed. Twenty years' experience in design and construction of industrial and railway mechanical equipment. Highly specialized in practical application of applied science, locomotives, cars, trucks, boilers, engines, turbines, tanks and special machinery, shop layouts and power plants, towers and structural work. E-158

MECHANICAL ENGINEER, 27, at present employed as assistant master mechanic with large packing company. Experienced in power-house design and layouts with refrigerating machines and steam plant; also general packing-house building, machine repairs and layouts. E-159

MECHANICAL ENGINEER, 30, M. E. graduate, practical shop, power-plant, drafting, plant maintenance, and production experience. Desires position in engineering, estimating, or maintenance department of reliable concern. Location immaterial. E-160

STUDENT MEMBER, 22, will graduate in June in mechanical engineering, University of Michigan. Desires position as assistant to chief engineer, production manager, or superintendent for manufacturing concern, preferably Ohio or Michigan. Has had experience in drafting and office work. Will furnish references. E-161

MECHANICAL ENGINEER, 28, desires junior partnership or interest in consulting or contracting firm. Will make investment or consider position on salary. University graduate, 3 years' experience, one year in Europe, in power-generation design and construction, industrial-plant design, investigations. Would consider locating permanently in Europe, particularly Russia. E-162

SUPERINTENDENT or CHIEF ENGINEER, 44, married, technical education. Twenty years' experience as chief engineer in brewery, railroad shops, largest stove foundry in world, and chemical works; manager electric light plant, superintendent foundry and machine shop, superintendent ice-machine factory, chief smoke inspector large city, and mechanical superintendent of hospital. Combustion engineering specialty. Desires position in large industrial plant or other responsible position. Highest references. Present salary $3600. E-163

RESEARCH ENGINEER. Assistant professor of mechanical engineering in leading university, ten years' continuous teaching experience, desires to engage for year in commercial research work, either in commercial laboratory or with power-generating equipment. Experience previous to teaching includes several years' commercial engineering and two years' sales work. Would consider instructional work in another school. E-164

MASTER MECHANIC, 29, M. I. T. graduate, '11. Selling experience. At present employed. Open to any live proposition with chance to progress. E-165

PUBLIC-UTILITY VALUATION ENGINEER, 27, M. I. T. graduate. Desires change from present position to one offering more opportunity for advancement. Three years' extensive experience inventory and appraisal water, gas, electric, traction, and telephone public utilities in East, as mechanical engineer in appraisal department of state public utility commission. Thoroughly familiar with efficient methods of construction and management of above corporation. Special training with unit-cost studies, estimation of annual and accrued depreciation and overhead charges. Author of technical articles on overhead charges and depreciation. Good draftsman. Capable taking charge field or office valuation department. Unmarried. Salary about $2000. E-166

ASSISTANT TO ENGINEER OR SUPERINTENDENT. Graduate mechanical engineer, 22, shop and estimating experience. Seeks position of some responsibility, with good future. Location preferred, Eastern States. E-167

MECHANICAL ENGINEER, graduating from well-known university in June, desires position with future, preferably in connection with consulting engineer's office. References given. E-168

INDUSTRIAL ENGINEER, technical graduate, 31, desires position as general superintendent or works manager in moderate-size plant with view to making permanent connection. At present employed as industrial engineer by large Eastern manufacturing corporation; work

nearing completion with this concern after six years' service. Wide experience in purchasing materials, employment of all classes of labor, design and layout of factories, and installation of scientific production methods, standardization and management in various industrial plants. E-169

FOUNDRY MANAGER or SUPERINTENDENT. Practical foundryman, capable of filling any foundry position. Charge of some of largest foundries in country for past 15 years. Best references as to ability. E-170

PLANT ENGINEER. Graduate mechanical engineer, with good practical experience in design, operation, and maintenance of industrial machinery and power plants. Specialized in combustion of anthracite and bituminous coals and generation of cheap power. Experienced in use of electricity in manufacturing plants. Location New York or vicinity. E-171

MECHANICAL ENGINEER, 15 years' experience in power plant and factory design, 10 years in responsible charge, now completing installation of power plant out of town, wishes to return to New York City. Accustomed to take full charge of design, purchase of apparatus and material, supervise construction, etc. Experience includes factory production and special tool design. Salary $3000-$4000. E-172

PROFESSOR OF MECHANICAL ENGINEERING desires work during vacation, from June 1 to September 20, teaching or practical work. Has had machine shop and drafting experience. E-173

MECHANICAL ENGINEER, 30, married, desires position with consulting engineer or as works engineer of medium-sized industral plant. Experience on steam-power plant and industrial-plant design and maintenance. E-174

MANUFACTURER'S REPRESENTATIVE. Graduate engineer maintaining engineering office in Twin Cities desires to represent manufacturer of mechanical line in Northwest. E-175

HIGH-SCHOOL HEAD OF DEPARTMENT. Technical and college graduate. Seven years in present position. Five years' shop experience. Employed at present, but desires to make change at end of semester. E-176

PRODUCTION ENGINEER. Graduate M. E. One year preliminary training with well-known firm of efficiency engineers, backed up by 5 years' practical experience in several industries. Have installed and operated cost systems, and organized and supervised work of planning departments. Competent organizer along modern lines, capable executive, and can handle men and produce results. Employed at present, but desires to form new connections, preferably as assistant to factory manager. E-177

PROFESSOR OF MECHANICAL ENGINEERING, technical graduate, 17 years' experience in teaching, engineering and consulting work. Practical experience in commercial engineering; specialized in steam-power plants. Head of department of mechanical engineering in leading university for number of years, and at present head of departments of mechanical and electrical engineering in university of good standing. Location abroad, China preferred. E-178

SUPERINTENDENT or EQUIPMENT ENGINEER. For past two years with large rifle works, in charge of installing equipment, manufacturing and heat treating. Thorough knowledge of modern methods for producing interchangeable parts. E-179

YOUNG TECHNICAL GRADUATE in mechanical engineering, with two years' general shop practice, wishes to change from present position. E-180

MECHANICAL ENGINEER, 30, university graduate. Five years' experience in factory layout, construction, power-plant design, heating and ventilating. Familiar with modern methods of factory and power-plant operation. Desires position as chief engineer or works engineer with manufacturing plant. Salary $250 per month. E-181

ASSISTANT SUPERINTENDENT, PRODUCTION ENGINEER, MAINTENANCE SUPERINTENDENT, CHIEF TOOL DESIGNER. Twenty years' practical experience in shop and drafting room as machinist, master mechanic, shop foreman, tool designer, chief draftsman. Design and supervision of construction tools, labor-saving devices, routing factory layout, installation and maintenance of equipment. Now employed as chief draftsman in munition plant. Seeks position with future. Location immaterial. E-182

MECHANICAL and ELECTRICAL ENGINEER. Technical graduate, 28. Four years in production and engineering; engines, pumps, compressors, motors, and generators. Three years' municipal work, electrical and gas. E-183

ENGINEER and SUPERINTENDENT. Cornell graduate, with extensive experience in designing, purchasing, constructing and operating power plants, track work transmission lines, distribution lines, car barns, office buildings, foundries, machine shops, chemical plants, tanneries, cotton mills, gun cotton and smokeless-powder plants, factories of reinforced concrete, flat slab or mill construction, also structural-steel docks, piling, sewers, and artesian wells, heating and drying systems. E-184

ASSISTANT TO PURCHASING AGENT. Varied practical and office experience, engineering materials, electrical and mechanical equipment and matters pertaining to construction. E-185

MECHANICAL ENGINEER. Stevens graduate, 26, married. Experience in steel-rolling mill. Desires position as works engineer. At present employed. East preferred. E-186

EXECUTIVE, until recently connected with one of Detroit's largest automobile concerns, desires responsible position. Experienced in modern methods of economical, intensive manufacturing. Competent to organize and handle large bodies of men. Selling experience this country and abroad. Salary $10,000 to $15,000, depending on character of employment offered. E-187

AUTOMATIC MACHINE DESIGNER, experienced in designing special machinery to economize labor and facilitate production. Has inventive faculty. Could reduce cost and increase production of plants manufacturing specialties. Permanent employment not required, but will study problems, make suggestions, and design special machines, tools, and attachments. Available about June 1. E-188

GRADUATE in mechanical engineering, '14, two years' experience in general testing work, with some machine-shop and foundry experience, desires position as testing engineer or assistant to engineer in charge of power plant operation. E-189

GRADUATE M. E., 25, Chinese, one and a half years' experience in shops and office, desires situation with aeroplane company or manufacturing concern with commercial interests in the Far East. E-190

MECHANICAL ENGINEER or ASSISTANT SUPERINTENDENT, technical education, 31, married. Twelve years' experience in manufacturing plants as toolmaker, toolmaker foreman, machine designer, chief draftsman, factory superintendent, and now as mechanical engineer in large rifle factory. Fully conversant with interchangeable manufacture. Salary $2600 per year. E-191

MECHANICAL ENGINEER. Technical graduate, 12 years' practice, desires change. Especially experienced in modern methods of boiler-room operation and maintenance, designer on heavy machinery, designer and engineer of construction on steel-frame buildings, plain and reinforced concrete. Experienced executive. E-192

ASSISTANT SUPERINTENDENT or EXECUTIVE, American, 36, technical education. Twelve years in drafting room, including chief draftsman; six years' shop experience, one as foreman. Practical mechanic, familiar with design of special machinery, tools, jigs, fixtures, etc., for manufacturing duplicate parts on interchangeable system. Salary $2000 per annum. Location preferred, Eastern States. E-193

EXPERIMENTAL or WORKS ENGINEER, RESEARCH ENGINEER, PROFESSOR OF MECHANICAL ENGINEERING. Experienced mechanical and civil engineer, now engaged in munition manufacture, open for engagement. Graduate of leading university, also member S. A. E., experienced in teaching and engineering work of all kinds. Would locate in England or France. E-194

DESIGNING ENGINEER, 30, married. Ten years' English and American experience in commercial trucks, tractors and motor fire apparatus; exceptional experience on front-wheel-drive trucks and interchangeable manufacture. Associate Member M.I.M.E. Minimum salary $2400. E-195

MECHANICAL ENGINEER, ten years' experience in coal and power-plant testing, and design and use of instruments for obtaining highest economy. Desires position with consulting engineer or testing department of large operating company. E-196

FUEL ENGINEER. Graduate M. E., 28. Three and a half years' shop experience. Three years with anthracite and bituminous coal mining companies; mining, preparation, sales, specifications, contracts, laboratory, and power plant testing. Experience with Federal Bureau of Mines and consulting engineers. At present employed. E-197

COLUMBIA GRADUATE, M. E., two years' experience in production and inspection departments, both in shop and in office, would accept position near New York City offering opportunity for advancement. Salary to start $1300. At present employed. E-198

ENGINEERING SURVEY

A Review of Engineering Progress and Attainment in Mechanical Engineering and Related Fields, Including a Digest of Current Technical Periodicals and a Selected List of Engineering Articles

THE scope of the Engineering Survey has now been extended to include a monthly review of progress and attainment in the mechanical engineering and related fields, in accordance with plans developed by the Publication Committee. In this number, issued at the beginning of our participation in the great war, foremost attention is given to the agencies through which engineers are working in coöperation with the Government *to bring the war to a successful issue.* These are mainly comprised by the Naval Consulting Board, the National Research Council, the Advisory Commission of the Council of National Defense, the Federal Shipping Board, and the National Advisory Committee for Aeronautics: together with the various sub-committees and boards organized under the direction of these major bodies. The constitution and objects of these organizations are described, as well as some of their most important accomplishments to date.

The Naval Consulting Board

THE first concerted effort toward coöperation between the Government and civilian engineers in this country was made in 1915 when Secretary Daniels of the United States Navy Department invited eleven engineering and scientific societies to form an advisory board of 23 members, constituting the Naval Consulting Board, headed by Thomas A. Edison. The American Society of Mechanical Engineers was represented on this board by 12 members, two, W. L. R. Emmet and Spencer Miller representing it officially.

The Naval Consulting Board resolved itself into committees, one of which, headed by Howard E. Coffin, Mem.Am.Soc.M.E., was the Committee on Production, Organization, Manufacture and Standardization. This Committee formulated a plan for a census and classification of the manufacturing establishments of the country which was effected through individual and painstaking work by members of the National Societies of Civil, Mining, Mechanical and Electrical Engineers and the American Chemical Society. A director for each State in the Union was appointed by each society, whose immediate work was to obtain an accurate inventory of the facts necessary to be known to the Army and Navy about the capabilities of our Nation to supply munitions in case of war.

This great work was carried through successfully and the returns received from 27,000 of the larger plants showed most impressively the almost unlimited resources which Industrial America is now able to place at the disposal of the Government for the prosecution of the war.

The data collected by the Committee on Industrial Preparedness of the Naval Consulting Board have been turned over to the Council of National Defense, where they are at the disposal of Director Walter S. Gifford, who had charge of the tabulation of the statistics as they were accumulated by the Committee on Industrial Preparedness.

The Naval Consulting Board is now devoting its attention mainly to passing judgment upon inventions submitted to the War and Navy Departments, so that the Nation may not only have the advantage of the work of its inventive citizens, but also will be shielded from having to consider worthless or unpromising inventions. The Secretary of the board is Thomas Robins, 13 Park Row, New York.

National Research Council

THE National Research Council of the National Academy of Sciences was formed at the request of the President of the United States in September 1916, for the promotion and furtherance of scientific research. The conception of the National Research Council is due to Dr. George E. Hale, Director of Mount Wilson Solar Observatory, who has visited Europe in order to obtain information upon the steps that were being taken in England and France in research and in coördinating the activities of scientific men for the purposes of war.

The officers of the Council are: Chairman, George E. Hale; First Vice-Chairman, Charles D. Walcott; Second Vice-Chairman, Gano Dunn, Mem.Am.Soc.M.E.; Secretary, Cary T. Hutchinson, Mem.Am.Soc.M.E., the office of the Secretary being in the Engineering Societies Building, New York. The Chairman, Dr. Hale, was authorized to appoint an executive committee to consist of ten members, in addition to the President of the National Academy of Sciences, Dr. William H. Welch, the Chairman and the two Vice-Chairmen. Dr. Hale appointed the following members: J. J. Carty, Russell H. Chittenden, Edwin G. Conklin, Gano Dunn, Mem.Am.Soc.M.E., Robert A. Millikan, Arthur A. Noyes, Raymond Pearl, M. I. Pupin, S. W. Stratton, Mem.Am.Soc.M.E., and Victor C. Vaughan.

The work of the Council has been carried on by the Executive Committee, which has held twelve meetings, the outcome of which is principally the appointment of a number of committees to report upon and organize research in different branches of science.

Military Committee. First in importance is the Military Committee for governmental research requirements, composed of three representatives of the Army, General Gorgas, General Crozier and General Squier, the heads, respectively, of the Medical, Ordnance, and Signal Corps Departments of the Government: of four representatives of the Navy, Admirals Taylor, Griffin, and Earle, and Dr. Gatewood, the heads, respectively, of the Construction, Engineering, Ordnance, and Medical Departments of the Navy: and of the heads of certain civilian bureaus of the Government. This committee will operate more or less independently.

Census of Research. This committee, acting under Dr. Stratton, is preparing to make a census of all research men and materials in the United States.

Research in Industrial Institutions. This represents an undertaking of great importance, under the direction of Mr. Carty. This committee expects to devise means by which the smaller industries can have the advantage of scientific re-

[illegible] through some scheme of coördination and the employ-[illegible] of some existing research means for the purpose of [illegible] the work itself.

Nitrate Supply Committee. This committee is directed by Dr. A. A. Noyes, and it has already done noteworthy work. It has been asked to advise the Government regarding the expenditure of $20,000,000 that Congress has appropriated for the purpose of providing a supply of nitrates; hence its work has an immediate practical bearing.

The personnel of an Engineering Committee is now being completed, as explained in the Society Affairs section of this number in the communication from Mr. Gano Dunn.

The Engineering Foundation, which is administered under the auspices of the United Engineering Society and the national Societies of Civil, Mining, Mechanical and Electrical Engineers has placed its funds at the disposal of the National Research Council for organization and operation expenses.

The National Research Council is maintaining close relations with the Council of National Defense in its work and preparation for the industrial activity which will accompany the prosecution of the war.

Council and Advisory Commission of National Defense

COINCIDENT with the Naval Consulting Board there was in process of formation the Council of National Defense which was organized as a result of the act of Congress of August 29, 1916, "for coördination of industries and resources for the national security and welfare." It was "to consist of the Secretary of War, the Secretary of the Navy, the Secretary of the Interior, the Secretary of Agriculture, the Secretary of Commerce and the Secretary of Labor."

The act further provided for the appointment by the President of the United States of an Advisory Commission of seven members having "special knowledge of some industry, public utility or the development of some natural resources or be otherwise specially qualified.. . . ." Two months later, the Commission was appointed, as follows:

Daniel Willard, President, Baltimore and Ohio Railroad

Howard E. Coffin, Mem.Am.Soc.M.E., Vice-President, Hudson Motor Car Company

Dr. Hollis Godfrey, Mem.Am.Soc.M.E., President of the Drexel Institute

Julius Rosenwald, President, Sears, Roebuck and Company

Samuel Gompers, President, American Federation of Labor

Bernard M. Baruch, Financier

Dr. Franklin H. Martin, Surgeon

The members of the Advisory Commission serve in a consulting capacity without compensation and are in practically constant attendance at Washington.

The organization opens up a new and direct channel of coöperation between business and scientific men and all departments of the Government, and constitutes a rallying point for civic bodies working for the national defense. Among other functions defined by President Wilson are: (1) coördination of all forms of transportation and the development of means of transportation to meet the military, industrial and commercial needs of the case, and (2) the extension of the industrial mobilization work of the Committee on Industrial Preparedness of the Naval Consulting Board.

One of the chief objects of the Council is to inform American manufacturers as to the part they can, and must, play in the national emergency. It has established and maintained through subordinate bodies of specially qualified persons, auxiliary organizations composed of men of the best creative and administrative capacity.

The constitution of the Council and Advisory Commission of National Defense is as follows:

THE COUNCIL

The Secretary of War, Chairman; the Secretaries of the Navy, Interior, Agriculture, Commerce and Labor.

THE ADVISORY COMMISSION

Headquarters, Munsey Building, Washington, D. C.

Daniel Willard, Chairman; and Messrs. Baruch, Coffin, Godfrey, Gompers, Martin, and Rosenwald as enumerated above.

Director of the Council and of the Advisory Commission, Walter S. Gifford.

Secretary of the Council and of the Advisory Commission, Grosvenor B. Clarkson.

Chief Clerk and Disbursing Officer, E. K. Ellsworth.

COMMITTEES

1 Transportation, including railroad and motor transportation, and Communication, Daniel Willard, Chairman.

2 Munitions, Manufacturing, including standardization and industrial relations, Howard E. Coffin, Chairman.

3 Raw Materials, Minerals and Metals, Bernard M. Baruch, Chairman. Sub-Committees: Oil, Wool, Steel, Nickel, Copper, Leather, Rubber, Brass and Aluminum.

4 Labor, including conservation of health and welfare of workers, Samuel Gompers, Chairman.

5 Supplies, Clothing, etc., Julius Rosenwald, Chairman. Sub-Committees: Cotton Goods, Woolen Goods, Shoes and Leather.

6 Science and Research, including engineering and education, Dr. Hollis Godfrey, Mem.Am.Soc.M.E., Chairman: Dr. Henry E. Crampton, Vice-Chairman.

7 Medicine, including general sanitation, Dr. Franklin H. Martin, Chairman.

COMMITTEES OF ADVISORY COMMISSION

The Transportation Committee mentioned above was organized under the direction of Daniel Willard, with the assistance of the American Railway Association which met in conference at Washington and nominated members for the committee. There are four sub-committees working with the Department Commander in each of the four military divisions of the country, to provide for rapid transportation of troops and supplies in times of emergency. Another sub-committee has been formed representing the leading telephone and telegraph companies of the country, headed by Theodore A. Vail. A Motor Transport Committee, headed by Alfred Reeves, General Manager of the National Automobile Chamber of Commerce, has been appointed for the purpose of mobilizing the motor vehicle resources of the country for emergency purposes.

The Munitions Manufacturing Committee, of which Howard E. Coffin, Mem.Am.Soc.M.E., is Chairman, supervises the work of sub-committees on munitions, and all matters pertaining to the selection of manufacturers for the production of munitions, and assists manufacturers in getting out the work properly and without delay. An aircraft board coming under the general direction of this committee is now being formed.

The Raw Materials Committee has been estimating the amount of materials that would be needed to put an assumed force of one million men in the field and the provisions and supplies required for each 90 days of service. Sources of

supply are to be studied and it is expected to be able to determine in advance any deficiencies which may exist in the resources of the country. This committee, at the instance of Mr. Baruch, has secured action whereby copper will be supplied to the Government at 16 2-3 cents per lb. and steel at greatly reduced prices.

Committee on Labor. Mr. Samuel Gompers, as Chairman, is working in coöperation with Mr. Coffin whose committee is charged, among other duties, with the question of industrial relations and proper method for building up an industrial reserve. Whereas a soldier may be made in a few months, it requires a corresponding number of years to make a skilled mechanic. Mr. Coffin has recently remarked that "in modern warfare the blood of the soldier must be mingled with three parts of the sweat of the man in the mills."

Committee on Science and Research, under the direction of Dr. Hollis Godfrey, Mem.Am.Soc.M.E., has been working out a fundamental plan for education in the higher institutions of the country during the period of war which, however, is primarily as a basis for peace. This plan considers, among other matters, the placing of emphasis on such branches of engineering or other subjects as pertain to the efficient production of materials of war, or to efficient work on the part of young graduates entering into Government service. This committee, also, enlists the service of engineers in whatever capacity they may be needed by the Council during the period of the war. Other developments of this committee are now reaching the point of publication and will be referred to from time to time.

SUB-COMMITTEES AND BOARDS

There have also been various sub-committees and boards appointed by the Council and Advisory Commission, of which the following are of the greatest interest to engineers:

Munitions Standards Board, under the general direction of the Munitions and Manufacturing Committee, dealing, in coöperation with the Government, with drawings and specifications, jigs, fixtures, etc.; Frank A. Scott, Mem.Am.Soc.M.E., Vice-President, The Warner and Swasey Company, Cleveland, O., Chairman. The other members are:

William H. Van Dervoort, Mem.Am.Soc.M.E., President, Moline Automobile Company, Moline, Ill.

Edward A. Deeds, Mem.Am.Soc.M.E., President, The Dayton Engineering Laboratory Company, Dayton, O.

Francis C. Pratt, Mem.Am.Soc.M.E., Assistant to President, General Electric Company, Schenectady, N. Y.

Samuel M. Vauclain, Mem.Am.Soc.M.E., Vice-President, The Baldwin Locomotive Works, Philadelphia, Pa.

John E. Otterson, Mem.Am.Soc.M.E., Vice-President, Winchester Repeating Arms Company, New Haven, Conn.

This Board, with other agencies, is bringing to the War and Navy Departments the knowledge acquired by the manufacturers of the country in making munitions for foreign governments, and other expert knowledge regarding the requirements for quantity production which is essential in the preparation of the proper drawings and specifications by the War Department. It is adapting peace-time standards to war-time conditions and endeavoring to avoid the difficulties of production which were encountered at the outset by the Allies. At that time Germany was the only country which had the methods of manufacture carefully worked out in detail. The experience of the belligerent countries in these matters is invaluable.

An important sub-committee of this board relates to small arms and ammunition, of which J. E. Otterson is Chairman. Like the larger committee, this one is endeavoring to coördinate the ideas of manufacturers and of the Government experts to standardize materials and design as far as practicable under the existing emergency conditions. Consideration is being given to the use of manufacturing facilities as they now exist as a result of the orders placed by foreign governments, in order to render the promptest service possible.

It is expected that the Government will accept foreign designs in some instances at least, in order to insure more prompt delivery through the utilization of components, dies, fixtures, etc., that are already in existence and in working order. Where designs can be changed to conform to United States Government standards without causing material delay in delivery, this will probably be done. In the case of rifles, a foreign design has been proposed; but in the case of cartridges, it is likely that the Government will require the United States Government cartridge.

General Munitions Board. Following the appointment of the Munitions Standards Board, there was formed a General Munitions Board headed by Frank A. Scott, Mem.Am.Soc.M.E., and comprising in its membership seven representatives of the Army, eight of the Navy, besides Messrs. Baruch, Coffin, Rosenwald and Martin of the Advisory Commission. The Secretary is Chester C. Bolton. The officers serving on the Board were designated by the chiefs of the several departments and bureaus, under authority of the Secretaries of War and of the Navy.

The purpose of the board is to assume the prompt equipping and arming of whatever forces may be called into the service of the country with the least possible disarrangement of normal industrial conditions. Its immediate efforts will be directed toward coördinating the making of purchases by the Army and Navy, to assist in the acquirement of raw material and manufacturing facilities and to establish the precedence of orders; but it is not intended that the board shall have authority to issue purchase orders or to bind the Government in contracts for purchase.

Commercial Economy Board, of which A. W. Shaw, President of A. W. Shaw Company, is Chairman, and Dr. Hollis Godfrey, Chairman of the Committee on Science and Research, is a member. This board is designed to meet in advance problems of war-time distribution and to bring business men together in a scheme of voluntary coöperation to eliminate waste by adopting commercially efficient methods: In short, to nationalize distribution.

Food Board, the Chairman of which is Herbert C. Hoover, Mining Engineer and head of the American Commission for Relief in Belgium. At the time of his appointment, Mr. Hoover sent from abroad, by Associated Press, a strong statement of the needs and opportunities of such a board. He has instituted an inquiry abroad into the methods used to control prices and for the elimination of speculation. From the fact that America must become the food source for a large part of the world's population, he proposes that the Food Board shall take such guiding action as may be necessary to increase the production of food, to conserve as well as to increase farm labor, to instill a willingness for the elimination of waste, to control the exportation of food and to prevent speculation or undue profits.

SIGNIFICANCE OF THE ADVISORY COMMISSION

The importance of the work which the Advisory Commission is accomplishing in this crisis in the Nation's history is per-

[illegible] not fully realized by the engineering public. Legally, the Advisory Commission has no executive power; in point of fact it has at its command information to supply the Nation with the same service that is rendered to the British nation by the representative business men appointed by Mr. Lloyd George's cabinet for the war reorganization of the British industries. While Mr. Willard, the Chairman of the Advisory Commission, is not the equivalent of the British Minister of Munitions, the service which he is rendering in the capacity of chairman is entirely comparable to that of the British minister, save the legal authorization to enforce his recommendations. The plan is American in its conception and administration. It is believed that as the duties of the commission are now organized no additional cabinet positions will be required in the conduct of the war, since, by informal extension of the power granted to Mr. Willard and his colleagues, as occasion may demand, the growing activities of the Government will be amply provided for.

National Advisory Committee for Aeronautics

Another important board is the National Advisory Committee for Aeronautics, organized under Act of Congress of March 3, 1915, from representatives of Government departments and expert engineers and scientists nominated by the President.

The board as at present composed consists of the Secretary of the Smithsonian Institution, Dr. Charles D. Walcott; the Director of the Bureau of Standards, Dr. S. W. Stratton, Mem.Am.Soc.M.E.; the Chief of the Weather Bureau, Prof. Charles F. Marvin; two officers of the Navy, two officers of the Army, and an officer of the Treasury Department. These representatives of Government bureaus are supplemented by four scientists at large, namely, Prof. Michael I. Pupin, of Columbia University; Prof. Joseph S. Ames, of Johns Hopkins University; Prof. John F. Hayford, of Northwestern University, and Prof. William F. Durand, Mem.Am.Soc.M.E., of Leland Stanford Junior University, Chairman.

Shortly after its organization the National Advisory Committee entered into an arrangement with various industrial companies specializing in aeronautical supplies and with several universities to conduct investigations on various matters of importance in the new art. Thus an investigation on pitot tubes was entrusted to the Bureau of Standards, and the Weather Bureau was commissioned to undertake the preparation of a report on the problem of atmospheric conditions in relation to areonautics.

The John A. Roebling Sons Co. undertook an investigation of aviation wires and cables. The Goodyear Tire and Rubber Co. was asked to investigate the relative worth of improved fabrics, and the United States Rubber Co. the allied subject of balloon and aeroplane fabrics.

At Leland Stanford Junior University an aeronautics laboratory was equipped and extended experiments are under way on the performance of different designs of propellers. Finally, Columbia University was given the difficult and important subject of thermodynamic efficiency of present types of internal combustion engines.

The reports of the advisory committee as a whole, and the various organizations entrusted with special investigations, in so far as they have been published, represent contributions to the science of aviation of the greatest value. Thus, Report No. 11, entitled *A Preliminary Study of the State of the Art of Carburetor Design*, prepared by Charles E. Lucke, Mem.Am. Soc.M.E., Professor at Columbia University, is a volume of 552 pages, probably the most complete and exhaustive study of carburetor design and performances available in any language.

Since the formation of the National Advisory Committee it has acted as the central source of information and research, as well as the clearing-house on all work on aviation carried on by the Government. In addition it has done valuable work in bringing together manufacturers of aircraft and accessories and officials of the Government interested in the progress of aviation. These conferences have been of great value in clearing up the ideas of all concerned.

The Advisory Committee has also done yeoman service in developing aviation in connection with the work of the Post Office and Treasury Departments. At present it is actively collaborating with the War and Navy Departments and the Council of National Defense.

Federal Shipping Board

Of the civilian organizations, other than those already mentioned, which are rendering expert service to the Government, the most important and far-reaching in its probable effect on the war is the Federal Shipping Board. This board was organized as a result of the Ship Purchase Bill of August 1916, and the names of its members were sent to the Senate by President Wilson in December 1916. William Denman, Merchants' Exchange Building, San Francisco, is the chairman of the board.

As very fully announced in the daily press, plans are being completed for the construction of wooden cargo vessels on a gigantic scale, to be leased to citizens of the United States for operation in foreign trade.

On April 17 the United States Shipping Board Emergency Fleet Corporation was chartered in the District of Columbia, with a capital stock of $50,000,000, the amount authorized by Congress for the Shipping Board to spend on ships. It is now announced that a bill will be introduced into Congress to increase the capital stock to $225,000,000.

Major General Goethals, at the direction of President Wilson, has agreed to supervise the building of the ships, and in view of the national call upon his services has been released by Governor Edge of New Jersey from his contract to supervise the $15,000,000 expenditure for reconstructing the highways of that State.

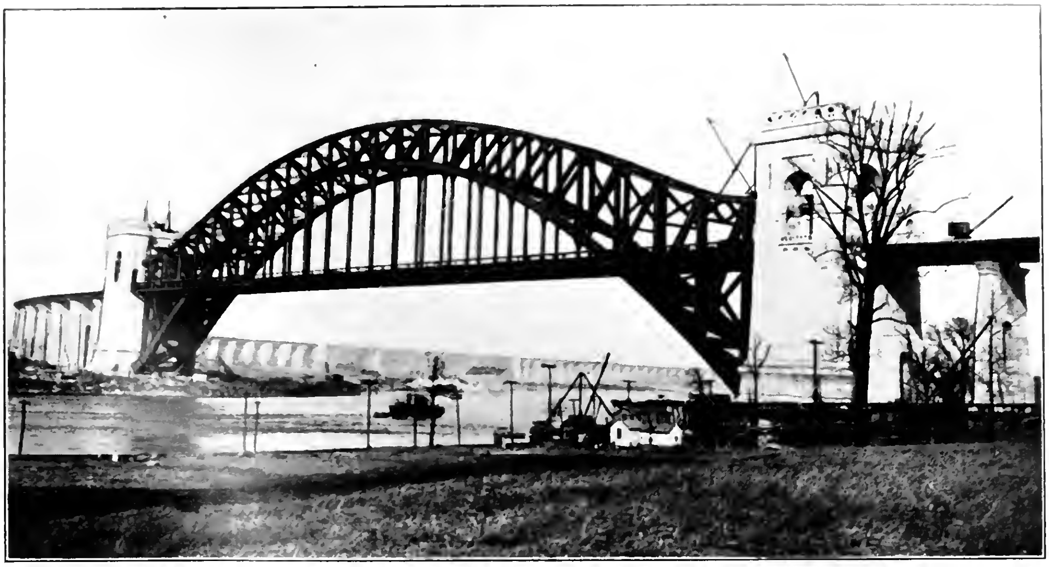
The wooden ships are to be of 2000 to 3500 tons displacement and will probably be equipped for oil burning. The ships and engines will be standardized as far as possible, and the boats will carry a crew of about thirty men, will be equipped with wireless, and armed for protection against submarines.

It is expected that the first of the vessels will be ready in about six months. The Shipping Board estimates that 150,000 men will be needed to complete the building program in the time determined on, and upward of 100 private plants will be engaged.

As The Journal goes to press announcement is made of a newly-created Shipping Committee of the Council of National Defense, with William Denman, chairman of the Shipping Board, at its head. This committee will work in coöperation with the Transportation Committee to facilitate transportation by rail wherever it seems wise to transfer coastwise vessels to trans-Atlantic service.

Opening of Hell Gate Bridge

THE engineering event of the month, from the standpoint of transportation, was the opening to traffic on April 1 of the Hell Gate bridge, the masterpiece of Dr. Gustav Lindenthal, chief engineer, which forms the final link of the New York Connecting Railroad between the New York, New Haven and Hartford and the Pennsylvania systems.



THE GREAT ARCH OF THE HELL GATE BRIDGE. IN THE BACK GROUND IS SEEN THE LONG APPROACH ON THE NEW YORK SIDE

For years New York City may be considered to have been the *dividing point* in the railway lines radiating from it in all directions. Both passengers and merchandise arriving in New York from the South or West had to be transferred in order to go East and North.

The building of the Pennsylvania Station on Manhattan and the construction of the tunnel under the East River to connect with the Long Island Railroad was the first step in the project for through trains and to reduce the ferry distance for the transshipment of freight at New York.

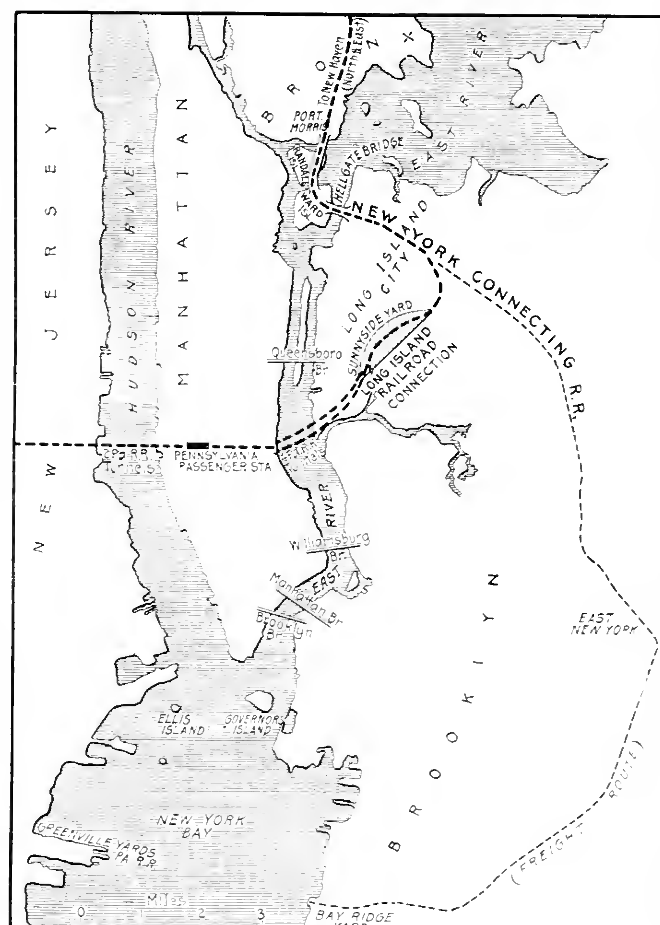
The course of the New York Connecting Railroad is indicated on the map. At 142d Street in the Bronx the line leaves the N. Y., N. H. & H. R. R. tracks, spans one after another the Bronx Kill and Little Hell Gate, and crosses Randall's Island and Ward's Island to the west shore of the East River, after a sweeping curve on the way. From the east shore of the East River the Connecting Railroad continues through Long Island City and then turns to the west, joining the Pennsylvania tracks at the Sunnyside yard. While passenger trains pass through the tunnels and under Manhattan en route to the West or East, freight is to go by belt line around Brooklyn to Bay Ridge on New York Bay, convenient of access by car ferry from the Pennsylvania terminal at Greenville, N. J.

The bridge and viaduct portions of the line from 142d Street in the Bronx to Sunnyside yard on Long Island was a difficult part of the construction. Three miles of it consist of steel spans on concrete piers, with one mile in fill, retained between high concrete walls held together by tie rods.

Apart from its importance as a traffic medium the Hell Gate bridge is also a remarkable engineering construction, if only because it has the longest and heaviest steel arch in the world. It is remarkable also for its beauty of outline, due to the collaboration between its designer and the architect, Henry Hornbostel. The following data are from the *Engineering News*:

Span, 1,016 ft. 10 in. between tower faces; [illegible] between centers of bearings.

Arch, height from center to end hinges to center of top chord



MAP OF THE NEW YORK CONNECTING RAILROAD

[illegible] at ends, 260 ft. at center. Height to [illegible] chord, 220 ft. Greatest height above mean high water, 310 ft. Clearance above mean high water, 210 ft.

Towers, height above ground, 240 ft.

Width, 95 ft. between centers of [illegible]; 60 ft. between centers of trusses.

Bottom chord 6½ ft. wide, 11½ ft. deep at ends, 7½ ft. deep at center; maximum section, 1384 sq. in.

Heaviest single piece, 185 tons (shipping weight 150 tons).

Load, the bridge carries four tracks on ballasted concrete floor; total dead load 52,000 lb. per lin. ft. of bridge; assumed live load, E 60 on each track.

Of unusual interest to mechanical men are the machine shop problems that were encountered because of the unusual size and weight of the bridge members. All holes and field connections were drilled to match before shipping, an undertaking of extreme nicety. The chord joints are polygonal-faced to secure uniform stress distribution and were planed. This necessitated having the roof of the planer house removable in order to handle the chords, for which latter purpose a 185-ton gantry crane was built.

N.Y. State Barge Canal to be Opened

By courtesy of Frank M. Williams, State Engineer, State of New York, the following data are published on the New York State Barge Canal, which will be opened on May 15 for through navigation between tidewater at Troy to Whitehall on Lake Champlain. The entire canal will be opened in May 1918, at which time through navigation will be available on the new channel between Troy and Tonawanda, where the Niagara River is entered and followed to Buffalo on Lake Erie. This summer, however, boats using the Erie will follow the new channel to a point north of Syracuse where the Oswego branch is encountered, and from there on to a point west of Rochester will have to use the old canal at places owing to the incompleted condition of the new channel. From Rochester on to Tonawanda the canal is completed.

Regardless of this feature, however, one boat line has awarded contracts calling for the construction of eight self-propelled barges each 150 ft. long and 22 ft. wide with a draft of 6½ ft. and a capacity of upwards of 600 tons. These barges are to be completed in 1918 and will be of steel construction with a wood lining which is calculated to protect the cargoes from heat. They will be driven by semi-Diesel fuel-oil engines.

Foremost among the various structures on the canal are the locks. These are all constructed of concrete and are operated by electricity which is generated at hydroelectric stations or gasoline-electric plants which are located on the various locks. A notable lock is that located at Oswego. This has a lift of 25 ft. and utilizes the siphon principle. It is the largest lock of this type in the world and the first to be constructed in this country. Four other locks of considerable note are those located at Lockport and Seneca Falls, there being a flight of two at each place, with a combined lift of each flight of 48 ft. The New York State Barge Canal has cost the State $150,000,000.00 to construct.

Curtis Bay Coal Pier at Baltimore

The new export coal pier of the Baltimore and Ohio Railroad at Curtis Bay, Baltimore Harbor, said to be the largest in the world, has a handling capacity of 12,000,000 tons a year, or a maximum of 7000 tons an hour, and is the first of its type. At the land end are two car dumpers, and on a concrete deck 8 ft. above mean tide are four loading towers and two trimming towers, to which coal is delivered by belt conveyors from receiving hoppers at the car dumpers or from the balancing bin interposed between the dumpers and the piers.

The tracks leading to the dumpers are on a descending grade, the cars running to the barney pit by gravity. The barney pushes the cars up the 10 per cent grade to the cradle of the car dumpers, where each, after being clamped, is turned upside down, delivering its contents to a counterweighted apron, which is raised when a car is being dumped, in order to minimize breakage. Each car dumper has three 60-in. belts with a capacity of 2000 tons an hour when traveling 500 ft. per min.

Each loading tower is equipped with a cage supporting a shuttle ram, and this cage may be raised or lowered to suit the height of the vessel being loaded, thus providing a further precaution against the breaking of the coal. The apparatus will load a hatch uniformly and reduce trimming to a minimum.

The two trimming towers, located on either side of the pier, have belts 48 in. wide with a capacity of 1500 tons an hour when the speed is 500 ft. per min. Coal for these belts is taken from the balancing bin. The trimming towers have 48-ft. swinging booms and are used for loading the bunker coal and also for finishing the slow work on a vessel, thereby releasing the loading towers for work on another vessel.

The functions of the tower are interlocked and controlled electrically, with push buttons located every 20 ft. on each belt-conveyor runway, and by pushing a button all movable parts of the belt, tower, and feeding are stopped. The operators are located in houses on the shuttles. The master control of the pier is located in the superintendent's office, enabling him to establish the maximum speed at which the belts are run.

The installation described here is interesting not only because of its large capacity and low drop, but also because it is the first attempt on such a large scale in this country at coal loading by mechanical means rather than gravity. (*Railway Review*, March 24, 1917.)

Huge Canadian Air Camp

Before summer, Canada will have a $5,000,000 aviation camp located at Camp Borden, north of Toronto, as reported by *Flying*, April, 1917. It will be the largest permanent establishment of its kind on this continent. Fifteen concrete sheds 120 by 66 ft., lighted and heated by electricity, are now being finished, and when the barracks are done, the camp will accommodate about 2000 men. This camp represents the first step taken by the Canadian Government in establishing its permanent air defenses, for which $80,000,000 are to be spent. Hitherto the greater number of aviators have been trained at Valcartier, but this camp will soon be given up for this kind of work, on account of the short season there, with its great amount of snow.

There will be 160 experienced military aviators constantly on duty at Camp Borden, either trained by the experts of the Curtiss Company, or selected from the 600 Canadian airmen now in service on the battle fronts of Europe. These 600 men form an available reserve of pilots, who have heard the shrapnel swish by them in actual battle, and know every detail of organization, as well as the work to be done in the air. Plans include training 5000 aviators, but it is not expected that the training of more than 2000 will be finished this year. As soon as pilots are graduated from the school they will be assigned to permanent camps, which will be scattered all over Canada. The localities of these camps, except Camp Borden, have not been announced.

Electric Propulsion on Battleships

THE recent decision to build battleships of the largest size with electric drive lends interest to the battleship *California,* of this general type, under construction at the New York Navy Yard. Her displacement is 32,000 tons and her maximum speed is to be about 22 knots, requiring about 37,000 shaft hp.

The equipment will consist of two turbine-driven generating units, four propelling motors, one for each shaft, two turbine-driven exciting units, and a complete equipment of condensing auxiliaries and ventilating blowers, all driven by motors from the exciting units.

The generators for the *California* are bipolar alternators, and the motors are arranged to be connected either for 24 poles or 36 poles. For economic cruising only one generator will be used, with motors on 36-pole connection. For higher speeds the 24-pole connection will be used.

Speed variation with either motor connection will be effected by change of turbine speeds through variable speed governors. This arrangement has been used in the *Jupiter* and entirely prevents racing.

Each of the auxiliary units is of 300 kw. capacity and a 240-volt direct-current generator geared to a high-speed non-condensing turbine. These turbines exhaust into the heaters, or main turbines, or both.

The steam consumption guaranteed on the *California* covers the total steam required for the main turbines and engine-room auxiliaries, at 250 lb. gage pressure, dry steam. The guaranteed water rates per hp. delivered to the propeller shaft vary from 14.6 lb. at 10 knots to 11.1 lb. at 19 knots.

W. L. R. Emmet, Mem.Am.Soc.M.E., in a paper read before the Society of Naval Architects and Marine Engineers in November 1915, gave the following comparison of steam consumption per effective hp. between the *California* as guaranteed, the *Florida* and *Utah*, which are driven by Parsons turbines, and the *Delaware,* which is driven by reciprocating engines.

POUNDS OF STEAM TO MAIN ENGINES PER HOUR PER E. HP.

	12 knots	15 knots	19 knots	21 knots	Prop. speed 21 knots
Florida	31.8	——	24.0	23.0	328
Utah	28.7	——	20.3	21.0	323
Delaware	22.0	——	18.7	21.0	122

Standardization of Army Trucks

THE Society of Automotive Engineers points out the vital importance of military motor transportation of troops and supplies. Tens of thousands of trucks will be needed for the armies now being organized in this country, and specifications covering important features of design and construction have been issued by the War Department and are appended to this note.

The standard truck is one of great capabilities, having a very low gear reduction and a large engine. Particular stress is laid on the inclusion of a four-speed transmission and on provision for adequate ground clearance, making possible negotiation of the roughest ground on which the trucks will travel. Demountable tires are considered essential owing to operations at points far distant from supply depots. Large gasoline tanks will be installed. Other items of interest are electric lighting, three-point engine suspension, locking differential, and large power-plant cooling capacity. Particular attention has been given to the spring suspension and the details of body construction. The gage of the wheels will be uniform. There is no doubt that trucks of different capacities excellently suited to the purpose of the Government have been specified. The Quartermaster and other corps of the War Department deserve great credit for this result.

The following are the principal features of the new truck:

Four-cylinder engine, 312 cu. in. piston displacement.
Poppet valves only.
Pressure lubrication.
Disk clutch.
Four speed transmission with low gear ratio of at least 40 to 1.
Preferably worm final drive.
Highest possible clearance, minimum at center about 11 in.
Some form of locking differential acting automatically to prevent wheel spinning.
Electric lighting equipment.
Radiator about twice the size normally used.
36 by 4-in. tires, must be demountable.

Interchangeability of radiators, gasoline tanks, and body-attaching devices are points, and the qualities of materials that must be used are specified, most strongly for such vital parts as the springs.

Submarine Chasers

INFORMATION has been variously published regarding the awarding of contracts by the Government for 110-ft. submarine chasers. The following specifications are condensed from an article to appear in *The Rudder* for May:

Contracts for the building of 345 of the 110-ft. submarine chasers have been awarded by the Navy Department. Of these 210 are to be built in private yards and the remainder in the Navy Yards. The Navy Yard in Brooklyn has started work and will have the first of this fleet ready by June 1. Nine more are to be completed by July 1, and after that ten are to be finished each month until the sixty are finished by December. The New Orleans Navy Yard is to build six, one a month after July 1; the Charleston Navy Yard, eight; the Norfolk Navy Yard, twenty-one; the Mare Island Navy Yard in California, fifteen, and the Puget Sound Navy Yard, twenty-five. These boats are to be built of wood, of 15-ft. beam and 4 ft. 6 in. draft.

The total cost of the 210 boats to be built outside the Government yards will be $10,741,063 and the average price of each boat so built is $51,100. The cost of engines, wireless, guns, fittings, etc., will be extra.

It was first planned to have the boats fitted with two slow-turning gasoline engines of 300 hp. each, giving a speed of 18 knots, but no engines of this type were available and it was decided to use three Standard Motor Construction Company's engines of 200 hp. each, and an 8-hp. engine for auxiliaries.

It is anticipated by builders that contracts may later be placed for boats of 80-ft. length, similar to those built in this country by the Elco Company, which recently completed an order for 550 for the British Government in the record time of 550 days. While boats of this length are undoubtedly less seaworthy than larger boats, reports of officers who have had charge of them in actual service praise highly their sea-going qualities. A marked advantage of the smaller size is the possibility of rapid production. In a boat up to 80 ft. in length, the great majority of parts can be handled by manual labor without the aid of cranes. In the construction of boats of larger size, a considerably larger number of elements must be handled by cranes, which materially retards production.

Inasmuch as the normal output in this country of large marine gasoline or oil engines probably does not exceed 250 a year, the question has been raised as to whether manufacturers of engines can keep pace with the construction of hulls for the submarine chasers, if put out in large numbers. The Journal has made inquiry regarding this among builders of such engines, who maintain that they will be able to meet probable demands. Estimates are more or less futile, because it cannot be predicted what will be the labor conditions or the possibility of procuring machine tools. The Elco Company had 1100 engines constructed for it in less than two years time.

The Engineering News Record

The consolidation of the *Engineering News* and the *Engineering Record* as a result of the merging of the Hill Publishing Company and the McGraw Publishing Company, brings together into one influential publication, two of the oldest technical periodicals. The combined "Engineering News-Record" appeared on the 5th of April.

The Engineering News was founded in 1874 when George H. Frost published the first copy of the Engineer and Surveyor. The next year the name was changed to the Engineering News. Prominent names successively associated with the journal are D. McN. Stauffer, Arthur Mellen Wellington, and in 1895 Charles Whiting Baker, who has since been its editor and is now the editor-in-chief of the *Engineering News-Record*. In later years, Mr. Frost repurchased a two-thirds' interest in the paper and in 1911 sold the journal to the Hill Publishing Company.

While the Engineering News has always been a paper devoted to civil engineering, the Record until recent years has been more in the field of heating, ventilation and sanitary engineering. It was founded in 1877 by Henry C. Meyer as the Plumber and Sanitary Engineer. It later became known successively as the Sanitary Engineer, the Engineering and Building Record and the Engineering Record.

After conducting the paper for 25 years, Major Meyer sold it to James H. McGraw. In 1902 John M. Goodell became the editor and in 1912 E. H. Mehren, who is now the general manager of the combined McGraw-Hill Publishing Company, was appointed in his place.

The *Iron Trade Review* calls attention to a rather perplexing situation which exists at present in the steel market. Inspection of the quotations reveals the surprising fact that some finished products apparently sell for less than the cost of the raw material from which they are made, and that this selling price seemingly bears but little relation to the cost of manufacture. Thus wire rods are quoted at $75.00 to $85.00 per ton, Pittsburgh. Plain wire made through many processes from the wire rod is quoted at $63.00 per ton, while nails made from this wire are quoted at $64.00 per ton. Plates are selling at $95.00 per ton and sheet bars, which in effect are narrow thick plates, are quoted at $65.00 per ton. Steel bars are $67.00 per ton, while angle bars, which are only bars with holes punched in them, sell at $55.00 per ton. This apparent inconsistency is in part explained by the fact that bars, sheet bars, and other partly finished steel are being bought for delivery in months hence at the quotations named. Wire and nails and sheets now being sold will be made from material bought a month ago at less than present prices.

News of Other Societies

Committee on Engineering Cooperation

Third Conference

The third annual conference of the Committee on Engineering Coöperation was held in the rooms of the Western Society of Engineers, in Chicago, on March 28 and 29. More than forty delegates, representing societies with a membership aggregating 50,000, were in attendance, and at the banquet, which was held on the evening of the second day, nearly 300 were in attendance, representing the members of the engineering societies in Chicago and vicinity.

On the first day, as each society was called, the delegate made an individual response. This was followed by specific papers, one by Mr. W. L. Saunders, Mem.Am.Soc.M.E., on the proposed Civic Scientific Alliance, and the Functions of Engineers' Clubs as illustrated by the Engineers' Club of St. Louis, by past-president F. G. Jonah.

On Thursday afternoon, Dean Potter, of the Kansas State Agricultural College, gave a report on the Land-Grant Colleges. There was also a remarkable address by President J. F. Dennis of the Canadian Society of Civil Engineers, and vice-president of the Canadian Pacific Railway, on the relation of the engineering societies to the war. The resolution, which was adopted with respect to coöperation, is as follows:

RESOLVED, That this conference requests and urges the national engineering societies in designing the engineering council to give consideration to, and create as soon as proper deliberation may permit, the machinery necessary to provide for a general permanent body of representatives of the various national, state and local organizations of the country in the interest of the common welfare and advancement of the profession as a whole.

This refers to the report of a sub-committee on the activities which the engineering societies are urged to undertake, as is shown in the following:

1. National Societies. As a preliminary to all efforts toward coöperation among existing engineering organizations there should be the expressed intent to assist in strengthening and unifying the work of the national engineering societies in the advancement of engineering knowledge and practice and the maintenance of high professional standards.

2. Local Organizations. The invigorating of local societies is fundamental because of the fact that while the great national societies are important in setting standards and in considering broad problems, yet local affairs make up at least nine-tenths of the vital problems of the engineer's life. In each locality where there may be a dozen or more engineers so situated as to be able to meet occasionally, there should be formed, if not already existing, an engineering association embracing all professional engineers and others interested in engineering to discuss and act upon these vital problems.

3. Home Rule. Each local engineering society should be autonomous or self-governed, wholly free in its activities from any dictation or control by other association or connections, fully adapted to local needs and conditions, and exemplifying in its activities the principle of complete home rule.

4. Welfare of Members. Each such local or self-governing unit in its organizations and activities should give full recognition to the fact that the majority of the membership necessarily consists of men not yet enjoying complete or independent professional status, but who in large part have had a college or technical training, and who in time may become professional engineers in the full sense of the word. Because of this diverse character of members, the activities of the local society, while maintaining high professional standards, should be so planned as to meet the needs of the young men as well as the older and be directed toward the welfare of all classes of its members and through them of the public.

5. Ethics. Each local engineering society should adopt and frequently make application of a code of ethics prepared in accord with the standards established by the national organizations or approved by other professional bodies. It is recognized that while it is impossible to prevent all violation of such a code, yet eternal vigilance is the price of maintenance of high standards. The enforcement of such a code is essential to the well being of the community at large as well as for the protection of professional men from the improper competition of unskilled or unscrupulous men tending to reduce the opportunity for effective service to individuals and to the public.

6. Civic Affairs. Each engineering society should devote time and thought to local civic, state and national affairs which influence engineering progress.

7. The Public Engineer. Each local society should give especial attention to the needs of those members who are in public employment, and should recognize the high ideals and performance of the public engineer, seeing to it that he is furnished sympathetic support in his efforts in the public service.

8. Publicity. Each independent association should maintain a local system of diffusing information on engineering subjects such as may be embraced in the term publicity or of proper advertising of the profession as a whole.

9. Employment. For the benefit of the great body of engineers there is needed the development of a scientifically planned and well conducted system of employment to be operated in coöperation by all engineering associations.

10. Conferences. A conference of representatives from each engineering organization should be held at least annually, at which all matters such as those above noted and those of general interest should be discussed.

The impression which I received was that a most earnest and sincere desire exists in those responsible for these conferences, and in the men who attend as representatives of the various local and national engineering societies, to secure, *first,* greater participation of the engineering societies in public affairs as an obligation to society; *second,* a proper ambition to secure recognition for the work of the profession by the public in general, and *third,* as a means to this end, there should be a definite effort to so inform the public about engineering works that the average layman will not only understand, but be actually interested in the manner that he would read other items of news. The conference was naturally gratified to learn the movement was spreading to effect coöperation among the national societies, which was very near completion in what is known as the Engineering Council.

C. W. R.

Engineering Society Organized in Southwest

At a convention held in El Paso, Texas, on March 8, 9 and 10, the Southwestern Society of Engineers was organized with more than one hundred charter members. Membership is open to civil, mechanical, mining, electrical or chemical engineers, or architects or other persons belonging to a technical profession, who are not less than 27 years of age, and who have been in active practice in their profession for at least six years. Provision is also made for associated, honorary and affiliated members.

In sending information about this meeting, Prof. A. F. Barnes, Dean of Engineering of the New Mexico College of Agriculture and Mechanical Arts, State College, New Mexico, states that the idea of the new society occurred to several members of the faculty of the Engineering School, and that its field is to include West Texas, New Mexico and Arizona, where there is little opportunity for the engineers who are widely scattered to get acquainted. Engineers residing in the Southwest are usually unable to attend the national society's meetings, and it was thought that it would be beneficial to all if an organization were perfected by which they could come together and exchange views on subjects of common interest. It is estimated that there are about from 800 to 1000 engineers available for membership.

National Employment Managers' Association

A conference of the National Employment Managers' Association was held at the University of Pennsylvania on April 2 and 3, under the auspices of Employment Managers' Associations of various cities, and several other organizations, local and national. The first day was devoted to a discussion of The Labor Turnover in Industry, with a banquet in the evening, at which there were miscellaneous addresses. On the second day, the subjects were the Selection of Employees and Termination of Employment: and Following Up After Hiring, the latter including a discussion of service work, mutual aid associations, etc. A National Employment Managers' Committee was formed to act as a clearing house among the local associations and to attend to such national affairs of the Society as may come up. There were approximately five hundred in attendance, from sections as far away as California, Georgia and Ontario, Canada. About fifty came from New England and fifteen from Chicago. The proceedings of the conference will be published. The Secretary is Prof. Joseph H. Willits, Wharton School, University of Pennsylvania.

Technical Textile Conference

The second Annual Conference of those interested in the consideration of problems relating to the testing and general technology of textiles and the closely allied materials, cordage, thread, and felt, is to be held at the Bureau of Standards, Washington, D. C., on May 21, and to continue for one to three days as required. Attendance is free to all persons interested. The meeting may consider the advisability of forming a permanent society for the promotion of research. A long list of topics for discussion is appended to the announcement of the conference. One of the subjects mentioned, namely, the determination of the effectiveness of textiles in resisting heat transmission, is of particularly timely interest. The value of an army blanket lies in keeping the soldier under it warm: that is, in the effectiveness of the blanket as a heat insulator. The development of a proper method for determining this quality in textiles would give the War Department a really scientific and reliable method for drawing up specifications for army blankets.

Medals for Safety Museum

The American Museum of Safety announces the following awards of the medals of the Museum for 1917:

The E. H. Harriman Memorial Medals, awarded annually to the American steam railroad most successful during the preceding year in protecting the lives and health of its employes and the public: The gold medal to the Alabama Great Southern Railway, Cincinnati, O., whose report for 1916 shows a remarkable record. Not a passenger was killed; no employes were killed in train accidents; and with more than 2000 industrial workers, none was killed and only two were injured. From minutes of meetings of employes submitted as part of the record, a wholesome stimulation of interest was evident in the direction of accident prevention and the promotion of good health. A silver replica was given to the Illinois Division of the Illinois Central Railway; and a bronze replica

to Mr. James A. McCrea, general manager of the Long Island Railroad Company, for his safety publicity campaign familiar alike to those who motor on Long Island and those who use the trains.

The Anthony N. Brady Memorial Medals, awarded for safety and health to American electric railways. The gold medal and replicas were all awarded to the Connecticut Company or its officers, New Haven, Conn.

The Scientific American Gold Medal, awarded for the most efficient safety device invented within a certain number of years and exhibited in the Museum: To the Pullman Company, Chicago, Ill.

The Travelers Insurance Gold Medal, awarded to the American employer who has achieved greatly in protecting the lives and limbs of workmen: To the Commonwealth Steel Company, St. Louis, Mo.

The Louis Livingston Seaman Gold Medal, awarded for progress and achievement in the promotion of hygiene and mitigation of occupational diseases: To the Julius King Optical Company, New York.

Talk on Aeronautics at Buffalo

Charles H. Manly, consulting engineer of the Curtiss Aeroplane Company, addressed the Engineering Society of Buffalo on April 19 on aeroplanes for the destruction of submarines. He said that in the immediate future there will be very important developments in flying boats. The answer to the submarine will be the flying boat large enough to carry a gun of sufficient caliber to sink a submarine when the latter is submerged or when nothing but its periscope is showing. Such a flying boat might also readily be equipped with torpedoes and tubes for launching them so that it could fight the submarine with its weapons, or it could be used against commerce raiders.

The largest flying machines will be of the marine type, and machines several times the size of any so far made will be seen eventually. The Curtiss flying whale now being tested by the United States Navy in Florida, has an upper wing spread of more than 90 ft.; is driven by two 200-hp. motors and has a boat 46 ft. long, weighing with fuel and pilot more than 5,500 pounds.

Several manufacturers of gears met at Lakewood, N. J., early in April and formed the American Gear Manufacturers' Association, the objects of which are stated to be to promote the interests of the gear industry by the standardization of gear designs, manufacture and application. The president is F. W. Sinram, Van Dorn & Dutton Co., Cleveland, O..

The Society of Terminal Engineers has been recently incorporated under the laws of the State of New York with headquarters in New York City, to promote the study of terminal engineering and mechanical freight handling as a specialty. A partial organization so far effected has H. McL. Harding for president, and J. Leonard as secretary. The office of the secretary is at 133 Broadway, New York City.

With its April issue, *International Marine Engineering* completed its second decade of usefulness as a technical journal of high character devoted to the interests of the shipbuilding industry. The double number marking the anniversary contained special articles dealing with recent progress and developments in the field of marine engineering.

This Month's Abstracts

One of the most significant features of modern engineering is the use of new materials of construction. The nineteenth century will always be known as the one in which was introduced commercially the greatest material of construction which most profoundly affected the life of mankind—that is, steel.

To the present century, however, belongs the honor of the consummation of the art of production of composite alloys, both ferrous and non-ferrous, with definite and often strikingly new properties, and the art of modifying the properties of carbon steel by heat treatment. Among the abstracts in this issue will be found data on developments in both of these latter directions.

H. W. Gillette and E. L. Mack, in a paper to be read at the Kansas City meeting of the American Chemical Society, discuss the so-called ferro-uranium, of interest because of great claims made for uranium steel as a tool steel. The data collected by the authors do not appear to support these claims.

Another article, by James Scott, Mem.Am.Soc.M.E., discusses the use of boron as a purifying and deoxidizing constituent of copper, aluminum, and copper-nickel alloys. This is of interest because, as appears from the work of the present writer, and especially the papers read before the various societies by Dr. Weintraub of the General Electric Company, boron imparts very remarkable physical and electrical properties to copper (compare paper read by Dr. Weintraub before the International Engineering Congress, 1915, vol. 9).

In the field of heat treatment of steel an interesting tendency is disclosed in the article by W. H. Phillips discussing the application of methods of heat treatment as perfected for automobile gears to the case of gear trains in rolling mills. This article suggests a promising subject for laboratory research, namely, the effect of dynamic blows on spur gearing when running at high speed and transmitting heavy loads.

The attention of those interested in locomotive design is called to the important tests of Atlantic type locomotives recently carried out at the testing plant at Altoona of the Pennsylvania Railroad Company.

Gardner T. Voorhees, Mem.Am.Soc.M.E., in *Ice and Refrigeration,* presents the results of a highly interesting investigation into the still somewhat unexplored region of the latent heat of ammonia. Substantially the work is based on experimental data previously published by Prof. J. E. Denton in the *Trans.Am.Soc.M.E.,* but the writer develops a new method for determining the value of the latent heat of ammonia and presents a series of interesting considerations on this subject. The matter of heat losses in the expansion valve is treated in this article with great thoroughness.

How much may be gained by a closer insight into comparatively simple phenomena is well illustrated by F. R. Low, Mem.Am.Soc.M.E., on Energy Stored in a Boiler Under Pressure, in *Power.* The writer discusses essentially the question whether the work done in forcing back the environment when water changes to steam should be included in calculating the energy released by a pound of water under certain assumed conditions. The interest of the article lies, however, in the fact that it brings out with great clearness the proper way of treating the various constituents forming the total energy released when a boiler under pressure explodes.

Attention is called to the advance notices of technologic papers on Glasses for Protection of the Eyes from Injurious Radiations in the Section *Safety Engineering,* and on Temperature Measurements in Bessemer and Open-Hearth Practice in the Section *Measurements,* published by courtesy of the U. S. Bureau of Standards.

REVIEW OF ENGINEERING PERIODICALS

SUBJECTS OF THIS MONTH'S ABSTRACTS

Air Machinery

Blast-Furnace and Steel-Mill Power Plants, Richard H Rice and Sanford A. Moss

Discussion of the most economical type of plant when all costs are included. A comparison of turbo-blowers for blowing and turbo-generators for generating electric power for steel mills from surplus gas on one side, with a plant using gas directly in gas-engine-driven blowers and generators on the other hand. Complete tabulations of the cost of operation of each plant for four blast furnaces are given; compare Table 1.

The writer discusses the centrifugal-compressor blast not only from the point of view of cost, but also from that of effect on the furnace, and calls particular attention to its steadiness and easy controllability.

As regards the value of accurate control of the rate of air flow in the case of a blast-furnace compressor, the writer quotes the following experience. The measuring device which was relied upon to determine the rate at which the blast was being blown was so located that the indications were inaccurate. This resulted in an inaccurate adjustment of the machine. After a considerable period of operation under these conditions the measuring device was so relocated as to make it more accurate. As a result the quantity of dust is said to have decreased to normal, and the output of the furnace increased.

The writer describes in this connection the governor used on blast-furnaces blowers built by the General Electric Company. A recent improvement of this governor consists of a means of adjusting the index on the sliding weight to compensate so that the weight can readily be set to take account of the variations in atmospheric conditions. This device is called a volume director.

In the early days of our experience with centrifugal compressors on blast furnaces there used to occur the so-called "surging," which appeared when the machines were operated at considerably less rates of blowing than those for which they were designed, or when excessive pressures were met with as in case of tightening up of the furnace. This "surging" consists of an alternate forward and backward flow of air with the compressor, and is the result of improper functioning of the discharge vanes owing to the variation of blowing conditions from those for which the vanes were designed. The steps which have been taken to eliminate this "surging" are reasonable proportioning of the machine to the requirements of the furnace, and provision of a by-pass with an automatic valve which in conditions which would ordinarily permit "surging" leads back into the inlet a small quantity of air.

The major part of the paper is devoted to a discussion of comparative costs of the two types of plant, turbine- and gas-engine-driven. (*Proceedings of the Engineers' Society of Western Pennsylvania*, vol. 33, no. 2, March 1917, pp. 81-130, 6 figs. c[illegible]

TABLE 1 COMPARATIVE COSTS FOR TYPICAL FOUR-FURNACE PLANTS

	Gas Engine.	Steam Turbine.
First Costs		
Primary Washers	$131,250	$131,250
Secondary Washing Station	300,000	......
Gas Pipe from Boiler House	212,500	......
Boiler and Piping	167,500	609,200
Boiler House	41,250	123,750
Electric Station Apparatus	3,250,000	745,600
Electric Station House	250,000	69,200
Blowers, etc.	1,812,500	726,416
Blowing Station House	237,500	69,200
Pumping Station, Standpipe, Conduits	787,500	293,484
	$7,190,000	$2,768,100
Charges, Dollars per Year		
Primary Gas Washers	$2,100	$2,100
Secondary Gas Washers	42,000	......
Boilers	12,000	52,750
Electric Station	90,000	68,250
Blowing Station	49,500	42,000
Pumping Station	6,000	4,000
Running Charges, Total	$201,600	$169,100
Fixed Charges at 13 per cent	934,500	359,800
Coal	21,652	78,352
Total Charges	$1,157,752	$607,252

Chisels

Chipping Defects from Steel Billets

Chipping is a costly practice, and unless properly handled may become excessively so.

Unskilled labor of the cheapest type obtainable proves to be the best suited for this work; in fact, no other can be had, as the job of chipping is extremely unpleasant, because of the constant jar of the hammer and the stooped-over position necessitated by the work. Under present conditions 25 cents or more per hour is an average price paid to chippers working ten hours per day, and unless the chippers are kept working as constantly as possible, the costs mount up incredibly.

The job is a hard one and chippers will avail themselves of the slightest excuse to stop work. An investigation recently carried out in a large steel plant in the Central West showed that most of the time lost arises from chisel breakage, or, in general, defective chisels.

This investigation resulted in the development of certain methods which are said to have reduced the cost of the operation. Where billets require chipping a thorough inspection must cull out the defective ones.

As regards the chipping hammers, Fig. 1 shows an improved type of two-piece nozzle used for holding the conical-shank chisels found more satisfactory than the type formerly used. The air consumption per hammer is 19 cu. ft. per min.

In order to keep air hammers in good working condition they must be properly cleaned and oiled at frequent intervals. For lubrication a small amount of clean light machine oil should be poured into the inlet of the handle, and when the tool is being constantly used, this should be done every two or three hours.

The matter of chisels is of very great importance. A typical steel for chipping chisels at one plant analyzed as follows: carbon 0.70 to 0.90 per cent, sulphur 0.035 per cent, phosphorus 0.015 per cent, and manganese 0.20 per cent.

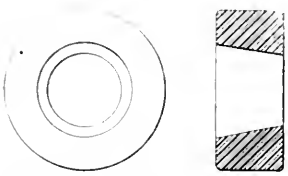


Fig. 1 New 2-Piece Nozzle For Air Hammer

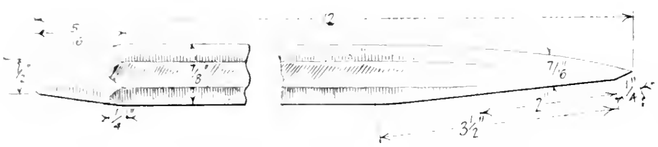


Fig. 2 Standard Half-Round Chisel

Each chipper needs from six to twelve chisels on hand at all times. Where chisels are used in large quantities it is found economical to have shanks machined outside at contract prices. Forging, shaping, and heat treatment are best performed in the plant, because of the necessity for having a repair man on chisels most of the time. Chipping chisels are subject to severe service requirements and rough treatment. Hence the steel should be put in the best possible condition. No rule-of-thumb heat treatment is effective, and the results of the tests conducted demonstrate the superiority of chisels treated under pyrometric control.

Experience has shown that straight 0.70 to 0.90 per cent carbon steel is well adapted for chipping chisels. A number of experiments were carried out at the plant referred to in this article for the purpose of standardizing the heat treatment of chisels. The following treatment was finally devised: Chisels of 0.80 per cent carbon steel were heated to 735 deg. cent., or just through the critical range, in a gas-fired muffle furnace having uniform temperature. Fifty chisels were charged at once and allowed to soak until a pyrometer rod in the middle of the pile showed 735 deg. cent. The assumption was that the entire pile of chisels had attained at least that temperature. Readings with the pyrometer at different places in the pile showed this assumption to be sufficiently accurate for practical purposes. When up to heat, the chisels were quenched by immersing the point about 1.5 in. in water. The strains induced by this drastic quenching were relieved and the resultant hardness mitigated somewhat by drawing the chisels at 250 deg. cent. in a bath of high-flash quenching oil. The drawing temperature was discovered by trial of the chisels. Lead baths for heating the chisels prior to quenching are preferable.

A great deal of trouble with chisels is due to improper grinding methods. The steel is injured by "drawing the temper," which really means that sorbite and pearlite are formed as the critical range is approached, as well as by checking and service cracks. For hard carbon chisels grinding wheels of fine grain are recommended, and the pressure during grinding should be light.

As regards the shape of the chisels, a half-round chisel proved to be the most suitable for the purpose. The one shown in Fig. 2 was adopted as standard. (*The Iron Trade Review*, vol. 60, no. 12, March 22, 1917, pp. 682-684, 4 figs., *p*)

Engineering Materials

Ferro-Uranium, H. W. Gillet and E. L. Mack

General discussion of uranium-iron alloys, their production and properties.

According to the information collected by the author the use of uranium in steel dates back at least as far as 1897. Among other things Escard repeated nearly ten years ago a report that Krupp used uranium steel in armor plate, and there have been various rumors that Germany is using uranium-steel liners in big guns in the present war.

In the United States commercial use of uranium steel is quite recent. According to a statement by R. M. Kenney in the "Mineral Industry" (1915), a high-speed steel showing excellent cutting qualities contained C, 0.078 per cent; Mn, none; Si, 0.16 per cent; P, 0.02 per cent; tungsten, 8.15 per cent; Cr, 3.62 per cent; vanadium, 1.18 per cent; and uranium, 1.02 per cent.

While uranium steel has been widely advertised as the last word in high-speed tool steel, the reports of Hoffman and Johnson were not so favorable, the former stating that a uranium steel with 5 per cent tungsten and 3 to 4 per cent Cr made a very good tool and did good work for, say, two grindings. After that it did not hold its efficiency and had to be rehardened. Johnson stated that a 40-point carbon steel with 0.3 per cent uranium was disappointing, being red-short at ordinary forging heat and altogether uninteresting from a practical point of view. Therefore, in the opinion of present writers, all that can be said now is that uranium deserves a careful trial, both in tool steel and in ordnance, though the former is probably the more promising field.

As regards the composition of the so-called uranium steels, Johnson states that he has encountered ferro-uranium containing 15 to 20 per cent aluminum and that vanadium was always present from 2 or 3 per cent to 28 per cent; he stated also that one ferro-uranium analyzed by him contained 15 per cent silicon.

The price of American ferro-uranium in February [and April—Ed.], 1917, was $7.50 per lb. of uranium content. Partly on account of the price, experiments on uranium steels seem to have been confined to those with the maximum of

about 1 per cent uranium. It would be desirable to try it out with a percentage of 10 to 12 per cent, similar to that of tungsten in tungsten tool steels, even though such a steel may not be commercial.

The article further discusses in detail the method of production of uranium steels, in particular in an experimental furnace. (Paper to be read at the Kansas City Meeting of the *American Chemical Society*, abstracted through the *Journal of Industrial and Engineering Chemistry*, vol 9, no. 4, April 1917, pp. 343-347, *ge*)

INFLUENCE OF GASES IN CAST METAL, J. E. Fletcher

Practically the only thing known about the constituency of molten cast iron and steel is that they must contain in solution iron, carbon, silicon, manganese, phosphorus, and sulphur, but it is not exactly known how these metals and metalloids occur when in the liquid state. The iron-carbon alloys solidify first and are followed by others in ordered succession. In cast iron, for example, there is a constituent which is a metallic mixture of iron carbide and iron known as the eutectic containing 4.3 per cent of carbon, and also another similar constituent containing 0.9 per cent of carbon and known as the eutectoid pearlite.

The author has made many experiments in the way of quenching various carbon-iron and other alloys from the molten state and believes that there are definite structures even in the liquid metal itself. Further, he considers it as certain that the 4.3 per cent carbon eutectic can be superheated to 1500 deg. cent., which is the melting point of iron, and on being quenched will still reveal under the microscope a characteristic stratified honeycomb structure. The silico-ferrite crystallites under such circumstances are small, but of the characteristic fir-tree or dendritic structure.

The gases are imprisoned or dissolved in all molten metals and in cast iron and other eutectic-containing metals or alloys. These gases are very probably the formative or directive element in the growth of a honeycomb-like formation of the primary eutectic. The flow-line structure always having a direction towards the upper and hotter portions of the freezing mass of a eutectic ingot, gives the impression of fine gas streams set in motion by conventional forces, just as the streams of steam bubbles are given conventional flow in a boiler. It may be that the primary gas streams in flowing through the semi-liquid carbide of iron plate-like crystals make the paths through which the more or less carburized ferrite enters and freezes, such freezing action being immediately followed by that of the carbide.

The structure of a cast iron in the opinion of the writer must have some relation to the primary structure it received in the blast furnace. While the ores are being reduced the iron oxides are attacked by the carbon monoxide gas which is both the principal reducing agent and the chief carburization medium. This produces the spongy porous nature of the reduced iron and may be called the first stage of the gas-absorbing tendency of the iron. The hydrogen which is also imprisoned by this action comes from the moisture evaporated from the blast ores, flux and fuel.

In the study of the gas influence the principal use of the microscope is in tracing the difference in crystalline structure between the outer rapidly cooled and the inner slowly cooled zones of a casting. If the cooling curves are taken simultaneously at each of these zones, in many cases the difference in the freezing behavior with its action of the phenomena of shrinkage and contraction may be observed.

Just previous to freezing of cast iron or steel the liquid metal may be conceived to consist of an agglomeration of liquid particles or crystals of various constituents of iron and manganese. The crystallites of partly carbonized iron first separate out and freeze at the molten surface and at right angles to it. Almost immediately afterwards the spongy of iron freezes around the iron crystallites and these crystallites, as they freeze, eject their occluded gases into the mother liquor or eutectic. As the iron or silico-iron crystallites enlarge and grow laterally the gases are driven inwards. The volume of any such partially frozen portion of the metal is as follows: Primary crystals A + mother liquor B + ejected gases C. As A increases, B decreases, while C simultaneously decreases. In cast iron the mother liquor B contains the segregates, slags, oxide and sulphide particles, together with the graphite flakes

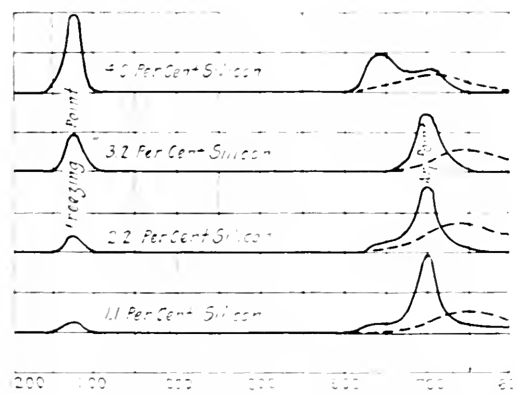


FIG. 3 DILATION OF CAST IRONS (DOTTED LINES 2% MN)

which escape with the gases into the hot fluid portions, which, when frozen, contain the highest percentages of these impurities. The gases thus liberated travel to the hot zones in the castings which are the last to freeze, and if there is no way for them to escape produce gas cavities or pipes.

The writer raises the question whether the phenomenon of shrinkage is connected with the volume of occluded gases, or rather with that of gases escaping during the freezing of iron and steel, and finds many evidences in favor of the latter conclusion.

Such is the case of a mild-steel block which was cast from a ladle of well-melted steel held in the ladle accidentally until close on the point of setting or congealing. The nozzle gave out and allowed scarcely any steel to rise in the casting head or riser. When cold the block was found to have contracted less than 1/16 in. per ft. The metal when planed revealed no pipe or cavity and was free from blowholes, while the weight of the casting indicated soundness. This case points to the fact that the gases escape freely during the slow rising of the steel in the mold, and that the occluded gases finally remaining in the metal mass were in a fine state of entanglement between the crystals uniformly throughout the mass. A similar casting made in the same heat from a more fluid steel piped deeply in the rising head and contracted normally at the rate of 0.2 in. per ft.

Whenever castings are made in chilled molds there must be shrinkage or contraction. Under such circumstances rapid freezing has a tendency to form small primary crystals which become quickly interlocked, imprisoning small gas bubbles. The cooling of the mass causes a shrinkage of the gas bubbles and it has been concluded that each gas globule occupies much less volume at 60 deg. fahr. than at 2000 deg. fahr.

From here the author proceeds to the discussion of the volumetric change during the freezing and later cooling of iron, as dependent on the analysis of the metal.

He bases his discussion mainly on the work of Professor Turner in this country.

Of interest is the part of the discussion referring to what happens at the point of recalescence. At that point there is another expansion (the primary expansion occurs at the moment of freezing), generally connected, as Professor Turner suggests, with the liberation of more free carbon, or temper carbon, and probably with the further increase in the volume of the gases as a result of the heat evolution which then takes place.

Baker in his experiments on the quantity of gases drawn off from iron and steel heated in a vacuum, decided that the greatest quantity is ejected at the recalescence point, thus confirming the work of earlier investigators. More recently Charpy concluded that the expansion or dilation of carbon-iron-silicon alloys was increased at the freezing point as the silicon content rose, while the expansion at the recalescence point is diminished, as is shown by the curves in Fig. 3.

This conclusion confirms experiments made by the author on cast irons with varying silicon contents, in which it was found that manganese and silicon together intensified such action. Generally speaking, white irons shrink most. The more highly silicious irons shrink last. But it would seem that whenever the iron carbide in either the primary crystals or in the eutectic is retained, as is the case when manganese or chromium is present, the speed of freezing is increased, and the gases liberated are driven rapidly into the more fluid portion of the metal mass, where there is a tendency to form shrink cavities. In low-silicon irons, free from phosphorus, high manganese generally produces such results, especially if the casting temperature is low. The presence of phosphorus is an aid to gas escape into the hot interior of a cooling casting.

The question of hot-casting is allied with the problem of shrinkage and of gas exit. Generally speaking, when the metal is cast hot there is a better distribution of the gases which remain in the cold metal and less risk of blowholes and cavities.

Hot-casting is especially important in the case of pure irons of hematite and cold-blast character low in total carbon, phosphorus and silicon. Such iron cools and shrinks rapidly, because its primary crystals freeze at a high temperature, and the mother liquor being purely eutectic also freezes rapidly.

The author calls attention to the fact that the importance of taking into consideration the influence of gases in the foundry problem can scarcely be underestimated. The major portion of foundry troubles are associated to a certain degree with the question of occluded gases. (Paper presented at a meeting on November 27, 1916, of the Birmingham Branch of the *British Foundrymen's Association*, abstracted through *The Iron Trade Review*, vol. 60, no. 11, March 15, 1917, pp. 617-621, 9 figs., *et*)

Boronized Metals, James Scott

Boron, which has an atomic weight of 10.9, is an element which, like carbon, is allotropic. It has a strong affinity for oxygen and may, therefore, be used as a deoxidizer. Boric acid (B_2O_3) has a remarkable property that when dry it can be heated to a high temperature without vaporizing, but when dissolved in water it readily passes away in the steam produced by boiling. From this it appears that its ability to prevent the development of blowholes is due to this refractoriness. It not only fails to generate cavities itself, but in some way attracts fumes which might otherwise get imprisoned in solidified metal.

The author microscopically examined the three more important boron alloys, namely, aluminum, copper, and copper-nickel.

The superficial texture of these alloys is shown in the original article in magnified microphotographs.

The form in which boron is now used for the purification of metals is as a fluoride. (*The Metal Industry*, vol. 15, no. 3, March 1917, pp. 115-116, 3 figs., *de*)

Foundry

The American Foundry in Time of War, Edgar Allen Custer, Jr.

The writer discusses in a general manner the conditions which American foundries had to meet when the European demand for munitions arose in this country, and the further conditions for which they should be ready with the United States itself facing the problem of war.

The production of cast-iron or semi-steel shells presents difficulties that heretofore few, if any, foundries have been called upon to meet. The range of physical qualities is limited to almost one precise point that will give the proper fragmentation, and it is essential to obtain and maintain this point. Too great a resistance to the bursting effect not only reduces the number of fragments, but necessarily reduces the destructive capacity of the shell, since too great a proportion of the explosive effort is needed to effect the bursting; on the other hand, insufficient resistance results in excessive fragmentation in which the pieces are so small that they are not capable of serious damage.

In addition to this, a sound casting is absolutely essential, not only because unsoundness tends to interfere with proper markmanship, but still more because of the possibility of a weak spot giving way under impact in the gun which may result in tearing the gun to pieces.

These strenuous conditions call for a most exact method of procedure. The chemical analysis of the heats must be not approximate, but exact, and it is significant that 75 per cent of rejections in French factories, while endeavoring to produce satisfactory semi-steel shells, could be traced directly to faulty analysis of the mixtures. To successfully produce semi-steel shells designed for active service the foundrymen cannot rely on approximations or the analysis of the irons guaranteed by a salesman, but must use the services of a chemist.

The next point of importance is the management of the cupola. The method of laying, lighting, and burning up a fire should absolutely eliminate the possibility of a poor start, for such a start may spoil the whole heat. Thus a poor start may mean that quite a proportion of the first metal charged is melted at a temperature below that necessary to produce satisfactory semi-steel. This may result in as much as 20 to 30 per cent of the heat being unfit for use.

The work of weighing and charging must be executed carefully and not left to the discretion of the laborer on the platform. Too often the given quantity is measured as average pigs, or so many buckets or forks of coke, and generally some more for good measure. Such a method of cupola operation is sufficient to set at naught any close or active work on the part of the chemist.

The melting temperature should be kept as constant as possible and at a point slightly above normal. Semi-steel like

cast iron will absorb or throw off impurities according to its melting temperature. In handling the metal it was found that the best results could be obtained by using a specially constructed receiving ladle under the spout of the cupola.

Second in importance to the chemical analysis and the means of obtaining it, comes the molding of semi-steel shells. According to one report a foundry in northern France failed to produce a single satisfactory heat until green-sand molding was abandoned. Too much attention cannot be paid to the use of the trap gate in molding with semi-steel, especially on shells. The position of the casting when poured gave considerable trouble when the French factories first started on semi-steel shells. At first it was considered necessary to pour the casting on end and to allow extra metal on the cope to collect dirt and gas holes and to provide metal for possible shrinkage, but later on the vertical form of molding was largely-discontinued, and this permitted the use of the match-plate form of machine molding and molding the shells in pairs, using a balanced core.

Among other things discussed in the article are the methods of taking samples of metal, analysis and inspection of the product. (*The Foundry*, vol. 45, no. 294/4, April 1917, pp. 127-130, *p*)

Fuels and Firing

The Permeability of Coal to Air and Gas and the Solubilities of Different Gases in Coal. J. Ivon Graham

A knowledge of the permeability of coal to air or gas is important for the comprehension of the processes of spontaneous heating in coal and the production and discharge of firedamp and blackdamp.

In experimenting on the permeability of coal to gases, difficulty was at first experienced in obtaining a gastight seal between coal and any form of connecting tubes. The method finally adopted as most satisfactory was as follows: Thin slabs were sawn off from a large lump by means of a fine hacksaw. Some of the slabs were cut in the direction of the cleavage of the coal, others at right angles to it. Pieces of glass tubing ½ in. to 1 in. in diameter were sealed on each side of the slab. To obtain an airtight seal, the following method was adopted: The end of the glass tube previously warmed in a blowpipe flame was dipped into molten bitumen, such as is used for electrical insulation purposes, and a small quantity of bitumen in an almost molten condition was thus obtained on the end of the tube. The latter was then quickly pressed against the coal slab and held rigidly until the bitumen became quite hard. Successive thin layers of seccotine were next applied around the junction and allowed to dry. A second tube was then sealed on to the opposite side of the slab in a similar fashion. It was found that by this method a practically airtight seal could be obtained, sufficiently tight to hold a vacuum for several days.

In the case of "softs" it was found almost impossible to obtain a slab free from cracks, owing to the fragile character of this coal. In cannel, cracks also developed very rapidly. The majority of the results so far obtained, therefore, deal with slabs from "hard" coal.

The article describes in detail the methods of experiment followed with various gases, and presents in tabular form a summary of results. These results are quite remarkable, as they show that, contrary to the usual supposition, solid coal is extremely airtight and lets very little air or gas through, even with a driving pressure of a whole atmosphere. Carbon dioxide passes through the slab much more slowly than hydrogen, and to a similar extent the same may be said to be true of methane.

It was thought at first that the solubility of the gases, which is very high for carbon dioxide and methane, might affect the results for the initial stages for the flow of gas through the slab. It was found, however, that this is not so.

The writer proceeds to show how the results obtained affect the explanation that the heatings and fires which often occur in the walls of main roads driven through solid coal, commonly many years after the roads have been driven. These fires are ascribed to "breaks" in the coal which let in the oxygen. These breaks appear to be just as dangerous many years after the road has been made as with a freshly made road.

The article proceeds next to the description of experiments on the solubility of gases in coal, and in particular on the solubility of methane.

It has been found among other things that there is a considerable variation in the degree of solubility of various gases and that this diminishes in every case with rise of temperature. For the less soluble gases the amount dissolved is practically directly proportional to the pressure or concentration of the gas over the coal (practically Henry's law for the aqueous solution of gases). For the more soluble gases, as carbon monoxide, methane and carbon dioxide, "the amount dissolved—concentration of gas" curves deviated somewhat from a straight line, this deviation being the more evident the greater the solubility of the gas. In fact, the amount dissolved at low concentration of gas appears to be proportionately greater than that dissolved at high concentration.

Among other things the influence of the coarseness of the dust on the solubility of the gas has been determined, as well as the solubility of gases in finely powdered shale dust (*Trans. Inst. Min. Eng.*, vol. 52, pt. 3, February 1917, pp. 338-347, *e*)

Spontaneous-Ignition Temperatures of Liquid Fuels for Internal-Combustion Engines, Harold Moore

Flash points and burning points are common tests used for both liquid fuels and lubricating oils. These properties provide a measure of the danger from fire which is encountered in the handling and storage of the fuels, but are of little use as an indication of the behavior of a fuel in an internal-combustion engine. Such an indication, however, is given by the temperature of spontaneous ignition, which is the temperature at which a substance surrounded by oxygen or air at the same temperature will burst into flame without an application of any spark or other local high temperature.

The paper describes the experimental apparatus by which the spontaneous-ignition temperature was determined, and Table 2 gives the results obtained.

In a Diesel engine firing depends upon spontaneous ignition of the fuel immediately after it enters the cylinder. It is, therefore, necessary to employ high compression pressures in order to obtain a temperature high enough to insure the spontaneous combustion of the charge, but provided the temperature is obtained, it is advisable to keep the compression pressure low. Hence the temperature at which the fuel will ignite spontaneously is of fundamental importance. By means of the formula

$$T_2 = T_1\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}}$$

it is possible to calculate approximately the temperature to correspond to any given compression. In this formula T_2 and

T_2 and T_1 are respectively final and initial absolute temperatures. P_2 and P_1 are respectively final and initial pressures, and n is a constant approximately equal to 1.35.

As an example of the influence of the ignition temperature of a liquid fuel the case of alcohol may be taken. It has been found in practice that alcohol, though much lower than gasoline in calorific power, when run in an engine can be made to yield approximately the same power per unit volume as gasoline.

TABLE 2 TEMPERATURE OF SPONTANEOUS IGNITION

Description	Sp. gr.	Spontaneous ignition temperature, deg. cent.		Difference, deg. cent.
		in oxygen	in air	
PETROLEUM DISTILLATES				
Pratt's [illegible] Spirit No. [illegible]	0.710	272	383	+111
Petrol [illegible] Max	0.718	279	361	+ 82
[illegible] Spirit No. [illegible]	0.721	270	371	+101
[illegible] Spirit, A. A. O. Co., Ltd	0.729	272	399	+118
Paraffin Oil from A. A. O. Co.	0.807	251	...	...
Petrolite Kerosene	0.814	251.5	432	+180.5
Empire Paraffin	0.782	253	395	+142
Petrol from Anglo-American	0.735	...	392	...
Gas Oil, A. A. O. Co., Ltd	...	254	358	+104
PETROLEUM (CRUDE AND RESIDUE)				
Crude Petroleum (Egypt)	0.851	260	...	...
Digboi Oil (Assam)	0.890	261	384	+123
Anglo-Persian Oil Co.'s Oil	0.894	254	408	+154
Crude Petroleum (Texas)	0.895	256	387	+131
Anglo-American Fuel Oil	0.900	260	430	+161
Anglo-Mexican Oil	0.908	259.5	417	+157.5
Crude Petroleum (Texas)	0.936	268.5	416	+147.5
Crude Petroleum (Borneo)	0.939	269	380	+111
Mexican Fuel Oil	0.948	259.5	424	+164.5
Crude Petroleum (Mexican)	0.949	258	425	+167
Crude Petroleum (Trinidad)	0.950	274	424	+150
Crude Petroleum (California)	0.952	264	...	...
Venezuelan Petroleum	0.955	275	429	+154
Crude Petroleum (California)	0.961	262	420	+158
SHALE OILS				
Oil-Engine Oil (Broxburn Oil Co., Ltd.)	0.768	253	333	+ 80
Lighthouse Oil (Broxburn Oil Co., Ltd.)	0.803	251	322	+ 71
TAR DISTILLATES				
Xylol Commercial	0.860	484	...	...
Toluol, 90%	0.863	516	...	...
Benzol, 100%	0.875	566	...	...
Premier Tarless (Tar Oil)	0.992	349	...	...
Creosote Oil (Harman & Holden)	1.010	415	...	...
Water-Gas Tar Creosote (Stainsby & Lyons)	1.036	473	...	...
Coke-Oven Tar Oil (Simon Carves)	1.046	478	...	...
TARS				
Tar (Product of low temp. carbonization)	0.987	307	508	+201
C. W. G. Tar (Stockport Gas Works)	1.074	464	...	...
Oil Gas Tar (Beckton)	1.077	415	...	...
Horizontal Retort Tar (Heywood Gas Works)	1.114	445	...	...
Horizontal Retort Tar (Stockport Gas Works)	1.123	454	...	...
Coke-Oven Tar (Simon Carves)	1.132	494	...	...
Coke-Oven Tar (Copper Co.)	1.140	488	...	...
Coke-Oven Tar (Koppers Type Ovens)	1.145	495	...	...
Blast-Furnace Tar (Carlton Iron Works)	1.172	498	...	...
Blast-Furnace Tar (Wm. Baird & Co.)	...	410	...	...
MISCELLANEOUS				
Alcohol	0.817	395	518	+123
Turpentine	0.842	275	275	same
"Mirrlees-Diesel" Compressor Lubricating Oil	0.875	265.5	405	+139.5
"Mirrlees-Diesel" Engine Lubricating Oil	0.894	265.5	410.0	+135.5
Whale Oil	0.921	273	470	+197
Ether	0.730	190	347	+157
Paraffin Wax	...	245	...	...
Naphthalene	...	402	...	...
Free Carbon from Tar	...	348	...	...
Asphalt from Oil	...	260	...	...

The net calorific power of gasoline is about 10,450 calories per gram, or 7315 cal. per cc. The net calorific power of commercial alcohol is about 5420 calories per gram, or 4440 cal. per cc. If both be burnt in an engine with the normal compression (i. e., compression adjusted to suit gasoline), the consumptions per b.hp-hr. will be approximately in inverse proportion to the calorific powers of the fuels, and over 1½ gal. of alcohol will be required to do the same work that 1 gal. of gasoline will. Now, the spontaneous-ignition temperature of gasoline (in oxygen) is about 272 deg. cent., while that of commercial alcohol is 395 deg. cent.; therefore alcohol will withstand a much higher compression.

The compression pressure of a gasoline engine tuned to run on gasoline is approximately 90 lb. per sq. in., but with alcohol this pressure may be raised to 200 lb. per sq. in., and by this means the overall thermal efficiency of the engine is raised from about 22 per cent to 35 per cent, when it is found that the volumetric consumption of alcohol per brake horsepower-hour is approximately the same as that of gasoline. Thus though gasoline possesses 65 per cent greater calorific power than alcohol per unit volume, the advantages of this high heat value are entirely lost on account of its low ignition point. The ignition temperature is of general interest to chemists, as it is a measure of the relative stability of the bodies towards heat. The accompanying table shows the spontaneous-ignition temperatures of several fuels which have been determined with the instrument described in the original article.

From general observations the author has concluded that:

1 Compounds containing simple molecules have higher ignition points than similar compounds containing more complex molecules. This rule applies to all types of compounds.

2 Ignition points of aromatic compounds are much higher than those of alipathic compounds.

3 Saturated hydrocarbons have lower ignition points than the corresponding saturated hydrocarbons.

4 Ignition points observed in air are higher than those observed in oxygen. This difference for petroleum products is generally 100 to 200 deg. cent. (*Journal of the Society of Chemical Industry*, vol. 36, no. 3, February 15, 1917, pp. 109-112, 2 figs. *eA*)

Internal-Combustion Engineering

THE USE OF KEROSENE IN GASOLINE ENGINES INSTALLED IN THE FORTIFICATIONS OF THE UNITED STATES, Capt. Charles O. Schudt and First Lieut. John W. Wallis, Coast Artillery Corps, U. S. A.

The writers do not believe in the possibility of the use of alcohol in such engines, and therefore limited their tests to kerosene only. These tests were carried out in the laboratory of the Coast Artillery School, and were made on the following engines:

Lathrop single-cylinder, two-cycle marine engine
Ferro single-cylinder, two-cycle, three-port portable engine
Engine attached to 5-kw. generating set; this is a four-cylinder, four-cycle stationary engine
Similar but larger engine attached to 25-kw. generating set.

The test with the Lathrop marine engine gave rather perplexing results. The engine had been operated many times previous on gasoline, using the Prony-brake load at a speed

of about 380 r.p.m. When the fuel was changed to kerosene the operation was not satisfactory.

The governor was then adjusted to give a speed of 525 r.p.m. without any change in the needle valve, or without intake spring when a load of 33 lb. at a radius of 24 in. was registered at the brake. The fuel was then changed to kerosene while the engine was running, and the speed immediately went up to 550 r.p.m., while the load on the brake arm remained at 33 lb. With the same adjustment, the engine, for a considerable time, carried a load of 40 lb. on the brake arm.

In subsequent tests after the fuel was changed to kerosene, the speed drop became erratic and the engine finally stopped. It appears, therefore, that this engine could be operated on kerosene only by very skilled operators.

It is probable that the principal reason for the failure of this engine to operate more satisfactorily is that it has an excessive crankcase clearance, resulting in low crankcase compression and permitting the fuel to separate from the air and settle while the mixture is in the crankcase. That the fuel immediately separates from the air is proven by the fact that it accumulates very rapidly in liquid form in the crankcase.

In the case of the four-cylinder, four-cycle stationary engine attached to the 5-kw. generator set, it was found that the operation of kerosene was quite successful, the behavior of the engine not being materially different from its behavior when operated on gasoline. Apparently, the only necessary change in the adjustments of the engine when the fuel was changed to kerosene was approximately to double the opening of the needle valve.

A supplementary test was run on a two-cylinder, four-cycle Standard marine engine of old design with a long, exposed intake pipe. Notwithstanding this latter feature, its operation on kerosene was entirely satisfactory. In fact, the change to kerosene fuel (the needle-valve opening was increased 50 per cent) was accompanied by a material increase in speed and brake horsepower. To determine whether the engine would "idle" satisfactorily on kerosene, it was operated for fifteen minutes without compression released and spark fully retarded. At the end of this time the load was thrown on, but one cylinder missed, and the engine would not come up to speed until a little gasoline was squirted into the air intake. This gasoline caused the missing cylinder to resume firing immediately, and the engine came up to speed. The exhaust smoke was fairly clear, indicating that the combustion was good, and consequently little probability of carbonization troubles.

From the limited tests conducted, it is believed entirely practicable for the enlisted specialist now in charge of these engines to operate them without very much difficulty.

One of the important things encountered in the tests was the mechanical inaccuracy of the valve timing. The valves in these tests were timed in the manner prescribed, and the setting was then checked on the flywheel. The angle past center at which the exhaust valves opened varied 9 deg. and the intake valves varied 7 deg. It is true that at this time the piston has very little motion, but this error in the cams causes trouble with kerosene fuel.

At no time was there trouble from knocking due to preignition. Curiously, knocking was accompanied by the best combustion: in other words, when all or most of the cylinders were knocking the exhaust was nearly clear. Knocking could be increased by shutting the needle valve. The influence of velocity of flame propagation is also discussed in detail. (*Journal of the United States Artillery,* vol. 47, no. 1, January-February 1917, pp. 24-35, *e*)

Machine Parts

PISTON DESIGN WITH SPECIAL REFERENCE TO ALUMINUM PISTONS, Harry R. Ricardo

General discussion of design of pistons for internal combustion engines of high output, and description of a "slipper" type piston.

The author establishes the general conditions with which a piston of a high-speed internal-combustion engine must comply, and calls attention to the fact that piston friction depends almost wholly on the viscosity of the oil, proved by the variation it undergoes with difference of temperature of cylinder walls. He reproduces a set of three curves of mechanical losses in a four-cylinder Daimler engine that was tested by Professor Hopkinson at Cambridge University.

In this engine piston friction at the higher speeds formed nearly 80 per cent of the total mechanical loss, and its susceptibility to changes of temperature is clearly shown. In another test recently made by the writer on a single-cylinder experimental engine, it was found that the mean pressure required to overcome piston friction varied from 18 lb. per sq. in. when the cylinder was quite cold to only 6 lb. per sq. in. when the jacket water was boiling.

The assumption that the friction loss in the countershaft and crankpin bearings is greater than that of the piston has been disproved by numerous experiments; the explanation of the fact that it is actually very much less appears to be that, although the same oil is used in both cases, the piston lubricant is largely contaminated by partially carbonized oil and its viscosity enormously increased in consequence. The carbonizing and thickening of the piston lubricant is mainly (but not entirely) due to the leakage of burned gases past the piston rings. In some cases this difficulty has been partly obviated by providing immediately below the lowest piston rings a recess having a number of holes drilled through it, so that any gases that succeed in passing the piston rings can escape freely into the crankcase.

As a matter of fact, a trunk piston has to perform two separate functions. The upper part of the piston is required to retain and transmit the gas pressure and distribute and dissipate the heat. Hence it should be made strong enough to withstand the pressure and thick enough to transmit the heat; also it should not bear against the cylinder walls, or receive any of the side thrust from the connecting rod. The piston rings should be relied on to keep it gastight, and since any oil which passes above the lowest piston ring will, of necessity, be carbonized, it should receive as little oil as possible, consistent with the maintenance of the piston rings and mechanical conditions of operation.

The lower portion of a trunk piston performs the duty of a crosshead and takes the side thrust from the connecting rod. Hence it should be fitted as closely to the cylinder as is consistent with the expansion and distortion that takes place, should be freely lubricated, should have as little bearing surface as is consistent with the loading and temperature, and the oil should be kept clean by allowing a free escape of any burned gases that may pass the ring.

Since the bulk of the losses is caused by the continuous shearing of oil film, it is important to reduce the surface to the lowest safe limit: while, as a rule, bearing surface is provided around the entire circumference of the piston, it is needed only around a small arc on either side of it. The bearing surface around the two sides of the piston which receive no thrust is particularly objectionable on account of

or local distortion set up by the great mass of metal in the gudgeon pin bosses and by the bending of the gudgeon pin.

The proper way is to regard the lower part of the piston as a crosshead and design it as such, that is, provide it with just sufficient bearing surface at just the right place, have it freely lubricated and safe from the passage of burned gases between its bearing surface and the cylinder walls.

It is also desirable to perforate the bearing surface with a number of large holes, for when two freely lubricated surfaces are sliding over one another the oil between them is, so to speak, rolled up and heavy hydraulic pressure set up, and this can relieve itself by escaping through these holes.

As regards the design of the gudgeon pin, the writer believes that it is preferable to use a short and stiff gudgeon supported directly from the crown of the piston and by points as near to the ends of the connecting-rod bush as possible. The necessary surface required to carry the side thrust from the connecting rod can be provided exactly where it is needed, and there only, in addition to which a short and stiff gudgeon pin can be used without necessitating long and heavy bosses.

In Fig. 4 is shown a design of piston which the writer has been using recently, and which is probably only suitable for aluminum pistons.

The particular features are that the vertical load is transmitted directly from the crown of the piston to the center of the gudgeon-pin bosses, so that a light gudgeon pin can be used without risk of bending. The horizontal thrust from the connecting rod is transmitted directly to the bearing surfaces and is distributed over them by means of two transverse ribs. Bearing surface is provided in the form of two slippers, so that the surface of oil in shear is reduced to a minimum, leaving an ample bearing surface. No load is transmitted through the side walls or past the piston-ring grooves. The surfaces of the two slippers are perforated to release the oil and the lower piston ring acts as a scraper ring; on the two sides of the piston where there is no bearing surface the scraper ring can prevent the slippage of oil almost completely, since it has to deal only with the oil adhering to the cylinder walls and not with oil under pressure. The weight of the piston is very low; for cylinder bores ranging from 3.5 to 5 in. in diameter the weight of the piston complete with gudgeon pin and piston

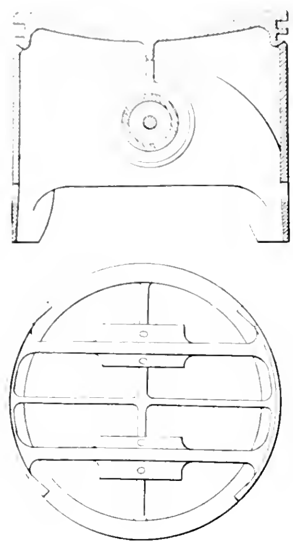


Fig. 4 Experimental Design of Aluminum Piston

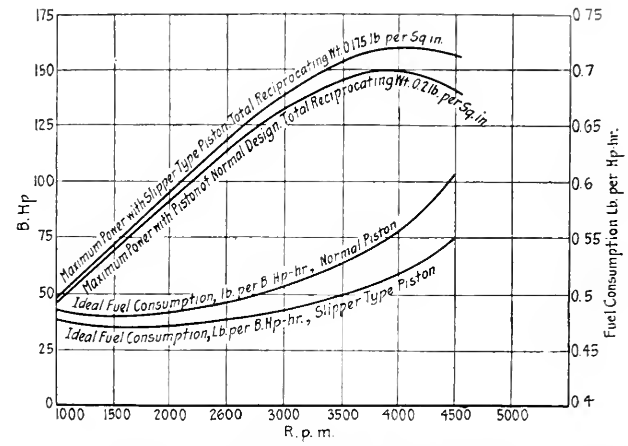


Fig. 5 Power and Fuel Consumption, Various Pistons

rings can be brought down to 0.1 lb. per sq. in. of piston area. Several pistons of this weight have been in operation for some considerable time in high-speed engines and have proved themselves to be perfectly reliable.

Fig. 5 shows a gain in power and fuel consumption to be obtained by the use of these pistons, which is ascribed to the reduction in mechanical losses. It seems probable from examination of some of the pistons which have been in operation for many months that the bearing surface might be still further reduced with perfect safety. After long runs on full load the bearing surface was found to be profusely lubricated, with the oil showing no signs of discoloration due to carbonization. Experience has also shown a reduction in the oil consumption; in one extreme case it fell from 0.06 lb. per b.hp-hour to 0.035 lb. per b.hp-hour with no other change except in the pistons. The fuel consumption dropped 4 per cent, while the brake horsepower increased by about 4 per cent. (*The Automobile Engineer,* vol. 7, no. 100, March 1917, pp. 60-63, 7 figs. *te*)

The loading on the gudgeon-pin bearing in a high-speed engine is not as severe as is generally supposed; providing the bearing is kept reasonably cold in order to maintain the viscosity of the oil, and the pin is well supported and stiff enough, it is perfectly safe to use bearing pressures vastly in excess of those now employed. Under these conditions a total projected area equal to 7 per cent of the piston area is amply sufficient for an engine running up to 3000 r.p.m., if the gudgeon pin is not more than 20 per cent of the diameter of the piston.

In the writer's opinion the best method of all is to float the gudgeon pin; that is, allow it to rotate freely in bearings, both in the piston and connecting rod, so that the rubbing velocity in each bearing is reduced to one-half. Under these circumstances the piston and the connecting-rod bearings may be reduced to 5 per cent, and that of the bearings on either side to 3 per cent with safety. The use of a floating pin has the further advantage that the difficult problem of fixing the pin and the risk of distorting both the pin and the bosses is obviated, but it must not be used unless the bosses are supported directly from the crowns of the pistons.

As regards the general design of steel pistons the writer describes two recent types, viz., the Sunbeam and the Zephyr. The aluminum piston affords a greater freedom of design, since ribs may be used with very little fear of distortion, and without adding perceptibly to the cost of manufacture.

Gearing Development Through Heat Treatment. W. H. Phillips

The author attempts to show how the development of heat treating as perfected for automobile gears may be usefully applied to the case of rolling-mill gear trains.

If by increasing the cost of gearing from 25 to 50 per cent a gear is produced that will triple the life of the untreated gear, and at the same time eliminate breakage, there can be no doubt of its economy.

The writer mainly considers carbon-steel gearing and divides its treatment into three general classes: oil treatment, case hardening, and special treatment, with particular reference to the last one.

He emphasizes the fact that poor heat treatment is worse than no treatment at all, and insists on the necessity of an exact method of procedure checked by accurate temperature-recording instruments and facilitated by a closely regulated furnace.

In addition, one or more gears in every lot of one hundred should be taken for physical test. Since, however, even this does not necessarily insure uniformity, the Brinell hardness test may be used as a check on each gear.

Extensive experimentation has shown that by slight changes in the constitution of the metal a combination can be obtained which, when subjected to a special treatment, will produce physical properties peculiarly adapted to gearing. The hardness at the surface of the steel is from three to four times that of untreated steel, and grades off slightly toward the center of the tooth until it is from two and one-half to three times as hard as untreated steel. This reduction in hardness is in a straight-line ratio, and each fiber of the steel from the surface to the center or neutral axis of the tooth—which may be slightly to one side of the geometric center—will be stressed in proportion to its ability to carry the load, so that when the tooth receives a blow or shock every fiber is carrying its share of the load.

The effect of dynamic blows on spur gearing when running at high speed and transmitting heavy loads has never been accurately ascertained, but is known to be great, often excessive, and in such service forged steel should always be used, whenever possible. (*The Blast Furnace and Steel Plant*, vol. 5, no. 4, April 1917, pp. 152-154, *gp*)

Special Cams in Aluminum Engines of Premier Car. A. L. Nelson

The writer points out the gradual degrees of clearance between the tappet and cam in the valve mechanism. The reason for this reduction of clearance is that the motor speeds have been greatly increased and the standard of quietness of valve operation has been raised.

The clearance between the end of the rocker-arm lever and the valve stem of the aluminum motor with valve-in-the-head construction and camshaft in the crankcase is a matter of particular importance. The vertical expansion of the aluminum cylinder case is about twice as great as that of cast iron. Hence with the conventional type of cam adjusted with the valve-stem clearance at the working temperature of the motor that would give satisfactorily low valve-closing and lifting velocities, all the valves would be held open when the motor was cold.

It was found by experiment that the valve-stem clearance had to be at least 0.013 in. in order that the valves would retain sufficient clearance to start a cold motor, but with this clearance and the conventional cam the valves opened and closed at such high velocities that the valve action was entirely too noisy. In addition, impact on the valve seats and on all the valve mechanism parts made the wear very appreciable.

It therefore became necessary to change the method of operating the valves by designing a new cam.

Fig. 6, upper half, shows the conventional cam contour, while Fig. 6, lower half, shows the new one. The new cam is virtually the conventional one with 0.020 in. taken off the diameter of the base circle and with a tangent drawn from a point to the new base circle. The time of opening the valve is made earlier for special reasons. Lift of the valve for the added angle is only 0.004 in., while the angular increase is 3 deg. 52 min. That is, the first part of the lift is so slow that

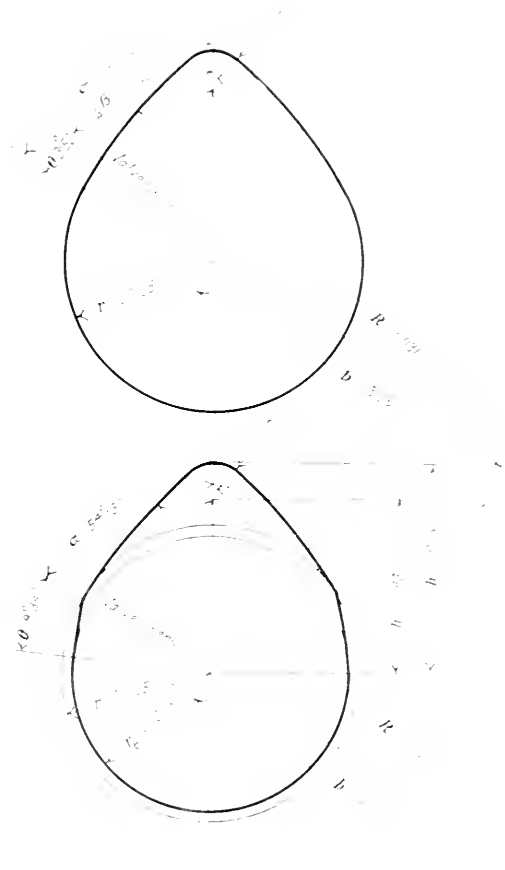


Fig. 6 Standard and Altered Cams for Automobile Engines

the valve has to be given an earlier start corresponding to the back-lash angle of the old cam.

As the valve-stem clearance increases by wear, the timing works towards the desired theoretical conventional timing and then past it instead of always away from it as in the conventional method.

An interesting feature of the design of the new cam is such an adjustment of the valve stem as to obtain an opening and closing of the valves at a cam position giving practically zero velocity at any speed.

From this the author proceeds to the mathematical analysis of the action of the new cam motion, viz., analysis of mushroom follower motion equations for the upper motion, and characteristic curves of the new cam. (*The Automobile*, vol. 36, no. 14, April 5, 1917, pp. 689-692, 6 figs, *dtm*)

Measurement and Measuring Apparatus

Temperature Measurements in Bessemer and Open Hearth Practice, George K. Burgess

The problem of temperature measurement and pyrometric control of furnace casting and ingot teeming temperature is shown, by a series of observations taken in several steel plants, to present no serious difficulties or uncertainties.

For this purpose the most satisfactory type of instrument is one of the optical pyrometers using monochromatic light and permitting observation from a distance of streams of metal.

It is shown that the necessary corrections to the observed optical pyrometer readings for emissivity of metal and oxides to give true temperatures are sufficiently well known, but there may be uncertainty in the case of liquid slags.

For streams of liquid iron or steel the most probable value of emissivity to take, with a pyrometer using red light of wave length $\lambda = 0.65\ \mu$ is $e = 0.40$, corresponding to a correction of 139 deg. for an observed temperature of 1500 deg. cent. The value of e for liquid slags is usually about 0.65, but varies with composition of the slag. A table of emissivity corrections is included in the text.

Determination of the temperature of the charge of bessemer converters is not deemed practicable by pyrometric methods.

The operation of the open-hearth furnace can be gaged by the pyrometer, it being possible to control readily the temperature of the roof and of the bath of metal and slag by observations taken through ports; and the temperature of the metal may be had at any instant, with a fair degree of exactness, by observation with the optical pyrometer of metal removed in a spoon.

The temperatures of the roof of an open-hearth furnace are shown to bear no necessary relation to that of the metal bath, which again is shown may have zones of considerable differences in temperature, depending upon the operation of the furnace.

The temperature of the roof of an open-hearth furnace, dependent upon the firing practice, may vary very rapidly and within wide limits, 1550 to 1750 deg. cent. The temperature of the open-hearth bath is usually kept between 1600 and 1670 deg. cent.

There appears to be a very remarkable degree of uniformity in casting temperature actually acquired by the melters in practice. Thus, for 10 consecutive bessemer heats the teeming temperatures of the ingots were all between 1500 and 1550 deg. cent., and a similar degree of concordance, although at slightly higher temperatures, was found in the open-hearth practice of several mills.

It is believed that a continuous, systematic following of the temperature, by the methods above outlined, for the various furnace and casting practices, on the part of steel and iron mills, would show the possibility of improvements and greater certainty of production in quality of product; also changes and the effects of variation in ingot or furnace practice could undoubtedly be carried out with greater certainty than at present appears to be the case. (*Bureau of Standards*, Technologic Paper No. 91.)

Pyrometers, Richard P. Brown

Brief historical discussion of methods of measuring high temperatures, followed by concise descriptions of modern pyrometers and methods of using them.

The writer describes in particular the use of thermoelectric pyrometers, with and without compensating boxes; the two methods of measuring the voltage produced by a thermocouple, namely, the millivoltmeter and the potentiometer methods; and finally, the use of the radiation pyrometer.

Methods of calibration of pyrometers are briefly described. The writer believes that the greatest feature in pyrometry is along the line of automatic temperature control, and calls attention to the fact that there have been already designed instruments capable of maintaining the temperature constant within 10 deg. fahr. He further suggests that the steel manufacturers, who are interested in the improvement of heat-treating methods, can be of great assistance to pyrometer manufacturers in coöperating with them to test out new devices in an endeavor to improve on present methods. (*The Iron Trade Review*, vol. 60, no. 12, March 22, 1917, pp. 671-673, *g*)

Mechanics

The Comparison of a Certain Case of the Elastic Curve with Its Approximation, R. W. Burgess

In the usual discussion of the elastic curve in elementary textbooks of physics and engineering, a certain term in the differential equation of the curve is neglected and the curve resulting from this approximation is said to be a good substitute for the real elastic curve. It is my purpose in this note to show by a comparison of one case of this approximate solution with the accurate solution, that the one is not always a satisfactory substitute for the other.

If a straight, thin rod in which I is the moment of inertia of a cross-section about a line perpendicular to the plane of bending, and E the constant of elasticity, is bent into a bow by two opposing forces each of magnitude H, acting at the ends of the rod, it is assumed, or deduced from more elementary assumptions, that the resistance to bending at any point is proportional to the curvature of the central axis at that point. The bending moment at any point is therefore proportional to the curvature; taking the central axis when unbent as the x-axis, and a perpendicular at its mid point as the y-axis, we have $Hy = EI/\rho$, that is, $\rho y = EI/H = a^2$, say, as the equation of the central axis. We can without difficulty integrate this equation, subject to the conditions $y = h$, $dy/dx = 0$ when $x = 0$. Substituting the known value of the radius of curvature in the equation $\rho y = a^2$, we obtain

$$a^2 \frac{d^2y}{dx^2} = -y\left[1 + \left(\frac{dy}{dx}\right)^2\right]^{3/2}$$

From this the author derives the common expression

$$l = \pi a\left[1 + \frac{h^2}{16a^2} + \dots\right]$$

The usual approximation is to omit from the original expression the term for the slope $(dy/dx)^2$, which is small if the bow is only slightly bent. The equation is then

$$a^2 \frac{d^2y}{dx^2} = -y$$

and the solution is $y = h \cos x/a$, which is said to be a good approximation to the solution.

Actually, however the author shows that for small deflections the error of this solution is nearly 100 per cent. He thinks therefore that the cosine curve, with h determined by a formula deduced from this equation, is not satisfactory, in any case where the length of the bow or column is one of the given physical constants. The difficulty is of course due to

the fact that deflection is of the same order of magnitude as the slope which was considered negligible.

Errors of this nature due to dropping terms from a differential equation probably exist in other physical problems; this one is unusual in that both the exact and the approximate equations can be solved in terms of known functions. (*Physical Review*, vol. 9, no 3, March 1917, pp. 193-197, *tm*)

Railroad Engineering

Pennsylvania Atlantic-Type Locomotive Tests, Andrew C. Loudon

The article describes the most recent form of Pennsylvania Atlantic-type locomotive, as well as the tests carried out at the testing plant at Altoona.

During the period of development of the Atlantic-type locomotive, experiment has shown that if boiler tubes are increased in length without any increase in diameter, there is a point beyond which the lengthening of a tube fails to produce a proportional increase in evaporation. For best results, the tubes should be extended fully up to the point where the increase in evaporation ceases to be proportional to the increase in length. It has been found on the Pennsylvania that the most desirable length for a tube is about 100 times its internal diameter, and this rule has been adopted, with a leeway to the designer of 10 or 15 per cent to satisfy other boiler conditions.

In the final form of the locomotive (E6s), the original 14-in.-diameter piston valve was replaced by a 12-in., which has been found to be practicable, because superheated steam flows through the steam passages with greater freedom than saturated steam of the same pressure.

The reciprocating parts are very light, and, although the maximum weight on a pair of drivers is now 67,000 lb., the dynamic augment at 70 miles an hour is less than 30 per cent of the static weight on the drivers.

The article describes the tests in detail. Because of lack of space only the outstanding features can be here reported.

The tests in this instance (No. 51) are throughout compared with previously published tests of the older type locomotive No. 89 (locomotives of the latter type are no longer in service).

Fig. 7 shows comparisons between the evaporations per pound of coal at all rates of evaporation. This shows improved results for No. 51 up to the maximum rate where the two lines meet. The maximum rate of equivalent operation for No. 51 is 17.22 lb. per sq. ft. of heating surface per hour.

The shorter-tube boiler showed a great activity of combustion for light drafts, but there was very little difference in the rapidity of evaporation in the two boilers until a draft of 5 in. of water was obtained back of the diaphragm. The shorter-tube boiler thus showed a more rapid rate until its evaporation limit was reached.

As regards engine performance, the efficiency tests made at the testing plant were at speeds between 28.1 miles per hr. (120 r.p.m.) and 84.4 miles per hr. (360 r.p.m.), the nominal cut-offs being between 15 and 50 per cent. At 75 miles per hr. and 35 per cent cut-off, the i.hp. was 2357.2, while in a second series of tests the i.hp. reached 2488.9, or 1 hp. for each 96.5 lb. of total weight.

The coal rate per i. hp-hour did not exceed 3.6 lb. in the first test, and was usually below 2.9 lb.

The steam consumption per i.hp-hour up to 1800 hp. was practically the same for both No. 51 and No. 89. The maximum steam temperature reached (in the branch pipe) was 635.7 deg. fahr., or 251.3 deg. superheat, but in general the superheat was below 230 deg. fahr. Considering the efficiency of the engine, and taking the Rankine cycle as a base for an ideal engine, it is found that the actual engines developed an efficiency which was 67.8 per cent of the ideal.

The maximum drawbar or dynamometer hp. obtained was 2250.5, with the coal rate of 3.8 lb. per dynamometer hp-hour and the steam rate of 19.8 lb. In the curves of the drawbar pull, Fig. 8, the advantage of the larger cylinders of No. 51 is in evidence, the greater drawbar pull being maintained by this engine at every speed up to 85 miles per hour. An interesting feature of the drawbar-pull tests is shown in Fig. 9. The straight lines show the drawbar pull at the various cut-offs given, and indicate a falling off in pull as the speed increases. It is believed that this effect is due to losses of pressure in the cylinder as the piston speed increases. (*The Railway Age Gazette*, vol. 62, no. 12, March 23, 1917, pp. 635-640, 12 figs. *eA*)

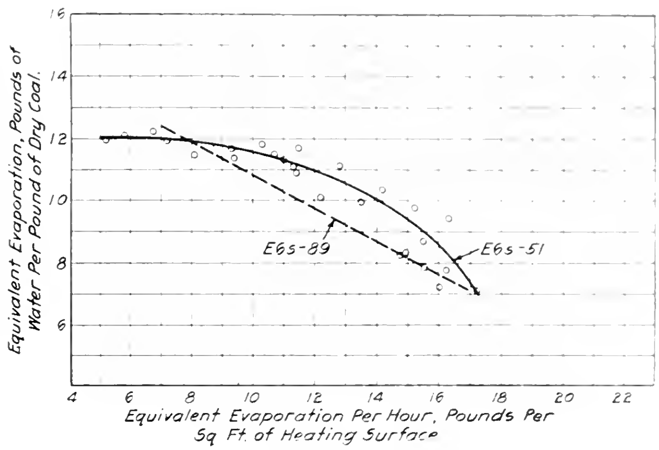


Fig. 7 Equivalent Evaporation Per Pound of Dry Coal

Refrigeration

High-Speed Ammonia Compressors, C. R. Neeson

The writer discusses the reason for using high-speed ammonia compressors and the main features of their design.

In regard to the latter he states that the only type of valve feasible is one consisting of a thin plate of special steel to cover a series of slots in the valve cage, which gives a maximum opening with a very small lift, thus allowing a rapid movement of the valve without shock or noise. As the valves must be as small as possible they are placed radially in the cylinder body at each end, suction valves at the top and discharge valves at bottom. All valves are alike and interchangeable.

A special principle has been adopted in order to completely fill the cylinder to suction-pipe pressure. This is a series of ports around the center of the cylinder casting which are uncovered by the piston at the end of the suction stroke when its speed is least and its acceleration greatest, and where the inertia of the gas in the suction pipe tends to build up the pressure at the cylinder. The length of the piston is about the same as its stroke. As there are no valve springs to overcome, it is possible in spite of the so-called high speed to fill the cylinder to the exact pressure in the suction line. Several diagrams are shown to prove this statement. These diagrams show that the pressure in the suction pipe at the

[illegible] ... Mar. 1917, ... 10 figs. ...

COMPOSITION AND PROPERTIES OF COMMERCIAL LIQUID AMMONIA, E. C. McKelvy and C. S. Taylor

The present paper is a progress report presented at the Twelfth Annual Meeting of the American Society of Refrigerating Engineers in December, 1916, published by permission of the Director of the Bureau of Standards.

As part of the work of the Bureau of Standards upon the determination of the physical constants of ammonia, especially those which are of importance in refrigeration, an investiga-

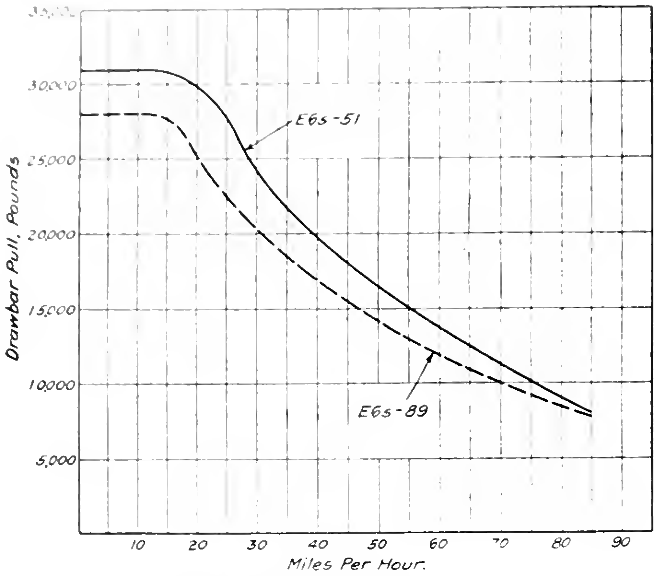


FIG. 8 DRAWBAR-PULL CURVES

tion was undertaken, one of the objects of which was "the acquisition of the necessary information regarding the state of the methods of testing and analysis of liquified ammonia" in industrial use.

The present investigation covered the determination of the impurities in commercial ammonia, the methods of sampling, methods of analysis, and standards of quality.

As regards the composition of commercial ammonia, the results of the present investigation indicate that about two-thirds of the samples examined are about equally suitable as the starting material for the preparation of pure ammonia to be used in exact chemical and physical work.

The results of chemical analysis indicate the adequacy of the simple evaporation test as conducted in many works in detecting samples of poor quality, but such a test is useless in differentiating the majority of the samples now on the market.

The following tentative specification for liquid ammonia is offered. It is based upon determinations that can be carried out in the chemical laboratory, and will insure the delivery of high-grade material. In large shipments where the testing of each drum is out of question, only a general indication of the quality can be obtained by examination of the contents of a few drums chosen at random.

1 The gas drawn from the cylinder (gas phase) on the first opening must contain per 100 grams of ammonia not more than 30 cc. of non-condensing gas (gas unabsorbed by 0.2 N sulphuric acid).
2 The residue on free evaporation of the liquid ammonia, with due precaution for excluding moisture and contamination of the sample on drawing, must be not more than 0.03 per cent.
3 The amount of aromatic amines estimated as pyridine must be not more than 0.001 per cent; the amount of organic acids estimated as acetic acid must be not more than 0.005 per cent.
4 The total organic material converted into carbon dioxide must not give more than 30 milligrams of carbon dioxide per 100 grams of ammonia.

A brief bibliography is appended. (*A. S. R. E. Journal*, vol. 3, no. 5, March 1917, pp. 30-49, 2 figs. *ep*)

LATENT HEAT OF AMMONIA, Gardner T. Voorhees

Derivation by a new method of the values of the latent heat of ammonia.

The writer establishes in the first part of his article formulæ for the latent heat of ammonia or other similar substances.

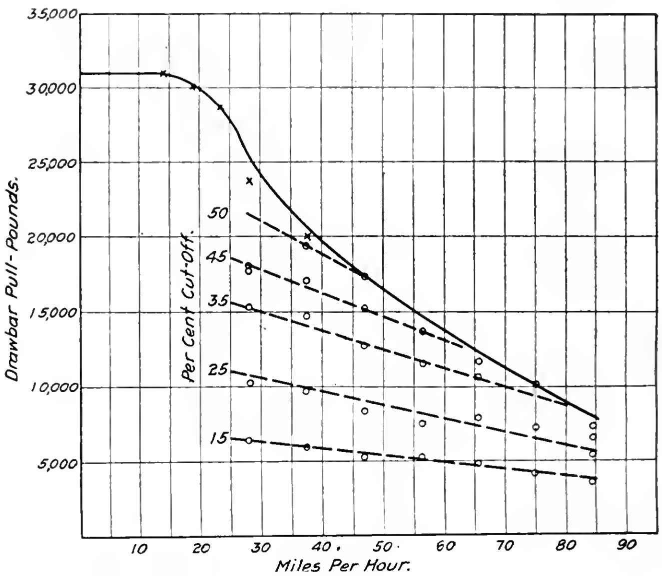


FIG. 9 MAXIMUM DRAWBAR PULL AT VARIOUS CUT-OFFS

From this he proceeds to the derivation of the curves shown in Fig. 10. This work is substantially based on the data of tests made by Professor J. E. Denton, and published in Trans. Am. Soc.M.E., Vol. 12.

Professor Denton gives all the figures for his tests on brine meters and the ammonia meter, but uses a fixed coefficient. Since, however, the brine coefficient for brine meter will vary with the quantity, the present writer has surveyed coefficients from his actual meter tests, and thus obtained slightly different weights of brine circulated. Similarly, a variable coefficient has been derived and used for the ammonia meter.

Tests 2 and 4 of Professor Denton had estimated temperatures for the liquid to the expansion valve. The writer reëstimated these temperatures by a different method and deduced the same results as Professor Denton.

The heat balance as figured by Mr. Voorhees showed about 4 per cent for test 2, about 3 per cent for test 4, and about 3

per cent for test 8, more heat given to the ammonia than taken from it. A correction of less than a fraction of one per cent of the quantities involved was further made for the exposure of the condenser.

On the basis of the above considerations has been plotted on Fig. 10 the curve of high latent heats of condensation. The low latent heats of vaporization, figured by taking the difference in heats of liquid from the latent heat, are shown at 2, 4, 8*l* in the same figure.

Any peculiarities in the action of the ammonia would not have any material effect on the latent heat, and therefore the writer has averaged the three high latent heats and their corresponding saturated temperatures given as 2, 4, 8*h* in Fig. 10. Next the author applied two previously derived equations and has deduced therefrom the approximate latent heats for all conditions from the freezing point of ammonia to its critical temperature. The approximate curve of latent heat is not shown.

The average high-temperature latent heat as represented by point 2, 4, 8*h* of Fig. 10 is at 79 deg. and is 504 B.t.u., the value deduced from Denton's tests by the present writer for this latent heat.

The writer has also plotted a curve not shown here which is the average of the low-temperature latent heats deduced from Denton's tests and equal to 564 B.t.u. The low-temperature latent heat was below the curve above referred to. This occurred because the energy that was dissipated in passing the

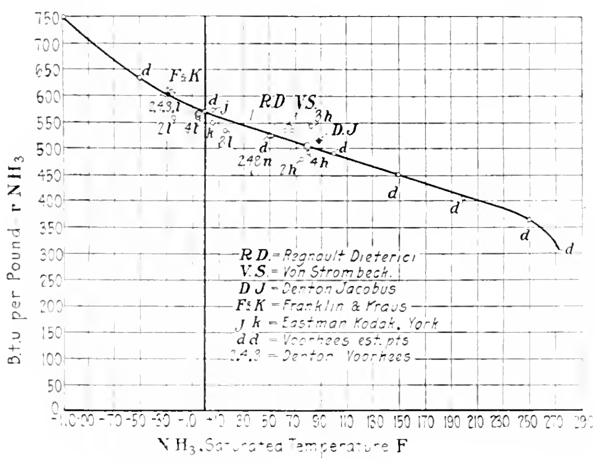


FIG. 10 LATENT HEAT OF AMMONIA (—108 TO +273° F.)

expansion valve was not taken into consideration, and this energy is equal to the euergy that we would have had, if we had had an expansion cylinder. This energy loss at the expansion valve is made up of two parts: First, the energy that would have been required to get the liquid back from the cylinder into compression chamber from the low pressure to the high pressure; and second, the work that would be required to saturatedly compress vapor formed at the expansion valve from the low to the high pressure, and push the resultant liquid back into the proper chamber. The writer gives formulæ for the loss of heat by dissipation at the expansion valve.

A still further important correction is suggested for the latent heats. Up to this point it has always been estimated that the evaporation at the expansion valve was due to the difference of heats of liquid, as if the latent heat used for so doing was entirely at the low pressure.

To determine this the writer deduced successive new curves with successively closer approximations to the true average latent heat, and continued this process until any further approximate curves would make less than 1 B.t.u. difference at any point. These points gave what is believed to be the true latent heat of ammonia as it would actually be in a practical refrigerating system, because its foundation is laid on actual, very accurate tests of a practical refrigerating system and the deductions therefrom based on what is believed to be sound thermodynamic reasoning.

These points have been plotted on Fig. 11 and joined with a smooth curve.

The article gives equations for useful refrigeration with an expansion-valve refrigerating cycle, and a table of figures on

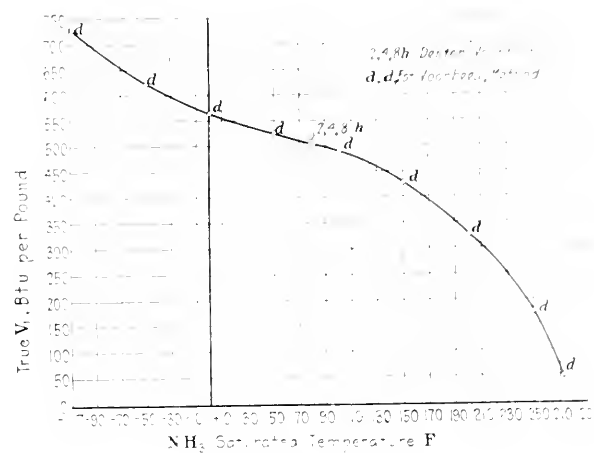


FIG. 11 TRUE LATENT HEAT, FREEZING PT. TO CRITICAL TEMP.

practical latent heat of ammonia-reproduced in Table 3. (*Ice and Refrigeration*, vol. 52, no. 4, April 1917, pp. 177-183, 3 figs., *etA*)

Safety Engineering

GLASSES FOR PROTECTING THE EYES FROM INJURIOUS RADIATIONS, W. W. Coblentz and W. B. Emerson

The object of the present paper is to give the general characteristics of certain newly developed glasses sometimes used for protecting the eye from radiant energy, especially the infra-red or so-called heat rays. Because of the difficulty in reproducing the same color in different melts, no attempt is made to give specific data on the transmission for a given thickness of glass. In order to obtain exact data it is necessary to examine samples from each melt.

These data are representative of an extensive group of glasses available for protecting the eye from (1) the ultra-violet, (2) the visible and (3) the infra-red rays.

For protecting the eye from ultra-violent light, black, amber green, greenish-yellow, and red glasses are efficient. Spectacles made of white glass afford some protection from the extreme ultra-violet rays which come from mercury-in-quartz lamps, and from electric arcs between iron, copper, or carbon. The vapors from these arcs emit but little infra-red radiation in comparison with the amount emitted in the visible and in the ultra-violet rays.

For shielding the eye from infra-red rays deep black, yellowish-green, sage green, gold-plated, and bluish-green glasses are efficient. For working near furnaces of molten iron or glass, if considerable light is needed, a light bluish-green or sage-green glass is efficient in obstructing the infra-red rays. For working molten quartz, operating oxy-acetylene or elec-

for welding apparatus or other intense sources of light, it is important to wear the darkest glasses one can use, whether black, green (including gold-plated glasses) or yellowish green, in order to obstruct not only the ultra red, but also the visible and the ultra violet rays.

Data are given showing that of the infra-red rays emitted by a furnace heated to 1000 to 1100 deg. cent. (1) about 99 per cent are obstructed by gold-plated glasses, (2) about 95 per cent by sage-green or bluish-green glasses, (3) about 80 per cent by very-deep-black glasses, and (4) about 60 per cent by greenish-yellow glasses.

At higher temperatures these data would be somewhat different, but not sufficiently so to modify the rough estimate dealt with in this paper. (*Bureau of Standards*, Technologic Paper No. 93, November, 1916.)

TABLE [illegible] PRACTICAL LATENT HEAT OF AMMONIA

t°	r	t°	r	t°	r	t°	r	t°	r
108	729	8	558	36	535	64	514	92	493
100	709	9	557.5	37	534.5	65	513.5	93	492.5
90	684	10	557	38	534	66	513	94	492
80	667	11	556	39	533	67	512.5	95	491
70	650	12	555	40	532	68	512	96	490
60	635	13	554	41	531.5	69	511	97	489
50	622	14	553	42	531	70	510	98	488
40	608	15	552.5	43	530	71	509	99	487
30	597	16	552	44	529	72	508	100	486
−20	585	17	551	45	528.5	73	507.5	110	476
−10	575	18	550	46	528	74	507	120	465
9	574	19	549	47	527.5	75	506	130	454
−8	573	20	548	48	527	76	505	140	441
−7	572.5	21	547.5	49	526	77	504	150	426
−6	572	22	547	50	525	78	503	160	409
−5	570.5	23	546	51	524	79	502.5	170	391
−4	569	24	545	52	523	80	502	180	371
−3	568.5	25	544	53	522.5	81	501	190	350
−2	568	26	543	54	522	82	500	200	328
−1	567	27	542.5	55	521	83	499	210	305
0	566	28	542	56	520	84	498	220	280
+1	564.5	29	541	57	519	85	497.5	230	252
2	563	30	540	58	518	86	497	240	220
3	562.5	31	539	59	517.5	87	496.5	250	181
4	562	32	538	60	517	88	496	260	131
5	561	33	537.5	61	516.5	89	495	270	68
6	560	34	537	62	516	90	494	273	46
7	559	35	536	63	515	91	493.5		

Steam Engineering

Energy Stored in a Boiler Under Pressure, F. R. Low

An interesting discussion of the computation of the energy that would be released by an exploding boiler per pound of contained water and steam.

It is known that when steam separates from water out of which it is generated, a certain amount of work is necessary to overcome the atmospheric pressure. If the pressure per square foot be called p, and the difference in volume between that of the original water and the final volume of water and steam be called u, the pressure being in pounds per square foot, and the volume in cubic feet; if, further, the mechanical equivalent of heat be denoted by A, then the external work done in forcing back the environment when water changes to steam will be Apu (in foot-pounds).

The writer asks whether this Apu work should be included in calculating the energy released by a pound of water under the assumed conditions. There is no doubt that the Apu work is exerted upon the environing atmosphere, but pushing it back is all that it can do. Apart from that, any damage that is caused or any disturbance that is produced must be at the expense of other heat units. The Apu work in itself simply means the generation of a certain volume against the atmospheric pressure, so that as far as the computation of energy released is concerned, i.e., energy available for damage or disturbance, it would appear that the Apu work should not be included.

It makes a difference, however, how the case is stated, and *Power*, in its editorial work, has found such disagreement among authorities that it has asked a score or more of authorities what the value would be for 115 lb. absolute and 212 deg.

The writer presents the matter in the following way.

Imagine a pound of water heated to 338.1 deg. fahr. in a non-conducting cylinder and retained under 115 lb. per sq. in. absolute pressure by a diaphragm as in Fig. 12. Suppose the diaphragm burst. Further, assume that the cylinder, instead of being open as in Fig. 12, was closed at the top, with a partition, as in Fig. 14, the space between the partition and the diaphragm retaining the water being vacuous.

When the diaphragm broke, the mass of steam and water would be projected against the partition. But the partition and the containing wall are assumed to be non-absorptive and impervious to heat, and therefore the heat represented by the kinetic energy, the energy of motion of the projected mass, is reconverted by impact and eddying and friction into heat, and is applied to evaporating more of the water than as though it went off in the energy of flying masses. In this case the entire energy is available for evaporating water.

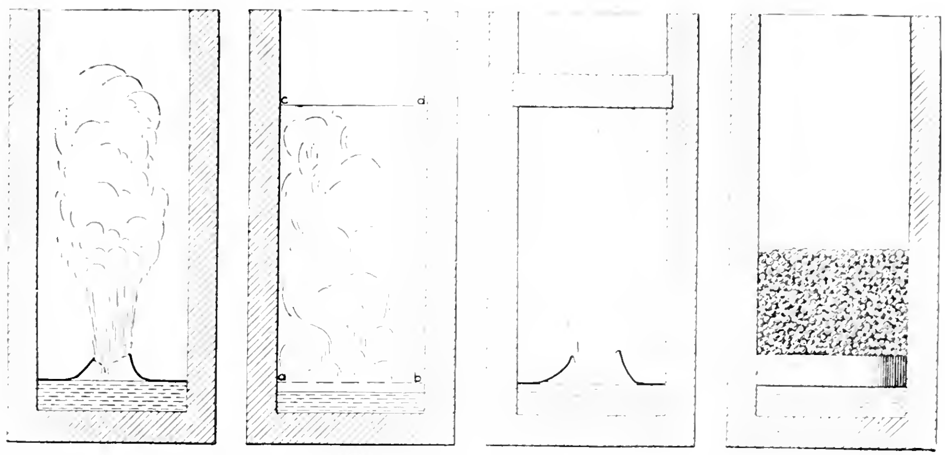
Let us imagine the case as shown in Fig. 15, in which a frictionless and weightless but still non-conducting piston over the liquid is loaded with, say, 100 lb. of shot per sq. in., with its area exerting upon the water the combined pressure of the shot and the atmosphere, 115 lb. per sq. in., and allowing it to be heated to 328.1 deg. without boiling. If now some of the shot is removed, the pressure will become less and the water will boil until, by evaporation, its temperature is reduced to the boiling point under the new pressure. When the shot is all removed, there will be only the atmospheric pressure upon the mixture, and the temperature will be 212 deg. Of the 309 B.t.u. in the pound of water at 115 lb., 180 are in the mixture of steam and water at 212 deg.; 8.87 are represented by the work of raising the piston against the atmospheric pressure, and the rest are consumed in making a part of the water into steam and lifting the shot.

The question raised by the author is whether the 8.87 B.t.u. used to push back the atmosphere is to be credited to the effective work of this steam. This question is answered in the following manner.

Imagine a pound of steam at 115 lb. to change places with an equal volume of free atmosphere. All that it can do is to expand, to generate energy equivalent to the portion of the pressure-volume diagram, Fig. 16, beneath the expansion line; the area *BCDEB*. The energy represented by *ABEFA* was generated when the steam was made and is developed during the admission of this pound of steam into an engine cylinder or turbine nozzle by the simultaneous generation of an equal volume of steam in the boiler, pushing this one out; otherwise the pressure would not remain constant. A pound of steam changing places with an equal volume of free atmosphere can do none of this work; it can simply expand, and if the expansion is adiabatic or isentropic (that is, without the gain or loss of heat), the heat accounted for will be the same in the initial and final conditions.

The internal heat (that is, the difference between the total

heat and the heat equivalent of the Apu work) is given in the tables under the designation E, and since the action is by definition to take place without gain or loss of heat, the difference between these internal or intrinsic heat energies before and after expansion will be the heat equivalent of the work performed; that is, of the area *BCDEB*. For a pound of dry saturated steam at 115 lb., this is given by the table as 1106.5 B.t.u. After expansion, if it were still all steam, we could take the tabular value of E at the lower value away from 1106.5 and find the heat available for performing work. But during the expansion a part of the steam will have condensed and the quality and consequent internal energy will have to be computed.



Figs. 12 to 15 Methods of Change of Water, from 115 lb. and 338 deg. to Atmosphere and 212 deg.

The difference between the internal, or inherent, energies in the initial and final conditions, x_2 in this case being 0.885, is

$$E_1 - E_2 = 1106.5 - 974.34 = 132.16 \text{ B.t.u.}$$

This is represented by the area *BCDEB*. *Power* asked if the person addressed agreed that the energy released (that is, available to produce disaster and disturbance) is that represented by this whole area, or whether it should be reduced by taking out that represented by the area *HCDEH* (that is, the energy absorbed in pushing back the atmosphere with a pressure proportional to *CD* through a volume proportional to *ED*); in other words, whether for the case of the steam the energy available for damage and disturbance should be taken as that represented by the area *BCDEB* or by the shaded area *BCH*. (*Power*, vol. 45, no. 15, April 10, 1917, pp. 475-477, 6 figs. *t*)

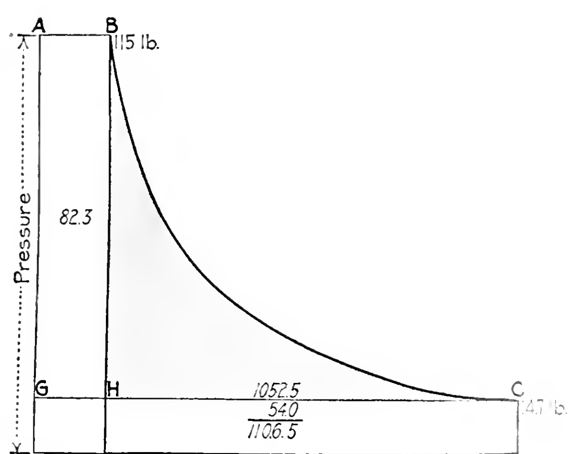


Fig. 16 *PV* Diagram for Steam

Thermodynamics

Exhaustive Tests on Electric Water Heaters, Stanley V. Walton

The article gives details of tests of various types of electric water heaters. It is of considerable interest to mechanical engineers in view of the fact that incidentally valuable data were obtained on heat-transfer phenomena.

Among other things tests were run on heat-insulating materials, in particular, the so-called Economy boiler covering. This material consists of hair felt sewed up in canvas jackets, formed to fit a standard 30-gal. domestic boiler and held in position by lacing. A single-ply covering consists of a single jacket 1 in. thick. The three-ply covering consists of three separate concentric jackets applied one over the other. The magnesia was applied in the form of bricks to a total thickness of 2 in. with an outer cloth covering.

The purpose of the test was to determine radiation losses from the boiler alone, disconnected from all piping. For this purpose the boiler was insulated and filled with water which was heated approximately to the boiling point and the time-temperature curve in cooling was determined. From this curve and known quantity of water the radiation loss can be readily calculated. The results of the tests are given in Fig. 17.

Another test was run on uninsulated boilers, either bare or painted, and the results are given in Figs. 18-19.

A number of similar tests on heat losses from water piping, either bare or insulated, were run, the results being given in the form of curves. (*The Journal of Electricity*, vol. 38, no. 7, April 1, 1917, pp. 227-235, illustrated. *e*)

Varia

Intake Well at the Dubuque Electric Company's Plant, E. M. Walker

General description of the central power station at Dubuque, Iowa. This station has been recently reconstructed

...ized without interruption of service and now has a generating capacity of 9,400 kw.

An interesting feature of the station is an intake well shown in cross-section in Fig. 20. The station is located on a slough of the Mississippi River, about 2,000 ft. away from the main river, and the supply of water for the condensers was a source of trouble for a number of years. The new well has

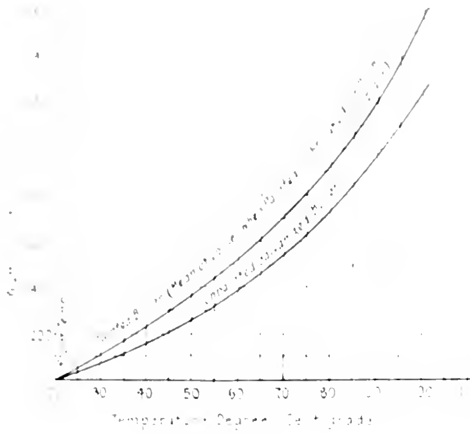


Fig. 17

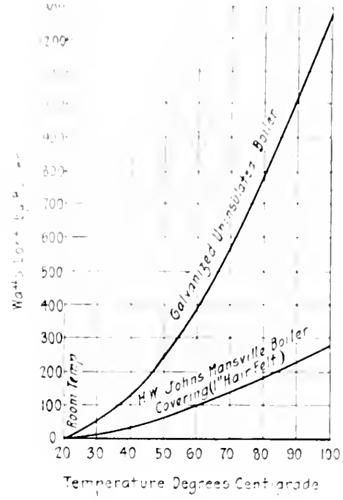


Fig. 18

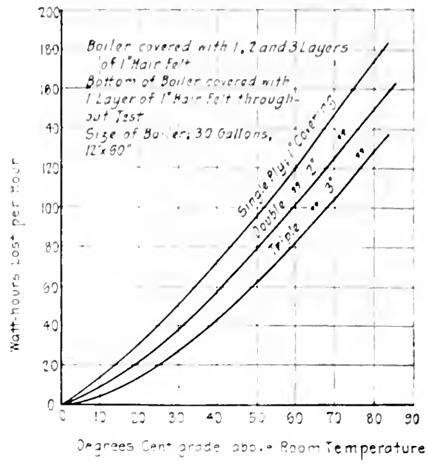


Fig. 19

FIG. 17 RADIATION LOSSES FROM BOILER. FIGS. 18 AND 19 HEAT LOSSES WITH UNINSULATED BOILERS

provided a solution and removed the possibility of a scarcity of water at low stages of the river, which frequently occurs in midwinter and late midsummer.

This well is designed to overcome the difficulty of low water, and also by the whirlpool action of the water in passing through the well to remove automatically a large percentage of the sediment in the river water. The well is built on the spiral principle, the water traveling around it many times, and thus allowing the sediment to settle into a sump in the center, from which it can be periodically removed by an ejector pump.

The well is 20 ft. in diameter and 36 ft. deep, the bottom

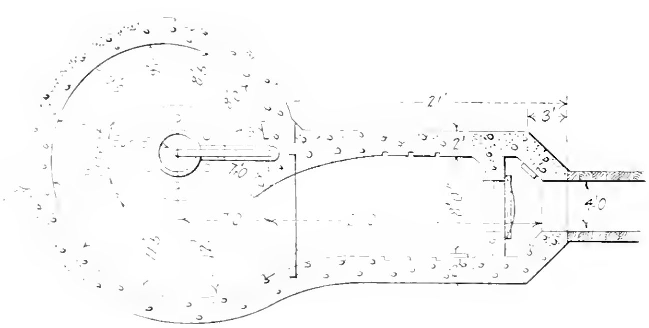


FIG. 20 CROSS-SECTION OF INTAKE WELL

being 6 ft. below zero stage of the river. The intake pipe is 36-in. flanged cast-iron. (*Electrical Review and Western Electrician*, vol. 70, no. 12, March 24, 1917, pp. 485-487, 6 figs., *d*)

RUSSIAN TESTS OF BRITISH TRUCKS, R. Douglas-Vickers

Some time last November the Russian Purchasing Commission in England arranged for trials of commercial vehicles, so as to give British makers an idea of the unusually severe conditions to be met with in Russia where roads are in most cases either poor or entirely absent.

All the vehicles submitted for the test had to carry a 30 per cent overload over an exceptionally poor stretch of ground. The heavy machines were unable to negotiate several stretches of very soft ground, while the lighter machines were better able to get over the difficult places.

It is believed that this test showed the British makers that, if the bad stretches of road referred to were anything like those which were commonly met in Russia, the Russian Commission was fully justified in calling for special requirements. These special requirements are as follows:

- More powerful engines
- Stronger frames and springs
- Greater clearance
- Larger wheels and twin tires on all rear axles for passenger cars
- Especially strong bodies
- Accessibility of all parts for repairs and simplicity to enable repairs to be effected without carrying a large amount of special material.

The writer believes that vehicles used on bad roads should not be of greater load capacity than 5000 lb., should drive on all four wheels, and if not, some means of locking the differential should be provided. (*The Commercial Vehicle*, vol. 16, no. 5, April 1, 1917, p. 23, *g*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer.

Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

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PERSONALS

*In these columns are inserted items **concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary and items should be received by May 16 in order to appear in the June issue.***

CHANGES OF POSITION

Andrew C. Loudon has accepted a position with the Locomotive Superheater Company, New York. He was until recently associate editor of the *Railway Age Gazette*, New York.

Channing Turner, formerly assistant industrial engineer with the Winchester Repeating Arms Company, New Haven, Conn., has become ranch manager at Clearwater, Mont.

Leon P. Alford is now associated with *Industrial Management*, formerly Engineering Magazine, as editor-in-chief. He was editor of the *American Machinist* for about ten years.

Ralph S. Barnaby, formerly with The Elco Company, Bayonne, N. J., as inspector of material, has joined the engineering department of the Standard Aero Corporation, Plainfield, N. J.

Albert W. Bissell has resigned as assistant sales manager of the American Refractories Company, Chicago, Ill., to enter the employ of the Colorado Fuel and Iron Company, Pueblo, Colo.

David Van Alstyne, until recently assistant to vice-president of the N. Y., N. H. and H. R. R., New York, has accepted a position with the American Locomotive Company, New York.

John W. Brassington, formerly engineer with The Pusey and Jones Company, Wilmington, Del., has assumed the duties of chief engineer of the American Writing Paper Company, Holyoke, Mass.

Charles J. Tehle has accepted a position with the Kerr Turbine Company of Wellsville, N. Y. He was until recently in the employ of the Chicago Pneumatic Tool Company of Franklin, Pa.

La Vern J. Charles, until recently construction engineer with the U. S. Reclamation Service, Lakewood, New Mexico, has assumed the duties of assistant state highway engineer of Santa Fe, New Mexico.

Frederick A. Otto, superintendent of the electrical department of the St. Paul Gas Light Company, St. Paul, Minn., has become affiliated with the Minnesota Gas and Electric Company, Albert Lea, Minn.

James McNaughton has become affiliated with the Eddystone Ammunition Company, Eddystone, Pa., as assistant to the president. He was formerly vice-president of the American Locomotive Company, New York.

P. M. Smith has resigned his position with the William Tod Company of Youngstown, O., to become connected with the Standard Engineering Company of Ellwood City, Pa., in the capacity of chief draftsman.

Andrew Westwater, formerly marine engine and boiler draftsman with the Moore and Scott Iron Works, Alameda, Cal., has be-

come identified with the Columbia River Shipbuilding Corporation, Portland, Ore.

Gilbert I. Vincent has accepted the position of engineer with the Syracuse Lighting Company, Syracuse, N. Y. He was until recently connected with the Des Moines Gas Company, Des Moines, Ia., in a similar capacity.

Forrest E. Cardullo, formerly chief draftsman of the Pierce-Arrow Motor Car Company, Buffalo, N. Y., has assumed the duties of engineer of tests with the Curtiss Aeroplane and Motor Corporation of the same city.

Frederic C. Holmgren, material engineer with The Remington Arms Union Metallic Cartridge Company, Bridgeport, Conn., has assumed the duties of automobile expert with the Rock Island Arsenal, Rock Island, Ill.

Harold E. Rowe has left the employ of The Carborundum Company, Niagara Falls, N. Y., and has again become associated with The Sinclair Refining Company, with headquarters at their main office in Chicago, Ill.

Edwin J. Lanham, formerly employed as mechanical engineer for the Elyria Machine Company, Elyria, O., has recently become associated with the B. F. Goodrich Company, Akron, O., in the capacity of estimating engineer.

Herbert R. Lucke has resigned his position as manager of the De La Vergne Engine Company, Houston, Tex., to assume the duties of vice-president and assistant general manager of the Hughes Tool Company, Houston, Tex.

Frank L. Dalas, formerly with the Youngstown Sheet and Tube Company, Youngstown, O., in the capacity of inspector of the electrical and mechanical department, has become head electrician at the Burma Mines, Burma, India.

Orlo L. Waugh has accepted a position with The Crown Cork and Seal Company, Toronto, Ont., Canada. He was until recently employed by the Curtiss Aeroplane and Motor Company, Buffalo, N. Y., in the capacity of testing engineer.

Thomas M. Roberts has resigned his position as electrical engineer's assistant, Interborough Rapid Transit Company, New York, and has become associated with the Navy Department, Bureau of Yards and Docks, Washington, D. C.

P. T. Sowden has resigned as works manager of the Torsion Balance Company, New York and Jersey City, to accept the position of assistant general manager of Arkell and Smith, Canajoharie, N. Y., manufacturers of paper bag machinery.

Bruce M. Swope has accepted the position of assistant master mechanic of the Renovo Division of the Pennsylvania Railroad Company. He was formerly motive power inspector of the Pitcairn Car Shops of the same company, at Pittsburgh, Pa.

John H. Wynne has assumed the duties of vice-president of E. B. Cadwell and Company, Inc., New York. Mr. Wynne was formerly connected with the American Locomotive Company, New York, in the capacity of sales manager of construction equipment.

Edwin Frank, formerly instructor in mechanical engineering, University of Illinois, Urbana, Ill., has become affiliated with the C. H. Wheeler Manufacturing Company, North Philadelphia, Pa., in the capacity of centrifugal pump designer in the marine department.

R. J. S. Pigott, until recently associated with the Interborough Rapid Transit Co. in a consulting capacity, and for the last two years power superintendent of the Remington Arms and Ammunition Company, has become associated with the Sanford-Riley Stoker Company, New York, in a consulting capacity on [illegible]

ANNOUNCEMENTS

E. C. Henn has been elected one of the directors of the Cleveland Chamber of Commerce.

Sir Robert A. Hadfield has offered 200 pounds to provide for a prize for a new and accurate method for determining the hardness of various metals.

W. B. Gregory, professor of experimental engineering, Tulane University of Louisiana, New Orleans, has been commissioned Major of the engineer section of the Officers' Reserve Corps.

James G. Scrugham, Dean of the Engineering College of the University of Nevada, Reno, Nevada, is to take a two years' leave of absence to accept the position of state engineer of Nevada.

Paul M. Lincoln, Jack S. Herbert and Elmer K. Hiles have received commissions signed by President Wilson, making them officers in the engineering division of the Officers' Reserve Corps of the United States Army.

Paul C. Philipp has taken into partnership H. K. Beach. Mr. Beach has had a wide experience along power plant work and general engineering for industrial concerns, especially designing of brass and copper mills. Mr. Philipp has been in private practice for a number of years, specializing in the valuation of public utility and industrial properties and preparing financial reports. The partnership will be conducted under the firm name of Philipp and Beach, with office headquarters at Philadelphia, Pa.

APPOINTMENTS

Jacob A. Teach has recently been appointed mechanical engineer of the Minneapolis Steel and Machinery Company, Minneapolis, Minn.

AUTHORS

C. R. Knowles presented a paper on Railway Water Supply at the April 20 meeting of the New York Railroad Club.

Julian C. Smallwood has contributed an article on Heat Balance of an Absorption Plant to the April 10 issue of *Power*.

Harold B. Bernard has contributed an article on Natural Gas Pumping Station at Roystone to the April 17 issue of *Power*.

Donald A. Hampson is contributing a series of articles on The Tools of the Automobile Repair Shop to the *Horseless Age*.

Gardner T. Voorhees is the author of Latent Heat of Ammonia, which appears in the April number of *Ice and Refrigeration*.

Charles C. Lynde is the author of Uniflow Steam Engine for Rod Mill Drive, which appears in the April issue of *The Blast Furnace and Steel Plant*.

Calvin W. Rice and Leon Goldmerstein (Cammen) are the joint authors of an article on Mechanical Engineering in *The American Year Book*, 1916.

Alanson P. Brush is the author of an article on Crankshaft Problems in Automobile Engines, which appears in the April number of *The Gas Engine*.

Paul A. Bancel has contributed a brief article entitled World's Two Largest Steam Hoists, to the April 7 issue of the *Engineering and Mining Journal*.

Frederick W. O'Neil is the author of Recent Developments in the Design of Hoisting Engines, which appears in the April 7 issue of the *Engineering and Mining Journal*.

Henry M. Hobart has contributd an article on Electrical Machinery Tests and Specifications Based on Modern Standards to the April issue of the *General Electric Review*.

Allen F. Brewer is the author of an article on The Principles of the Calculation of "Straight Line" Depreciation, which is published in *Industrial Management* for April.

P. C. Idell presented an illustrated paper on Development of Boilers and Modern Boiler-Room Construction at the April 12 meeting of the Engineers' Club of Trenton, Trenton, N. J.

George W. Fuller has contributed to the April 5 number of *Engineering News-Record*, an article entitled Relations Between Sewage Disposal and Water Supply Are Changing, in which an appraisal of progress is made, viewed in the light of recent developments in the field of sanitary engineering.

W. D. Forbes is the author of Marine Machine Shop Equipment, published in the April issue of *Marine Engineering*. This article deals with tools ranging from the smallest and finest to the largest and heaviest required in shipyard machine shops.

Power Losses in Pneumatic Tires by E. H. Lockwood, read before the January 25th meeting of the Pennsylvania Section of the Society of Automobile Engineers, was published in the February Bulletin of the Society of Automobile Engineers, and republished in the February Proceedings of the Philadelphia Engineers' Club, the February 1 issue of *The Automobile* and the March 31 number of *Automobile Topics*.

THE NEW BOOKS

All books received by The Journal will be listed under this heading, generally accompanied by brief descriptive notes. Works of special importance to mechanical engineers will be commented on at length by members and others peculiarly qualified by reason of their experience and training.

Riveted Boiler Joints. By [illegible], B.S., M.S., Member of Boiler Code Committee, Am.Soc.M.E., Chief Engineer, The Hartford Steam Boiler Inspection and Insurance Company. McGraw Hill Book Co., Inc., New York, 1917. Cloth, 11 x 8 in., 52 figures and 75 full page [illegible]. $[illegible] net.

The twofold aim of the author is to give a graphical treatment of riveted joint design and to determine the best arrangement of rivets in a given joint. The graphical treatment is extensive and charts are given for nearly all diameters of rivets used in practice. The method of constructing additional charts is given should there be need for these in cases other than those given in the text. The best arrangement of rivets is attempted by the author, and is indicated by a statement rather than by proof. In this connection the chapter on Riveted Joints of Maximum Efficiency requires much polishing before the treatment becomes clear. The discussion refers mainly to lap joints, and the author does not state always whether the analysis is general or specific, thus leaving the reader to decide this question. If the book is intended for those who do not wish to undertake an intensive study, the previous criticism carries its maximum weight.

According to the author, the book is intended for boiler designers, boiler inspectors, students, and to some extent for structural engineers. For the latter class, however, the book seems to offer little, since structural engineers use rivets mainly in compressive members, and the joints subject to tension are rare.

The treatment is both analytical and graphical. The mathematics required of the reader consists of simple algebraic transformations and only a slight suggestion of analytic geometry. One accustomed to the use of cross-section paper will perhaps meet with little difficulty in plotting the linear equations given in the text. Moreover, the author works out a sufficient number of examples, so that the reader could hardly go astray, even though the explanations are extensive rather than explicit.

The graphical treatment is original, although it has been published previously by the author in the columns of *Power*. A discussion of limiting pitches is given, and this is a desirable asset.

The author does not devote any attention to the question of eccentrically loaded joints. In fact, lap joints are shown with the same prominence as double butt-strap joints with equal-width cover plates. Even the double butt-strap joints with unequal-width cover plates are shown, and these have the same disadvantages as the ordinary lap joints. It will be remembered that lap joints are going out of use rapidly, and in many states are prohibited by law. The reviewer concludes from the text that it makes little or no difference in the author's mind which are to be advocated.

Whether this book will be of service to the designer depends entirely on the designer's point of view. If one wishes to select joints with little or no calculation, the charts are of service. If, on the other hand, the designer prefers to calculate the joints from first principles, the book is of less service, since this part is not given with utmost clearness. One objection to the use of charts for boiler designers is that in drawing them the values of the resistances in tension, shear, and crushing must be fixed. Hence such charts would become obsolete should cases arise in the future when these values might be changed. They may be redrawn for the new values, however. This disadvantage does not hold for the analytical treatment.

Alphonse A. Adler.

Mechanical Equipment of Buildings. Vol. I, Heating and Ventilation of Buildings. By Louis Allen Harding, B.S., M.E., and Arthur Cutts Willard, S.B. John Wiley & Sons, Inc., New York, 1916. Leather, 9¼ x 6½ in., 606 pp., 66 illustrations and charts. $4 net.

Volume I of this work deals with the heating and ventilating of buildings, and subsequent volumes will, it is said, relate to power plants, elevators, lighting systems, refrigerating plants, sprinkler systems, vacuum cleaning, and plumbing. The object of the authors is to produce a reference book for engineers and architects which will contain sufficient theoretical and commercial data for practical use in the designing room, and at the same time serve to show the student the relation between the theoretical principles involved and their practical application to actual problems. The various chapters cover the properties of water, steam, and air, the mechanics of their movement, heat transmission of building materials and of radiators, fuels and combustion, boilers, heating water in tanks and pools, chimneys, direct steam and hot-water heating, electrical heating, ventilation, warm-air furnaces, fan heating, air conditioning, temperature and humidity control, exhaust-steam heating, district heating, pipe fittings, valves, covering, the cost of equipment, and the preparation of plans and specifications.

While a great deal of information in the book is of value to the trained engineer, many of the rules given are so complex as to puzzle the average architect and the heating engineer without a thorough technical training. As a matter of fact, the work cannot help but impress one familiar with the subject that it will be of far more value in the classroom and in the hands of a technically trained engineer with the patience to digest the information contained in it, than it will be to the heating engineer that has graduated from the bench, and even the technically trained engineer seeking formulæ for his work that may be easily understood and easily applied. A great deal of the matter in the book has been taken from other sources. Much of the matter so obtained could have been omitted to advantage. In fact, one might well question the advisability of encumbering the book with tables of valve and pipe-fitting dimensions and the various dimensions of proprietary articles. As this information can be obtained from catalogues obtainable for the asking, it hardly seems fair for the purchaser of the work to pay for so much information that could be obtained elsewhere without cost. Again, there is a complete chapter on fuels and combustion. It would seem preferable to present instead a brief summary of the essential data required by the heating engineer and refer him for further information to the many excellent treatments of this subject in other books. In many cases a number of rules proposed

by different authors for solving the same problem are given, and it is to be regretted that their advantages and disadvantages and their limitations are not commented upon by the authors, for their presentation without such comment leads to perplexity in the mind of users of the book. The selection of rules given might here and there be improved. For instance, one finds no reference to the data on heat transmission through building substances, and to the rules for determining radiating surfaces as used by the late Alfred R. Wolff. When one considers the effect these data had on the science of heating in the United States, their omission in a work of this magnitude is to be regretted. This criticism should not obscure the fact that the work contains a great deal of very useful information, a most excellent and lavish selection of illustrations, and a good deal of matter that cannot be found in other works on the subject.

A Member.

To the Editor:

The authors believe, in common with many other engineers, that the subject of heating and ventilation is of such commercial importance that a somewhat more comprehensive treatment is warranted than has thus far appeared.

This volume is now in use in many engineering offices, and from the reports the publishers and authors have received the method of treatment employed has apparently been justified.

The work is distinctly not a set of "Rules," and we are inclined to agree with the reviewer that the book was written for the man of technical training, or one who is acquiring such a training. Engineering subjects fortunately, perhaps, require some study to grasp, and this branch of engineering apparently is no exception to the rule.

Engineers in general, we believe, prefer to have the derivation of the formulæ and constants used stated in the text, rather than the bare statement of rules or formulæ. For this reason we have included such matter as our experiments on the heat transmission of building construction, which we believe are more complete, in many respects, than any heretofore published data in this connection.

The section devoted to hot-blast heating can hardly be reduced if one is to cover the subject properly.

Particular attention is directed to fan testing and the application of fan tables—a subject that comparatively few engineers are familiar with. This is the first treatise on the subject to include complete data on air washing and humidification, as well as a number of other subdivisions of heating.

The Authors.

Elementary Course in Lagrange's Equations. B. N. W[illegible], Mechanical Engineer. Philadelphia Book Co. [illegible] Cloth, 6x9 in., 195 pp., 58 illustrations. [illegible]

In the preparation of this book the [illegible] to present the methods of analysis of Lag[illegible] that the average engineer might have a[illegible] for the formulation of the fundamental pro[illegible] arising in engineering practice. It is there[illegible] condensed selection of fundamental equati[illegible] developed from foundational principles, an[illegible] the methods of the calculus and a ready inte[illegible]lic notation are essential to its reading.

The work is divided into [illegible] which treat of the following subjects: Synopsis of principles of dynamics, 85 pp.; Lagrange's equations for a particle, 27 pp.; Lagrange's equations for a system, 31 pp.; Lagrange's equations for relative motion, 16 pp.; small oscillations, 35 pp. The method of treatment is quite similar to that found in the usual mathematical texts of this sort, in that the bases for the derivation of the several formulated relationships arrived at are certain general and fundamental concepts symbolically expressed, and the usual applications of the laws of numbers are resorted to in their treatment and transformation.

Aside from the references to the embodiment of certain dynamic problems in the case of the gyroscope, the automobile, and the balancing machine devised by the author, there are hardly any references to engineering practice illustrative of the problems dealt with. The treatment of the subject may therefore be characterized as academic. It would appear therefore that the main purpose of the book—to promote a use of Lagrange's method in the solution of dynamic problems—has been defeated. There never has been any lack of material of the sort this book contains. The difficulty does not seem to lie in this direction. Since the capacity to recognize in engineering problems certain fundamental principles needs more cultivation than the faculty of dealing with laws of numbers, it appears that the value of the book would have been enhanced for the engineer if more attention had been given to engineering problems. It is a simple matter for the student to learn that, given a beam of certain material, proportions, loading and methods of support, the moments and stresses arising are found "thus" and the relations are formulated "so." But one able to solve this sort of a problem is wholly at sea if given a machine and told to determine the nature and magnitude of the loadings of certain members, the rigidity of their support, the probability of maximum stress, where found and how much. This latter sort of text writing is rare and is very much needed.

The value of the book would be very much increased if there were a number of engineering applications given to illustrate the different problems. As it is, the engineer reading the book will naturally ask himself the question, "If this sort of analysis is so valuable for the solution of dynamic problems arising in engineering practice, why are there not some engineering problems given in illustration?" It is hoped that in future editions the author will more intimately associate the purely mathematical with the engineering problem, and thus show engineers how this work of Lagrange may be used to a greater extent than it is today.

The book is well bound and neatly printed on good paper. The figures are clear and neatly made.

Walter Rautenstrauch.

Fatigue Study. The Elimination of Humanity's Greatest Waste. A First Step in Motion Study. By Frank B. Gilbreth, Mem.Am.Soc. M.E. and Lillian M. Gilbreth, Ph.D. Sturgis & Walton Company, New York, 1916. Cloth, 5x7½ in., 159 pp., 33 illustrations. $1.50.

This little book should be read by the president and directors of every industrial corporation, and copies of it should be presented to the superintendent of each department, with instructions to read it and then hand it to the foremen. A copy of it should be in every works library. "It is a good thing, pass it along." "Safety first" is the motto of every well-conducted factory: "fatigue study next" should be added to it.

Fatigue, the authors say, is a necessary by-product of activity. A little fatigue is easily overcome if proper rest is supplied immediately. Twice the amount of fatigue requires more than twice the amount of rest. Excessive fatigue requires a rest period that might have to be prolonged indefinitely. It is this fact that lies at the basis of the great unnecessary

[illegible] accumulated fatigue. Fatigue study is an attack upon unnecessary waste. It aims: 1 To determine accurately what fatigue results from doing various types of work; 2 To eliminate all unnecessary fatigue; 3 To reduce the necessary fatigue to the lowest amount possible; 4 To provide all possible means for overcoming fatigue; 5 To put the facts obtained from the study into such form that every worker can use them for himself to get more out of life.

This book will outline a method of attack and furnish a working [illegible] for attacking the fatigue problem in an [illegible] place. What *has* been done is worth while when we know [illegible] has been done, and *why* it has been done." The authors discuss, in simple language that a child can understand, the what, the how, and the why of fatigue study and fatigue elimination. Fatigue elimination in a factory serves a double purpose. It makes money for the owner, by decreasing the waste of time which is caused by unnecessary fatigue, and increases the number of "happiness minutes" of the worker, and in order to begin fatigue study and fatigue elimination the best thing to do is to get the ideas that are so ably expressed in Mr. and Mrs. Gilbreth's little book. For those readers of the book who are not personally acquainted with Mr. Gilbreth, it may be well to state, what is not stated in the book, that the picture of the man in shirtsleeves examining the micro-motion film, is an excellent photograph of Mr. Gilbreth himself in one of his characteristic attitudes.

WM. KENT.

Oxy-Acetylene Welding. By C. W. Miller. The Industrial Press, New York, 1916. Cloth, 6x9 in., 287 pp., 192 illustrations. $2.50.

During the little more than ten years that oxy-acetylene welding and cutting of metals have been attaining importance as commercial industrial processes, considerable has been published concerning them. It has taken the form, however, for the most part of separate articles in the technical papers bearing on specific pieces of work that have been accomplished, or of the special forms of apparatus that have been developed from time to time for doing the work. The few books that have appeared have been rather limited in their scope as a rule or else lacking in detail when they attempted to cover the whole broad field.

The publisher of *Machinery* felt therefore that there was room for a comprehensive book on the art—entitled to a place in its Mechanical Library—and in compiling this Vol. XII of that series has supplemented what the author prepared with text and illustrations taken from miscellaneous articles previously printed in *Machinery*.

Mainly the purpose has been to make the work of practical utility to prospective users of the welding and cutting torches, and to that end highly scientific and technical treatment of the subject has been avoided. This intention appears to have been consistently adhered to, while at the same time enough has been included relative to the principles involved so that an intelligent understanding may be had of the functions of the apparatus and how to use it successfully.

As would be expected, the forepart of the book is elementary, describing the construction of the torches and the means for producing and storing the gases used. Then comes an account of the accessories desirable in a shop equipped for handling repair work, for this use of the process, rather than its application in manufacturing, comes more within the experience of the author. In fact, it would be difficult within the covers of any one book to deal adequately with manufacturing uses, since they are always more or less special and necessarily developed experimentally, hence no individual would be competent to discuss more than a limited field of such applications. If this were not so obvious it would be more an occasion of criticism that the title of the book does not indicate that it is practically confined to repair work.

One chapter embraces the contents thus far specifically alluded to, and the next nine deal with repair welding. A supplementary chapter describes the lead-burning process which, though much older and more familiar, is, after all, the original fusion-welding process; and finally, the last chapter takes up that distinctly different use of the oxy-acetylene torch, the cutting of metals by an oxygen jet actually burning its way through.

The section on repair work is the most valuable part so far as practical usefulness is concerned. It begins with the preparation of the work, which, being so essential to successful results, would have been better were it more fully treated. Expansion and contraction effects are referred to and directions given to allow for them in a few specific jobs, but since it is a lack of understanding the underlying principles of these effects and anticipating them with proper provisions that accounts for most of the failures in welded repairs, it would have added value to the book had there been a few well-chosen typical examples with illustrations explaining the fundamental principles of contraction in cooling. Knowing the whys and wherefores and when to look out for them, the reader could be put in position to work out his own problems as to the proper handling of almost any casting that he might be called upon to repair. It is a knowledge of just this element that makes the difference between a good and a poor welder.

On the matters of materials and fluxes and the obtaining of a properly adjusted neutral flame the discussion is excellent. The chapter on cast-iron welding which follows is also very commendable. It is one of the longest in the book, and justifiably so, for it deals with the most common class of repairs. Steel, malleable iron, copper, and copper alloys are metals less frequently welded, and one chapter suffices to cover the special precautions needful. Another whole chapter deals with that most difficult of metals, aluminum, and its extensive use in automobile parts makes skill in its repair a worth-while accomplishment.

Sheet-metal and plate welding, as of boilers, tanks, tubes, etc., is the nearest approach to manufacturing uses referred to and is sufficiently treated, considering the avowed scope of the book. Boiler welding is as yet not accepted as safe enough. State laws, insurance companies, and the A. S. M. E. Boiler Code forbid it. Probably it will not be countenanced until some trustworthy means is discovered for proving the integrity of a weld without testing it to destruction, when it is too late to put it in service, and we cannot be sure of duplicating results with what appear to be identical conditions. Tank welding, however, is usually permissible.

Some very useful general considerations are given in the last chapter of this section. They include such important subjects as unusual difficulties, qualifications and training of welders, care of apparatus, overhead costs, commercial limitations of the welding process, safety precautions in the use of apparatus, and other things that should be brought to the attention of the beginner to guard him against the pitfalls. A more than usually complete index is especially valuable in guiding the reader to those parts of the section on repair work where he will find the information needed for work in hand.

Assuredly, there is a field for such a book as this, and while it may not be perfect, nothing better of its kind has yet been brought out to the best knowledge of the reviewer.

HENRY R. COBLEIGH.

General Information Regarding Presentation of Papers

THE American Society of Mechanical Engineers solicits original papers upon subjects of mechanical-engineering interest for presentation and discussion at its forthcoming Annual Meeting to be held in New York City, December, 1917, and also at its Spring Meeting to be held in Worcester, Mass., May, 1918. The manuscripts of such papers should be submitted to the Secretary, 29 West 39th Street, New York City, who will refer them to the Committee on Meetings for consideration.

Papers for presentation and discussion at meetings of Sections of the Society, which are organized in 21 cities throughout the country and which hold meetings monthly from September to May, are also solicited by the Society. Correspondence regarding Sections papers should be addressed to the respective Sections chairmen as follows:

Atlanta, Ga.	Earl F. Scott, 707 Candler Building
Baltimore, Md.	C. C. Thomas, Johns Hopkins University
Birmingham, Ala.	Roy E. Brakeman, P. O. Box 297
Boston, Mass.	A. L. Williston, 27 Kilsyth Rd., Brookline
Buffalo, N. Y.	John Younger, 1695 Elmwood Ave.
Chicago, Ill.	Joseph Harrington, Riverside, Ill.
Cincinnati, O	F. A. Geier, Cincinnati Milling Machine Co.
Detroit, Mich	M. E. Cooley, Univ. of Michigan
Erie, Pa	J. F. Wadsworth, 310 Commerce Building
Indianapolis, Ind.	W. H. Insley, Insley Manufacturing Company
Los Angeles, Cal.	W. A. E. Noble, 5419 Russell Ave.
Minnesota	J. V. Martenis, Univ. of Minnesota, Minneapolis
Milwaukee, Wis.	E. Hutchens, 866 Superior St.
New Haven, Conn.	H. B. Sargent, 247 Church St.
New Orleans, La	W. B. Gregory, Tulane University
New York, N. Y.	H. R. Cobleigh, 29 West 39th St.
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Providence, R. I.	J. A. Brooks, Brown University
San Francisco, Cal.	F. W. Gay, 310 Sansome St.
St. Louis, Mo.	H. R. Setz, 5651 Maple Ave.
Worcester, Mass.	Paul B. Morgan, 15 Belmont St.

All papers accepted for a general meeting are printed in pamphlet form in advance of the meeting and are available to the membership of the Society. Also, comprehensive abstracts of the papers are printed in the monthly Journal in advance of the meeting.

After presentation and discussion, the revised papers are printed in The Transactions of The American Society of Mechanical Engineers, issued annually.

All papers presented at Section meetings are considered by the Publication Committee for publication in The Journal. The most meritorious Section papers are also assigned to general meetings and may be printed in The Transactions.

Authors of accepted papers receive twenty specially-bound copies with the compliments of the Society. Arrangements for the purchase of reprints at nominal price both from The Journal, size 9 in. x 12 in., and from The Transactions, size 6 in. x 9 in., can also be made through the Secretary.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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[1]A complete list of the officers and committees of the Society will be found in the Year Book for 1917, and in the March, 1917 issue of The Journal.

OIL BURNING

Some Practical Details of Burning Oil Under Boilers to Produce Steam, with Particular Reference to Stationary Boilers, with Discussion

By B. S. NELSON, NEW ORLEANS, LA

Member of the Society

THE subject of oil burning should be particularly interesting to engineers in the South because Louisiana can take credit for originating the widespread commercial use of oil as fuel in the United States. While a great deal of oil was produced in Pennsylvania fields and some of it was utilized for fuel purposes before the discovery of oil here, the Pennsylvania oils were of such high grade as to make them more valuable when refined into illuminating and lubricating oils than as fuel. In fact, it has been stated that for a considerable time oil companies in Pennsylvania burned coal under their boilers.

With the discovery of Spindle Top in 1901 and the rapid development of the California fields, the supply of crude oil became greater than the demand for refined products; hence the use of oil as fuel. The recent development of the Mexican oil fields has given the South an additional supply of oil to draw on as fuel.

Fuel oil is oil which is more valuable to the producer as fuel than as a refined product. Due to the rapid increase in use of gasoline in motor vehicles and the use of distillates in stationary engines, and also to the improvements in refining crude oils, it is probable that very little crude oil will be used for fuel, and that the fuel most used will be some sort of residuum or scalped oils; that is, the oil from which the lighter constituents have been distilled off. Though the Mexican oils are, as a rule, heavier and contain less of the lighter constituents than American oils, even they are now being distilled and the residue used as fuel. The result of this will be that more attention will have to be paid to the oil-burning system than was necessary with the lighter crude oils used heretofore, because a scalped oil is heavier and more viscous than crude oil. One advantage in using a scalped oil is that there is less fire risk, because its flash point is higher than the flash point of the crude oil.

Fuel oils may be classified according to several of their characteristics, which are more or less dependent upon each other. Some of these are the flash point, or temperature at which an oil will give off inflammable vapors; the viscosity, which may be explained as the molecular friction; the specific gravity; the heat value, and the sulphur content.

The flash point of an oil is of interest particularly from the standpoint of safety. On land installations, where the oil is usually buried in a closed tank, the flash point is of less importance than on shipboard, where inflammable vapors are apt to accumulate in the hull or to be freed in a closed boiler room, due to leaky piping.

The viscosity of an oil is the principal consideration in the actual burning of that oil, because the success of the burner or atomizer depends largely on its ability to atomize the fuel into sufficiently fine particles to insure satisfactory combustion, and the more viscous the oil the more difficult this atomization. There are various methods of expressing the viscosity, one of the most used being in terms of the Engler scale. Degrees Engler means simply the ratio of the time it takes a given quantity of an oil to flow through a standard orifice as compared to the time it would take the same volume of water to flow through. Oil is usually sold, however, on the basis of its specific gravity (generally measured in degrees Baumé) and its heat value and moisture content. It is usually assumed that the heavier an oil in degrees Baumé, the more viscous is that oil, but this is not always strictly true.

Through the courtesy of E. H. Peabody, Mem.Am.Soc.M.E., in Fig. 1 is reproduced a very interesting chart giving the characteristics of some thirty different oils. This chart gives the temperature-viscosity diagram of these fuels, the specific gravity, the degrees Baumé and the flash point. Comparing two crude oils from these curves brings out the relation, or rather lack of relation, between degrees Baumé and degrees Engler:

	Deg. B.	Flash Pt.	Deg. Eng. at 230 Deg. Fahr.
Panuca Crude..........	13.7	140	13.75
No. 18 California.......	12.7	285	5.2

It is to be regretted that oil is not specified in terms of specific gravity instead of degrees Baumé, because in any calculations involving the weight of the oil per gallon or per barrel it is necessary to refer back to specific gravity. Further, the heaviest oil that can be designated on the Baumé scale for liquids lighter than water is 10 deg. B., or unit specific gravity. There are oils being used now of 10 and 12 deg. B., and no doubt still heavier oils will be used, which will call for two different Baumé scales and cause confusion.

Spindle Top oil has a specific gravity of about 0.92, corresponding to 22 deg. B., and its heat value averages about 19,700 B.t.u. California oil is somewhat heavier, the average grade of that oil having a specific gravity of about 0.95, or 18 deg. B., heat value about 18,500 B.t.u. The Mexican oils vary considerably in specific gravity and heat value, but as a rule they are much heavier than either the California or Texas oils; a typical oil now used has 0.99 sp. gr., or 12 deg. B., with a heat value of about 18,200 B.t.u.

Table 1 compares the prices of coal and oil, taking as a basis coal of the quality of Pratt, Alabama, and Pittsburgh coal, sold in the New Orleans market. While with these coals an evaporation of 10 lb. from and at 212 deg. can be realized with well-designed water-tube boilers when the boilers have ample heating surface and are in the hands of skillful firemen, it is extremely doubtful if any boilers in regular service are showing better than 8 lb., and the great majority are below this figure. Therefore, if we take 8 lb. as a basis, we are giving the coal its full value. Now, with oil giving 19,500 B.t.u. per lb., an evaporation of 14.5 lb. should be readily obtained if the apparatus for supplying the oil to the furnaces is of first-class design and if the furnaces are properly arranged. With this ratio as a basis, it is apparent that a pound of coal is equivalent to 8/14.5 or 0.541 lb. of oil. A barrel of crude

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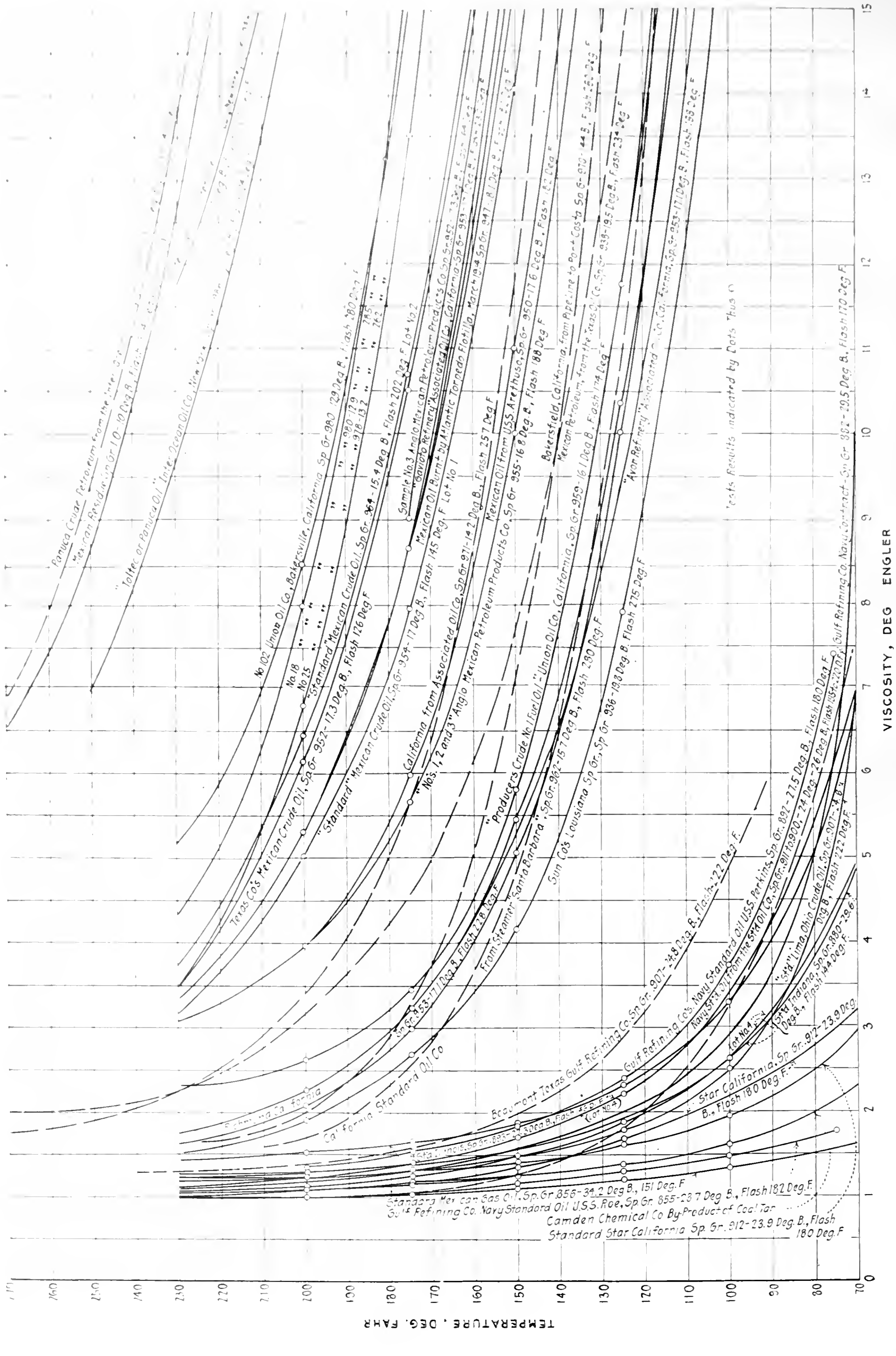

Fig. 1 Temperature-Viscosity Diagram of Fuel Oils

Reproduced from Curves of Lieut.-Comm. John J. Hyland, U.S.N., with additions (shown in dotted lines) by E. H. Peabody, Mem. Am. Soc. M. E.

oil weighs approximately 325 lb., therefore one ton (2000 lb.) of coal is equivalent in practical heating value to 3.34 bbl. of oil.

TABLE I COMPARISON OF PRICES OF COAL AND OIL

Coal. Dollars per Ton, 2000 lb.	Oil, Dollars per Bbl.	
5.00	1.50	[illegible]
4.75	[illegible]	[illegible]
4.50	[illegible]	[illegible]
4.25	1.28	[illegible]
4.00	1.20	
3.75	[illegible]	[illegible]
3.50	1.07	[illegible]
3.25	98	
3.00	90	[illegible]
2.75	[illegible]	[illegible]
2.50	[illegible]	[illegible]
2.25	68	[illegible]
2.00	60	[illegible]

[1] Not allowing for labor saving.
[2] Assuming 10 per cent of cost of fuel in labor of firing and handling ashes saved by using oil, a conservative estimate for plants of over 300 hp.

An interesting point to note with reference to the heat value of an oil is that the B.t.u. usually given is the high heat value or heat value determined in a bomb calorimeter. The actual heat value available in a boiler furnace is less because all fuel oil contains a considerable percentage of hydrogen, and the latent heat of the steam formed by the combustion of this hydrogen passes up the stack as waste heat.

In all the heavier grades of fuel, particularly the Mexican oils, water mixed with the oil is in the form of an emulsion and will not settle out in a tank as it will with the lighter American crudes. This is not so much a disadvantage as it would seem, other than causing a lowering of the heat value. With an oil light enough for the water to settle out of its own accord, this water will frequently accumulate in the tank and piping and go over into the burners in a slug, putting the burners out; but with heavy oil a very considerable amount of water can go through the burner with no bad effect. The writer is inclined to believe that a small quantity of water in heavy oil is an advantage in that these oils are usually heated above the boiling point of water to effect atomization, and the vaporizing of the moisture in the oil as it leaves the burner tip probably helps to atomize the oil more thoroughly.

Oil has numerous other advantages over coal than cost of fuel. The storage space required is much less for an equal number of heat units: there are no ashes to be disposed of; less boiler-room help is required for firing; the wear and tear on the furnace lining is smaller because the firedoors do not have to be opened, with the consequent chilling of the brickwork. Very little repairs are necessary to the grate bars; a much smaller stack can be used for the same boiler horsepower; the boiler can be forced with natural draft considerably beyond what it can with coal, an important feature where boiler capacity is scant; where feedwater is bad it is often possible to carry a load with two oil-fired boilers which would require three boilers were coal used, thus allowing the cleaning and repairing of one dirty boiler at a time. Steam can be raised much more quickly and with no loss due to banking fires. It takes about 10 per cent of the fuel normally consumed by a boiler at rated load to keep its fire banked with coal. In case of an emergency the fire can be instantly extinguished: any one who has had to draw a hot coal fire in an emergency can appreciate this particular advantage.

THE SUCCESSFUL OIL-BURNING INSTALLATION

There are several factors entering into the successful oil-burning installation, some of which affect the reliability of the system and others its efficient operation.

The first consideration for reliability is the oil supply to the burners, involving the storage tanks, pumping outfit, and heaters. The size of a storage tank varies, of course, with the size of the boiler plant, but it should be large enough, at least, to hold a carload of oil. A very popular size of tank is a 10,000-gal. tank, which is about 8 ft. in diameter and about 30 ft. long. These tanks are usually built of ¼ in. steel with ⅜ in. heads, though if the tank is subject to corrosion from the outside it should be made of heavier material. The tank should be equipped with a manhole and filling pipe, a suction opening, a vent opening, and openings for steam heating coil connections. The insurance requirements call for the tank to be below the level of the pumps and burners, which means that it is usually buried in the ground. The tank should be preferably not less than 50 ft. from the nearest building.

The oil pumps are the next consideration. The pump that has given the best results is a duplex steam pump, piston-pattern type, with brass valves, metallic packing in the oil piston and special gaskets and piston-rod packing. The size of pump should be based on a very low piston speed.

The pump should be fitted with an air chamber on the discharge side to steady its pulsations of pressure, and a governor on the steam end to maintain the pressure constant. The pressure at which the oil is delivered to the burners depends largely on the character of the oil, varying from 40 lb. for oil of 26 to 30 deg. B. to 80 lb. for oil of 12 deg. B. The pump should also be equipped with strainers on the suction side to keep trash from getting under the pump valves. Duplicate pumps should always be installed, so that if anything goes wrong with one pump the other may be put in service without shutting down the plant.

The pump should be set as near the level of the oil as possible to give the minimum suction lift, and the suction pipe should be as straight as possible, preferably with bends instead of elbows. Where the suction pipe is long, a foot valve at the bottom of the suction line in the tank is desirable. This should be a valve without leather seats, as fuel oil deteriorates leather. A very good valve to use is a horizontal-swing check used in a vertical position. In addition to air chamber and governor, the pump should be equipped with a relief valve set at a pressure heavier than the working pressure, so as to minimize the danger of breaking the pump. This relief valve should be of the enclosed type, so that its overflow can be piped back to the tank.

The heavier oils require heating in the suction tank in order to enable the pump to lift them. The temperature must not be high enough to cause the oil to vaporize under the suction pull of the pump. The writer has found a temperature of 110 to 130 deg. about right for Mexican oil of 12 to 18 deg. B. According to Commander John J. Hyland, U.S.N. (*Jour. A. S. N. E.*, May 1914), the viscosity of the oil had to be reduced to 375 deg. Eng. in order to obtain full capacity from a Blake pump. In order to gage this temperature accurately, a thermometer should be installed in the suction line near the pump. If this suction line is long, or has several elbows in it, it should be made one or two sizes larger than the suction opening of the pump.

The next question is that of the heater. Practically all the oil now burned as fuel requires heating in order to reduce its viscosity and facilitate atomization at the burner. There is a wide choice of heaters, but the principal considerations are,

first, to have the heater of ample heating surface, and second, to be sure that this heating surface is all utilized. In heating oil with a steam coil in a vessel of oil there is a tendency to local heating, that is, the oil next to the coils may be very warm, but this heat is not readily transmitted to the adjacent oil, so that a heater in which the oil is kept in rapid motion over all the heating surface in the coil is apt to give best results. In one type of heater the oil is sent at high velocity through a long coil of brass pipe heated by steam on the outside.

There are several pumping sets on the market which combine all the requisites enumerated above in one self-contained unit. Fig. 2 shows such an outfit which, it will be noted, consists of duplicate pumps with pressure governor, air chamber, gage, suction strainers on pumps, relief valve and heater.

The temperature to which the oil must be heated naturally varies with its viscosity. For fuel oil usually burned in the South, a temperature from 180 to 220 deg. is satisfactory, the higher temperature being for oil of 12 deg. B. As far as we know, no experiments have been made to determine the degrees Engler to which oil must be heated, but judging from our experience and with the aid of the temperature-viscosity diagrams, we should say that about 8 to 9 deg. Eng. is the viscosity required for a steam-atomizer burner. It has been stated, however, that any oil which can be pumped readily can be atomized by a steam atomizer. After the oil is heated at the pump (and its temperature should be read by a thermometer permanently fixed in the discharge line from the pumps), care should be taken to keep the oil hot until it reaches the burner by proper covering of the pipes. When the discharge line is very long or the oil pump is a considerable distance from the burners, a very helpful device is to run a small live-steam pipe inside the oil-discharge pipe. When this is done, a stuffing box should be placed at one end of the steam pipe to take care of expansion, which will be greater on the steam than on the oil pipe.

In an installation where the burners are shut down for any length of time, a bypass should always be provided from the farthest end of the oil supply to the burners back to the pump suction, or preferably to the tank. The function of this is to be able to fill the oil header with heated oil before attempting to light the burners. With much of the heavy oil now used, it will be found impossible to even light the burner until hot oil reaches the burner tip. If the above bypass is not used, there will be considerable messing up of the furnace and ashpit with unburned oil.

More stress has probably been laid on the oil burner than on any other part of the installation, which has led to the belief on the part of people unfamiliar with the burning of oil that the burner is the whole thing, whereas, as a matter of fact, the burner contributes but a very small part to the success of the installation. The term *burner* is really a misnomer, because the only function the burner performs is to atomize the fuel into sufficiently fine particles to effect complete combustion in the furnace.

For land installations, the type of burner which has proved best is the steam-atomizer burner with oil supplied to it under pressure. The essentials of such a burner are simplicity, cheaply renewable wearing parts, economy in steam for atomizing, and the production of a flame of such shape that makes good combustion and, hence, high boiler efficiency possible. The burners may be of either the round-flame or flat-flame type. The flat-flame type is preferable because it uses less steam for atomizing and produces a flame of such shape as to permit proper mixture of air to support combustion without excess air, which is not the case with a round-flame burner.

The use of a target wall is not necessary and may cause injury to the heating surface of the boiler by causing the flame to concentrate on a small portion of the surface, resulting in what is termed "blowpipe" action.

The general type of flat-flame burner is a tip in which are two narrow parallel and horizontal slots, the oil flowing out of the upper slot in fan shape on to the fan-shaped jet of steam issuing from the lower slot.

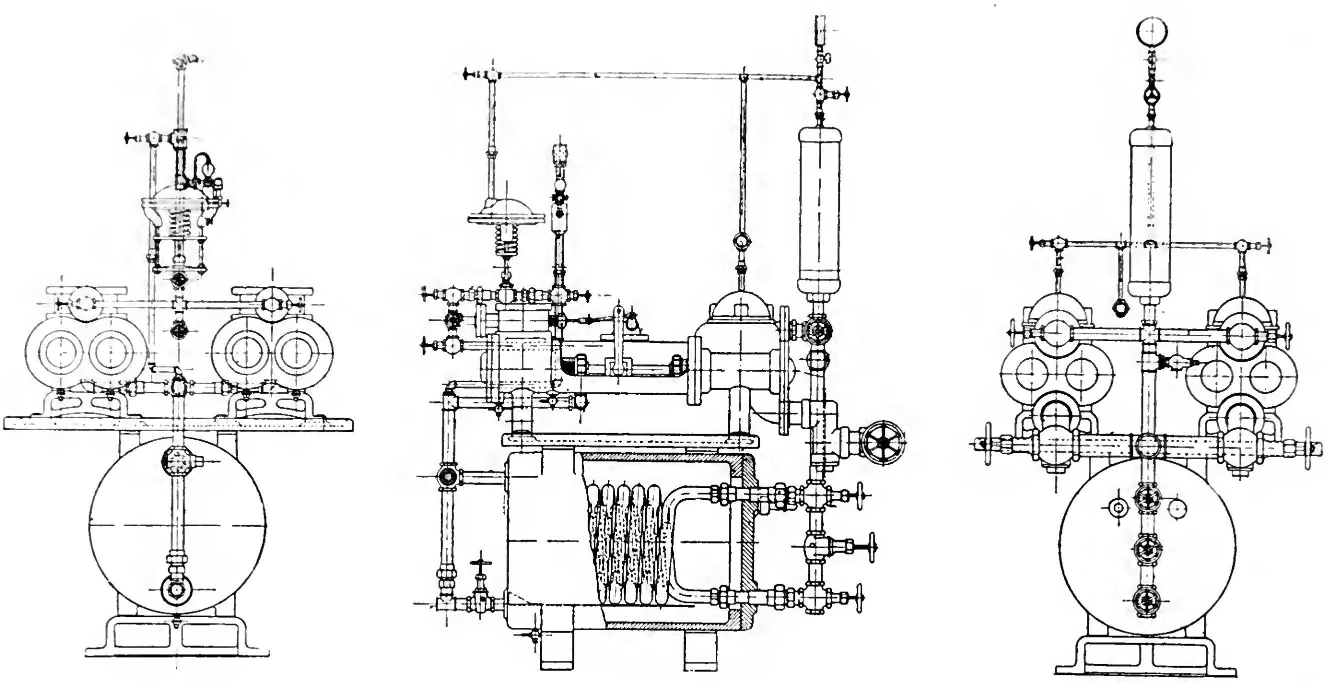

Fig. 2 Oil-Pumping Set, Showing Duplicate Pumps with Pressure Governor, Air Chamber, Gage, Suction Strainers, Relief Valve and Heater

The position of the burner depends largely on the type of boiler. For a boiler with a long unobstructed furnace, such as a horizontal return tubular, or a boiler of the Heine or Erie City type, a burner set in the firing door is very satisfactory. For boilers where the furnace is short and the travel of the gases is upward, such as in the Babcock & Wilcox or Stirling boiler, the best arrangement is to put the burner at the back, shooting toward the front of the boiler. In either case air should be admitted to the furnace through a checkerwork of firebrick laid on the grate bars. The shape of this checker work should approximate the shape of the flame and thus reduce excess air, and the area of all the holes should be equal to 4 sq. in. per boiler horsepower.

Steam and oil connections to a burner should be made to allow for the expansion and contraction of the oil and the steam headers, and should have unions above and below the burner to enable the latter to be taken out quickly for cleaning. A very essential point in installing a burner is to see that it gets dry steam. The simplest way to do this is to take the steam from the top of the auxiliary steam header. A steam connection should be provided on each burner for blowing the oil out of the burner when it is shut down, as otherwise this oil will carbonize, due to the heat radiated from the hot furnace.

The principal consideration affecting the efficiency of an oil-burner installation, other than the choice of a burner economical in the use of steam (and giving the proper shape of flame), is the proper control of the air supply. One of the advantages of burning oil, mentioned above, was the possibility of reducing the excess air to effect combustion. Conversely, one of the principal losses is the ease with which excess air can be admitted. For any particular installation (assuming the setting is tight and checkerwork properly arranged), the best draft should be determined by installing a draft gage on each boiler connected to the furnace, then gradually closing the damper until there appears just a faint trace of black smoke at the stack, and finally maintaining the draft at that point. It should be noted, however, that there can easily be smoke with excess air for two reasons, first, if the checkerwork is not properly arranged in the furnace there will be excess air, even though the combustion be incomplete, and second, poor atomization of the oil at the burner will give a grayish-white smoke, which is often mistaken for insufficient air. A more accurate method of gaging the air supply is to make periodical analyses of the stack gases and keep a record of the stack temperatures. The stack gases should not be over 100 deg. hotter than the steam, and no difficulty should be experienced in getting 13 to 14 per cent CO_2 in regular operation.

DISCUSSION

MR. SNYPP GIVES THE REQUIREMENTS FOR SUCCESSFULLY FIRING HEAVY CRUDES

Charles E. Snypp spoke of the difficulties experienced in handling and firing heavy Mexican crude oils. He recited an experience in which these heavy crude oils were substituted for the lighter crude oils, such as Spindle Top, Beaumont and Louisiana oils, in a plant especially adapted to the burning of lighter grades. Fortunately for the continuous working of the plant, the change came about gradually over a period of a couple of years, and thus the machinery was corrected and adapted from time to time to the heavy grades.

Owing to the rigid insurance requirements, the supply tank was located about 400 ft. distant from the boilers, and about 2 ft. beneath the level of the burners. This tank was buried and dirt arched over the top to supply the necessary weight to overcome its buoyancy when empty, as the ground was more or less saturated with water.

The pump which supplied the burners was located in the boiler room, and light crude of 22 deg. B. could be easily drawn through a 1½-in. pipe by pump suction without heating. For heavy crudes a 3-in. pipe was substituted and a large-capacity, slow-motion pump was used. This would handle medium grades, but in cold or wet weather the arrangement was too delicate to be relied upon. A booster pump was then located at the tank, and oil was heated to 130 deg. fahr. and forced through this 3-in. pipe. This relayed the oil to the burners. A 2-in. overflow pipe was laid from the pump, located in the fireroom, to a return pipe to the ground tanks. This slow-motion pump was speeded by allowing oil to flow freely through a ½-in. vent pipe located in the top of the pump chamber and controlled by a gate valve, and this oil circulated through the 2-in. pipe to the ground tank. This proved to be a very satisfactory arrangement for handling Mexican crudes.

Mexican crudes of 12 to 13 deg. B. should be heated to 120 to 130 deg. fahr. and delivered to the burners just under the distilling temperature, which is about 250 deg. fahr.

Superheated steam was found to be beneficial in atomizing this oil and delivering it to the fires. (The speaker had no data on the amount of preheat used, but believed that the oil should be delivered in a gaseous state to the fires.)

A 3-in. closed tube about 8 ft. long was located in the bottom of the firebox between two burners, and protected with one thickness of firebrick. Steam from the boilers was led through the front end of this tube through a ½-in. pipe, and the pipe extended to the rear end. A ¼-in. pipe was led from the steam space of this tube to the burners. The fuel oil was fed through a ¼-in. pipe into the rear end of a ¾-in. pipe which was inserted into this tube, extending the full length of the tube. Thus the oil was preheated by superheated steam and the superheated steam was used for atomizing.

The oil, flowing from the pump, located in the fireroom, was heated by the usual exhaust heater at the pump, then passed through a live-steam heater before entering the superheated tube.

The requirements for successfully firing heavy crude oils seem to be, first, large pipe lines and slow-moving, large-capacity pumps; and second, proper preheating; third, superheated steam to atomize the oil.

MR. BURWELL BRINGS OUT POINTS NEEDING SPECIAL ATTENTION IN OIL BURNING

Robert T. Burwell. Wherever any trouble with oil burning under boilers has occurred, it has generally been of a local nature, due to the impinging of the flame on some portion of the boiler, or to the scaling of the boiler, more than to anything else, and where the oil is properly distributed, we may expect as much life from the oil-fired as from the coal-fired boiler.

We thought when the Beaumont field was discovered that, inasmuch as this oil gave such a driving-hot fire—boilers could be forced so easily—the boiler would show defects much more quickly, but we have not met with anything of that kind in our experience. The railroads now drive their boilers rather hard, and yet they do not seem to have any such trouble. They have to be careful that the oil is well distributed so that the flame will not impinge against the tubes, and for that reason most of them place the burner at the front of the firebox so that the flame passes to the rear first.

As to the type of burner, Mr. Nelson has pointed out the

[illegible] advantages of the flat [illegible]; it has the additional advantage [illegible] flame against the boiler as is [illegible] burner [illegible] seems to distribute the fire [illegible] across the chamber. I am glad to see that they [illegible] away with the [illegible] which formerly caused us a great deal of annoyance because the flame would strike the [illegible] on one portion of the boiler [illegible] not exist in a coal fire.

[illegible] should bear in mind that they can [illegible] and in forcing it they should also [illegible] is forced, the more important it [illegible] good quality.

[illegible] Government Report on oil burning, one [illegible] the emphasis placed on the importance of having good men in charge of the burners. This factor does seem more important than in the case of burning coal, and yet we [illegible] that there is frequently considerable difference in efficiency of men firing coal.

An efficient fireman is very important to the economical operation of a plant. One of the best illustrations of the saving by a good fireman was shown in a test made at Milwaukee burning coal, where very accurate data were taken covering a period of twenty-four hours. This test was started at 9 a.m., when fireman *A* was on duty, and his showing at the end of five hours was 9.98 lb. of water per lb. of dry coal. Fireman *B* then came on and his watch lasted 8 hours, during which time the rate was 9.23 lb. At 10 p.m. fireman *C* came on for 8 hours, and showed exactly the same amount as *B*, namely, 9.23 lb. It was thought that the discrepancy was due to the boilers being cleaner during *A*'s watch, but he came on the next morning at six, and during the three hours to the end of the test made a showing of 9.87 lb. At the average price of coal this plant would save $2.40 per day by having firemen like *A* instead of *B* or *C*, and yet these three firemen were supposed to be in the same class. It is quite probable that many of our plants which have to select practically a new crew every year, such as our sugarhouses, must suffer in economy from this source.

Mr. Nelson has also pointed out the importance of a proper distribution of the air and a regulation of the air to reduce the excess air to a minimum, to which we might pay more attention with a view to developing a system by which we can determine exactly what we are doing in a plant. Mr. C. R. Weymouth, in Vol. 30 of Trans.Am.Soc.M.E., gives a table showing the boiler efficiency corresponding to varying percentages of excess air.

Referring to burners, while it appears that it does not make much difference about the type of burner, yet the Government Report gives the results of a test of the Korting mechanical burner showing an evaporation of 16.13 lb. of water from and at 212 deg. fahr. The temperature of the oil at the burners was 162 deg. fahr. and its pressure was 105 lb. per sq. in.; the temperature of the air entering the furnace was 250 deg. on one side and 290 deg. on the other, and the temperature of the gases at the fan suction was 465 deg. This result (16.13 lb. water) is unusually high, and with a burner that uses neither air nor steam to atomize the oil. The oil under pressure is forced through screw threads to the nozzle, the orifice of which somewhat resembles an injector. Most authorities place a limit of 130 deg. fahr. to which the oil shall be heated, and yet in this test the oil was heated to 162 deg., giving the best results that I have been able to find.

One point not yet touched on is the importance of having ample room in the combustion chamber. As a matter of fact, I think a small Dutch oven would give better results. I recall a power plant in this city where the boilers equipped with Murphy stokers were fitted up some years ago to burn oil—simply by lining the bed of the stoker with brick the fire had a clear sweep to the combustion chamber beneath the boilers. It was apparently the most perfect fire I have ever seen.

The form of furnace undoubtedly has considerable effect upon the temperature of the fire; in the case of a fuel in which a considerable portion burns as a gas, if these gases come in contact with a cool surface such as the boiler, before combustion is complete, there is a corresponding loss. It requires a temperature of about 1500 deg. fahr. to burn carbon monoxide, and it would therefore seem desirable that the furnace be of such proportions as to keep the gases above this temperature until complete combustion is assured.

An interesting illustration of the effect of the temperature of the fire on the burning of a fuel is seen in the case of bagasse. Green cane contains about 76.5 per cent water, thus if 10,000 lb. of cane were dried and the water caught, we would have 7650 lb. of water. The dry matter will burn readily and produces sufficient heat to evaporate more than 7650 lb. of water per 10,000 lb. of cane. The reason green cane will not burn is because the water in contact with the combustible matter prevents the temperature from attaining a point necessary for combustion.

My observations indicate that there is a practical operating condition against the use of oil in a bagasse furnace; as a rule, the man in charge is too prone to wait until the blowing of the safety valves notifies him that it is time to shut off the burner, whereas in using coal he is not apt to add it any more frequently than the condition of the bagasse fire demands. I recall one house that burned coal with bagasse with good results, but reported unsatisfactory results with oil. Of course, this is a condition that can be improved by careful supervision; it emphasizes, however, the importance of capable men in charge of the burners.

Speaking of forcing boilers, the Government Report calls attention to the fact that a burner has a limit, and it is impossible to force a boiler with an insufficient number of burners. This suggests the idea that in many instances more burners might be used to advantage; a greater number might also permit a wider range of regulation.

PROFESSOR WILLIAMSON DISCUSSES THE HEATING OF THE OIL AND ALSO ITS ATOMIZATION BY AIR

PROFESSOR C. S. WILLIAMSON. I do not know much about tests on oil burning, but it stands to reason that provided you do not reduce the oil to the elemental condition, in which case carbon would be deposited, the more nearly broken the oil is, the greater the heat value obtained, for this reason: we are all perfectly familiar with the fact that if a certain product—take a chemical compound, for instance—requires so many heat units to decompose it, we have put in that many heat units before we begin to get back any heat units from its actual combustion. Oils should not be heated above their flash points nor to a temperature at which carbon is separated. This temperature depends upon the property of the particular oil undergoing use or test, and so the flash temperature will vary.

Another point is the free play of the flame. It might not be accurate to so designate it, but it often causes a loss to the boiler efficiency, for if you impinge the oil flame on the boiler, the oil will split and produce a tarry residuum which drops into the pit, thereby losing a portion of the oil, although getting the best heat value possible for the oil actually consumed. There is a certain point, which varies for different oils, at

which the separation will take place, but one would have to determine this point for each oil to tell at what temperature the oil can be most economically preheated. If then the oil is preheated too highly, causing separation at this point and, further, the flame is allowed to impinge against the boiler plate, we have the formation of a residuum at two places, one (the former) of which may clog the burner, and the other produce the tarry residue in the pit below the furnace. The temperature of the flame at the point of combustion is considerably above that of the boiler plate, which possibly does not exceed 300 deg. fahr. in most cases. Hence the boiler plate will act as a condenser to the tarry residue, which has a higher boiling point than the surface upon which it is formed, and the cause of inefficient burning may be this mechanical arrangement instead of the oil being low in heat units. There is a splitting point then for different oils, which varies as mentioned.

There is a method of atomization which has not been spoken of, but which also gives good results where the installation is large enough to warrant putting it in, and that is compressed air. If you do your atomizing with compressed air, you do away with the steam you have accounted for in the absorption of heat. So where the plant is large enough, this method can be worked very successfully. It is somewhat a question of the amount of water which you introduce, in case of steam, as pitted against the nominal amount of water introduced in the case of air; also of thoroughly mixing the oxygen with the particles of oil as they are atomized.

MR. LEBERMUTH DISCUSSES COMBINATION OIL AND BAGASSE FURNACES

C. D. LEBERMUTH.[1] Mr. Burwell has struck the keynote in bagasse burning when he mentioned getting rid of the water. Not only is the heat value per pound of bagasse raised with a reduction of water, but also the heat value per pound of fiber. This has been worked out theoretically and experimentally by Prof. E. W. Kerr, Mem.Am.Soc.M.E. In practice it has been equally well demonstrated, where factories have reduced the moisture from 52 to 56 per cent, the limits in ordinary Louisiana six-roller mill work down to 47 per cent, now obtained by the best nine-roller mill plants.

It has been shown that under normal Louisiana conditions, 75 per cent excess air is about the minimum practicable in order to keep fires burning, this excess air being necessary in order to dry the water out of the bagasse. It can readily be seen that with this as a minimum and with the ordinary operating condition being about 100 per cent excess, bagasse-furnace conditions are not at all suited for burning oil. In every case where these fuels have been tried together the results have been poor. At Meeker, built as recently as 1912, such combination furnaces could never keep up steam until they were changed and the oil and bagasse fired separately.

At the Gramercy Refinery, some years ago, they found that when they were grinding cane about 1000 tons a day, the fuel used in the refinery was practically the same as when they were not grinding. They felt that the bad influence of the bagasse on the oil-furnace conditions overbalanced all the fuel value that they got from the bagasse. Now that no grinding is done they have some well-perfected furnaces using oil which give them from 72 to 74 per cent total furnace and boiler efficiency right along, and I saw the results of a 72-hour test there, where they obtained a total furnace and boiler efficiency of 80.4 per cent with return tubular boilers. From any other source than their chief engineer, such a figure looks almost too good to accept on its face value. But as I received it I feel sure of its validity.

What is needed in the way of a combination furnace is one which will burn bagasse efficiently and permit of burning oil to run boilers full load, efficiency not counting in this case at all. For oil will only be used when the milling tandem is stopped, which occurs only at infrequent intervals. It is simply a matter of getting the same horsepower out of the bagasse boilers during these stops.

MR. HUTSON DISCUSSES THE HANDLING OF MEXICAN OIL

H. L. HUTSON. When the Mexican oil companies first sent men up here to sell their oil, they sent an engineer to give instructions as to how the people should arrange to handle it, and I remember that his instructions were about as follows: Where the consumer had a large tank near the river, as most sugarhouses have, and was in the habit of gravitating the oil from the storage tank to the suction tank, he told them that they must put in a large pipe between those two, and put a pump and boiler at the storage tank, with heating coils in the storage tank, and force that oil from the storage tank to the suction tank, as it would not flow by gravity in cold weather. He said also that they should provide compressed air from some source, and when they shut down, particularly in the winter, they must blow all the oil out of the pipe line with compressed air, because if it froze on a cold day they would not get it started again. That surprised me very much, and for the first time I appreciated that they were furnishing us a semi-solid instead of a real liquid fuel.

PROFESSOR GREGORY CONSIDERS STEAM ATOMIZATION MORE SATISFACTORY THAN AIR

W. B. GREGORY. Professor Williamson has suggested the use of compressed air as an atomizer. In the pumping plant of the Neches Canal, near Beaumont, Texas, they first used steam as an atomizer, and then later installed a Connersville blower and thoroughly tried out burners with air as an atomizer. Whether the work was handled with great skill and intelligence I do not know, but I do know that they abandoned the use of air after some months of trial, and have ever since used steam instead. I think that in general, and for stationary plants at least, steam has been found by experiment to be far more satisfactory than air.

MR. DUSENBURY ENDORSES OIL AS FUEL

ALBERT T. DUSENBURY.[1] Our plants are scattered about through the waterways of South Louisiana, and we can handle oil to much greater advantage than we can coal. For small pumping plants, if I order a carload of coal and take it to the plant, sometimes it will last a year or more, but the deterioration in the common line of coal is very great; whereas with a carload of oil, you put it in a tank and you may keep it indefinitely. For that reason alone, for our work, and also in getting fuel oil to the dredgeboats, it has been very convenient, and I would be willing to pay a considerable premium to get oil rather than coal for the purposes for which I have need of fuel.

THE AUTHOR GIVES HIS CLOSURE

B. S. NELSON. In regard to the handling of heavy fuels, it may be stated as a general rule that heavy oils have to be

[1] Lebermuth & Israel Planting Co., New Orleans, La.

[1] Louisiana Meadows Co., New Orleans, La.

heated every time they are moved through a pipe. Assuming the case of an ordinary plant which gets its oil in tank cars, if the plant is so located that the tank car reaches the plant within a day after it leaves the refinery, it will usually be found warm enough to run out by gravity, as the oil is well heated when it is put into the tank car. In case the oil is too cold to run out by gravity, every tank car is fitted with heating coils, and a steam connection should be provided at the unloading switch to connect to these coils. A ½-in. or ¾-in. steam line is usually ample to heat up the oil in the tank.

As to precautions to render storage of oil safe, most of the oil now burned is of such high flash point that there is very little danger of gas accumulating. The curves in Fig. 1 give the flash points of various oils. However, any one can find the information required on this point in a new book entitled Fire Prevention and Protection, Rules for the Safe Storage of Oil.[1] Aside from insurance requirements, it is well to always keep the oil tank closed and have a vent pipe extending up out of danger from sparks or matches. Where oil storage is particularly dangerous, as on shipboard or barges, it is well to provide the storage tank with a large live-steam smothering connection, the function of which is to cover the oil with steam and so exclude the air. The refineries which have in the past suffered large loss from lightning setting their tanks afire now use an ingenious method of extinguishing fire by the use of foam made by pumping simultaneously to the top of the tanks two liquids which, when mixed, produce a heavy foam, which blankets the surface of the oil, thus excluding the air and extinguishing the fire.

With reference to the burner mentioned by Mr. Burwell, one reason that type is not used more is because it operates on the mechanical-atomizer principle, and the characteristic of it is high oil temperature and high pressure. I have seen cases where oil was heated as high as 240 deg. and carried 240 lb. of pressure on it. It is used a good deal in the Navy, but the oil has to be heated to such a high temperature and carry such a high pressure that it makes it dangerous. The burner used is a round-flame burner, usually, and requires forced draft, though in the naval vessels they use forced draft in any case.

The mechanical burner has been tried in stationary furnaces. Mr. Lockett and I did a little work on a mechanical flat-flame burner, but we did not get very far. A burner of that kind would be a desirable thing. Most of the mechanical burners depend on centrifugal force, and the oil comes out at the end of the burner as a diverging radial spray, and it is thrown out in a mist, which means that you get a round flame.

The average amount of steam used by the burner, to atomize the oil, depends on a good many things, for instance, whether the boiler is being run at full capacity or at part capacity. For a good burner, working under favorable conditions, you should not use over 1½ to 2 per cent of the steam generated by the boiler to atomize the fuel. With a poor burner, you may use 8 or 10 per cent. I have heard of some using as high as 15 per cent. The highest I ever got on a burner was 7 or 8 per cent.

With regard to the quantity of air required in the burning of oil, we figure on about 250 cu. ft. to a pound of oil, allowing for excess.

The manganese ore used in this country in the manufacture of ferromanganese has been hitherto mainly secured from three principal sources: viz., Russia (southern), India (southern British), and Brazil (east central). For a large number of years these three countries have outranked all other producing countries in the output of manganese ores. For the five years preceding the European war, Russia produced annually about 844,000 long tons, India 694,000 long tons, and Brazil 200,000 long tons.

The history of the manufacture of ferromanganese in the United States dates from the outbreak of the European war, summer of 1914. It appears that in no other substance entering intimately into the manufacture of steel have the war and the conditions brought about thereby produced such a radical effect upon domestic production and demand as in ferromanganese. The war itself, and coincident industrial activities, showed clearly the dependence of American steel makers upon European sources to furnish an adequate supply of one of the most essential ingredients in steel-making processes. Nor was there any vital reason for this, other than the excuse that foreign ferromanganese was cheap and abundant and prior to 1914 there was no indication that the supply would ever be cut off. As in the dye industry, this indicates the alarming improvidence of American manufacturers. England and, in a lesser degree, Germany, who have furnished the greater part of the ferromanganese used in this country, have made the alloy from imported ores, coming from Russia, India, and Brazil. It appears, in the light of the developments of the past two years, that the manufacture of ferromanganese on a commercial scale has come to be an important domestic industry, but it will remain so only so long as we have an abundant supply of ores. The closer trade relations which have been secured with South American countries seem to indicate that the greater portion of our manganese ore will come from Brazil in the future.—*Journal of the Franklin Institute*, May, 1917.

Pres. George W. Dunham of the S.A.E. and his collaborators have presented arguments that it is entirely feasible through the proper use of tractors to furnish any quantity of small grains that may be required for the world's food supply. Even with the 35,000 tractors now available the production may be materially increased by furnishing operators and Government supervision of the use of the tractors.

The present manufacturing equipment of the country is capable of producing at least 75,000 tractors a year under Government aid, and these additional tractors are estimated to be capable of cultivating in one year sufficient land to produce 1,000,000,000 bushels of small grain.

As regards farm labor, it is said that one man with a tractor can accomplish more than two men with horses. This makes the labor problem involved in securing an increased yield relatively less serious with tractors than with animal power.

The Bureau of Standards is undertaking to compile the present state of knowledge and practice concerning the numerical values used by engineers and others for the properties of metals and alloys, with a view to making generally available the most acceptable values of these constants and also as a basis for further experimental investigation. A form sheet is furnished containing the various items required. These cover the mechanical, thermal, electrical, and optical properties of value to the investigator and engineer. A sheet of instructions for compiling the table—with an illustrative filled-out form for commercial electrolytic copper—is included. This contains a list of the alloys on which data are particularly desired.

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[1] Spectator Company, New York.

BY-PRODUCT COKE AND COKING OPERATIONS

By C. J. Ramsburg[1] and F. W. Sperr, Jr.[2], Pittsburgh, Pa.

On January 1, 1915, there were in operation 6138 by-product recovery ovens of various sizes in the United States and Canada, having a capacity to carbonize 24,000,000 tons of coal per annum, and to produce therefrom approximately 18,800,000 tons of coke. Despite the fact that in the interim practically five hundred ovens have been discarded, on January 1, 1918, there will be in operation, if present contracts are completed, 9900 ovens, having a capacity to carbonize 47,400,000 tons per annum, giving a coke production of 35,000,000 tons. In this three-year period by-product coke production will have practically doubled, and there will have been as much gain in capacity as in the previous twenty years.

The cause of this rapid increase has not been a desire to take advantage of the inflated prices for by-products due to war conditions, but a financial condition favoring large investments brought about by the war, and making it possible to carry forward plans made previously.

The most impressive fact is the conservation of our local supply brought about by the introduction of modern methods. It may be of interest to make a few calculations simply from the standpoint of *fuel values;* and to put the matter on the most conservative basis possible, let us figure such values in terms of coal.

Table 1 shows a total fuel saving of 825 lb. of coal per ton of furnace coke. The fuel value of the gas is put as against raw *coal,* B.t.u. for B.t.u. There is a further saving in the blast furnace of 200 lb. of coke per ton of beehive coke formerly used. Figured back on a coal basis, these 200 lb. of coke represent 282½ lb. of coal at the beehive oven, so that the total saving amounts to approximately 1100 lb. of coal—0.55 ton—for each ton of by-product coke made in the modern plant. Since the ovens added from January 1, 1915, to 1918 will produce practically 16,200,000 tons of coke per annum, it follows that they will save annually the fuel equivalent of 9,000,000 tons of coal.

Looking backward over the years consumed in bringing the coke oven to its present stage of development in America, there are some events which stand out preëminently. The first of these dates back to 1906. In that year the United States Steel Corporation was brought face to face with the necessity of formulating a definite policy as to its coke supply, and appointed a committee to study beehive coking and by-product coking and to make a recommendation to the company. The advice of this committee was quickly acted upon by the corporation in the decision to build a by-product oven plant at Joliet, Ill., in connection with the blast furnace and steel plant of the Illinois Steel Company, and to build that type of oven which they had found to give the most efficient results in European countries.

The success of this Joliet plant was so immediate that the corporation without delay proceeded with the construction of additional plants of the same type, including the largest by-product coke plant in the world at Gary, Ind., consisting of 560 Koppers ovens, and a plant of approximately the same size as the Joliet plant (280 ovens) at Ensley, Ala., for the Tennessee Coal, Iron, and Railroad Company.

The second event was the selection of silica material for one of the oven batteries at Joliet. The value of the silica in this connection is due to four characteristics.

TABLE 1 BY-PRODUCT YIELDS FROM COAL SUCH AS NOW USED TO MAKE FIRST-CLASS BY-PRODUCT COKE IN THE MIDDLE STATES DISTRICT

85 Per Cent High Volatile—15 Per Cent Low Vol.

		Fuel Value [illegible] Equivalent, [illegible]
To make 1 Ton Furnace Coke, 1.4 to 1.5 Tons Coal are Required. By beehive coking, the by-products wasted have a heat value equivalent to 625 lb. of coal.	*Surplus Gas, 5000 [illegible] B.t.u. Used as fuel.*	[illegible]
	Tar, 12 gallons. Used to make creosote oil, pitch, lampblack, various oils and dye materials.	
	Ammonium Sulphate [illegible] in form of 25 per cent ammonia liquor *33 lb.*). Used for fertilizer, for refrigeration, and for nitric acid and other chemical manufactures.	No [illegible] credit
	Benzols as light oil [illegible] gallons. Used for motor fuel, dye-material base, phenol and other chemical manufacture, solvent and cleanser.	[illegible]
	Coke Breeze, 120 lb. Used as fuel.	[illegible]
	Total	625
Add coal equivalent wasted in beehive oven		200
Total economy of by-product oven per ton coke		825

1 The conductivity at high temperatures is superior to that of clay brick

2 The fusing or softening temperature is much higher than that of fireclay

3 The action under heat may be calculated with scientific exactness, due to its practically constant composition

4 The expansion and contraction of silica material between 2000 and 2600 deg. fahr. is practically negligible, so that when the material has once been heated to within this temperature range (under which condition the coking operations are conducted) no further appreciable movement takes place.

The third event was the realization that with uniform heat distribution in the ovens and with the use of silica material much higher heats and consequent higher coking velocities could be employed, and, further, that, with the lower coking periods, higher volatile coals could be used, with increased yields of by-products and equally satisfactory coke.

The result can be demonstrated by the fact that the Joliet plant of the United States Steel Corporation, put into operation in 1908, was originally planned to use from 70 to 80 per cent of low-volatile coal, and the coking time was figured at 24 hours. A coke plant of 640 ovens, now building at Clairton, Pa., near Pittsburgh, is so designed that it may be operated on 15 hours' coking time and is expected to use 100 per cent high-volatile coal. Even if this does not make quite as

[1] Second Vice-President, The H. Koppers Company.

[2] Chief Chemist, The H. Koppers Company.

Abstract of paper presented at a joint meeting of The Franklin Institute and the Philadelphia Section of The American Society of Mechanical Engineers, February 1, 1917.

[illegible] grade furnace coke [illegible] will work [illegible] broad lines to better [illegible], and time will tell where [illegible] comparison [illegible] opportunity [illegible] given the [illegible] operators to [illegible] the new type of coke.

The effect on the [illegible] by reference to Table 2.

TABLE 2 [illegible] OF COKE

	[illegible]	[illegible] *B*
	[illegible]	100 per cent
	[illegible]	high volatile
[illegible]	[illegible]	1.5 gal
[illegible]	[illegible]	38.0 lb.
[illegible]	[illegible]	10,000 cu. ft.
[illegible]	[illegible]	560
[illegible]	[illegible]	5,600,000
[illegible]	[illegible]	5.4 gal

A comparison in value of by-products on a basis of normal values shows a credit per ton of furnace coke of approximately \$1.25 in favor of the high-volatile coal.

The fourth event was the awakening to the fact that, while an increase in the cubical content of an oven tends to a reduction in plant cost and in operating labor due to handling larger units, a decrease in oven width would more than offset this unit-size advantage because of absolutely different conditions.

The reason for this becomes apparent with an understanding of the factors involved. Increased length of oven gives increased cubical content, and the ultimate economic length depends upon the mechanical and structural limits. Of increased height the same may be said, except that this involves questions of time of contact of volatile products and speed of their flow which modify the advantage and which are yet to be finally worked out.

Increased *oven width* involves an entirely different consideration. Practically all the heat supplied for the coking of the coal mass flows from the two walls toward the center. This flow of heat depends to a large extent on the resistance and temperature, and in the coke oven the average rate of coking depends, of course, on the rate of heat penetration. For example, it becomes apparent at once, in a comparison between a 16-in. oven and a 20-in. oven, that the following is true:

a With the same temperature of wall the average velocity of coking in the 20-in. oven will be less than in the 16-in. oven, and the time required to coke the 20-in. oven will be more than proportionally greater than the 16-in. oven

b To coke the 20-in. oven in the same time as the 16-in. oven, the wall temperature must be increased very markedly

c To coke the coal in the two ovens at the same average rate, the wall of the wider oven must be considerably hotter than that of the narrower one

d With the *same wall temperatures*, more coke can be made per day in the narrower oven than in the wide one

e To make the same amount of coke per day, the wall temperature in the 16-in. oven would be lower.

Four points are of great value in this connection:

1 Overcoked material is of less value in a furnace than a greener coke

2 The wider the oven the more overcoked the outside layers will be and the larger the proportion of overcoked material for a given output

3 The production of by-products is enhanced by reducing the wall temperatures

4 The life of oven brickwork is increased by being operated at lower temperatures.

The result of this reasoning was the decision, in 1914, to reduce the width of oven from $19\frac{3}{4}$ in., average then being built, to $18\frac{1}{4}$ in.

Plants of the reduced width are now in operation as follows:

	Ovens
Toledo Furnace Company	94
Youngstown Sheet and Tube Company	204
United Furnace Company	47
River Furnace Company	204

There is no doubt among those who have been acquainted with the wider ovens that the narrower oven has the following distinct advantages:

1 Less sponge in the coke

2 Better coke from the same coal

3 As good coke from higher volatile mixtures

4 Higher yields of tar, ammonia, and benzols

5 Low temperatures for the same coking velocity.

The fifth event in coke-oven development is the universal recovery of benzols. The war furnished the primary inducement to developing this phase of the industry; but the fact that the material might be disposed of advantageously for motor fuel after the demand for explosives would cease had an important bearing in stabilizing the large investments demanded.

Previous to the war comparatively few plants were equipped for benzol recovery; in fact, outside the plants of the Semet Solvay Company, operated for their own account, there was comparatively little benzol extracted, and this was used, for the most part, in enriching illuminating gas. Today practically every coke-oven plant in America has installed this recovery, and the production in 1917 will be in excess of 40,000,000 gal., rated as light oil, if continued at the present rate.

While the removal of benzol reduces the heat units in the gas, the loss in this manner is a very small factor, and the return to be secured from the sale of this product is likely to be greater than that secured from the recovery of tar.

One feature of the benzol credit as related to motor fuel is the smallness of the quantity compared with gasoline production, and, since benzol and gasoline are miscible, the utility of benzol will be enhanced by increasing the quantities available.

Experiments recently conducted by a large oil company on its trucks and passenger automobiles proved that not only is benzol more valuable than gasoline as a motor fuel when used straight, but its effective value is increased by being mixed with gasoline. While these experiments are not complete, nevertheless they indicate that a mixture of equal parts of gasoline and benzol gives a value over 16 per cent greater that that of straight gasoline, which shows 32 per cent increased value for the benzol half. In 1917 there will be produced in this country over 1,000,000,000 gal. of gasoline, so, while the value of benzol is stabilized, for this reason it cannot be a very great factor in the motor-fuel situation. Every means should be taken not only to secure additional quantities from a standpoint of *preparedness,* but from a standpoint of motor-fuel supply.

In connection with the value of benzol as a motor fuel there is an interesting fact which may in the future have a very marked influence. In many quarters alcohol is looked upon as the ultimate fuel, but it cannot be employed except with less efficiency and with greater difficulties, due to its high

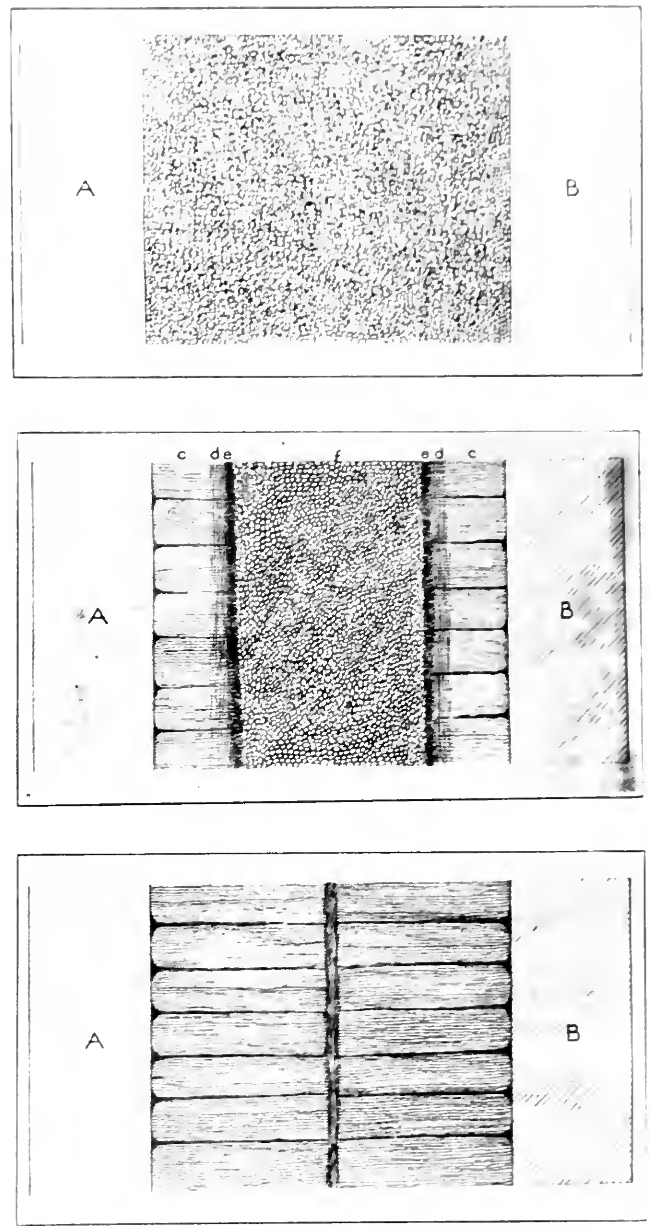
hydrogen content. Commercial alcohol and gasoline are not miscible. Alcohol and benzol are miscible and make a most efficient fuel, and, further, *after the addition of benzol to alcohol* the mixture will carry quite a high proportion of gasoline. The future may see benzol as the tie between gasoline and alcohol, permitting a piecing-out of the gasoline supply and an introduction of alcohol as a commercial motor fuel.

Taking up in somewhat more detail the study of by-product coke and its use in blast furnaces, the phenomenal growth of the by-product industry has stimulated a renewed interest in the main product. This interest is due, first, to the recent revolutionizing of ideas regarding the relative values of by-product and beehive coke. The tardy recognition of the fact that by-product coke of a fairly wide range of origin, when properly used in the blast furnace, gives results not merely as good as, but much *superior* to, those obtained from beehive coke, was accompanied by a realization that the limit of efficiency had by no means been reached; that Grüner's "ideal performance"— long the *ne plus ultra* of blast-furnace men —was actually being surpassed by many blast furnaces, and that much regarding the question of coke economy still remained to be learned. In the renewed study of the subject that this realization is just beginning to stimulate, we have the inestimable advantage that the by-product coke plants are being located in proximity to, and usually under the same management as, the blast furnaces that they are intended to supply, instead of at the coal mines as was the case with the beehive ovens. Thus the blast-furnace operator knows better the sources of the material that he has to use and the conditions under which it was produced, while the coke-plant operator can more intelligently regulate the performance of his ovens and the quality of his product, according to the requirements of the furnace. Above all, the combination and coöperation of the two plants result in a regularity of performance that is perhaps more to be desired than any specific quality of material. It is to be hoped that this coöperation may soon be extended to the foundry and other industries using coke as fuel.

It will assist in following the few descriptive studies of coke that we have to present, to give a brief account of the generally accepted theory of the coking process. The development of this theory is due to several German investigators, notably Much,[1] Hilgenstock,[2] Rau,[3] and Simmersbach,[4] and it has received such abundant confirmation from every practical standpoint that there can be no question of its soundness.

Let Fig 1 represent a section across a by-product coke oven immediately after the charge of coal is introduced. The layer of coal next to each wall *A* and *B* is very rapidly heated. A complicated process of destructive distillation begins, and at a temperature of about 375 to 400 deg. cent. the layer becomes soft and pasty. The pasty mass is for a time in a state of violent ebullition, due to the rapid expulsion of its volatile matter, and then rapidly solidifies, the [illegible] residue retaining the vesicular form and structure of the pasty, foaming stage.

The adjacent layer toward the interior has in the meantime reached the pasty stage, the fusion being assisted by the penetration of some of the soft material forced over from the outer layer. The gases and vapors follow always the line of least resistance and pass through the porous outer layer and up along the wall of the oven, as indicated by arrows, and not through the viscous inner portion of the fused zone and then through the mass of coal. In passing through the highly heated porous layer, the hydrocarbons undergo a partial secondary decomposition, depositing part of their carbon on the cellular surfaces just formed, thus building up and strengthening the coke. The coking process is thus to be conceived as [illegible]



Figs. 1 to 3—Diagrams of the Coking Process

the formation of a fused zone, and the gradual advance of this zone toward the center of the oven, the evolved gases and vapors depositing part of their carbon in the vesicular mass left as the zone progresses. The condition of the material in the oven when the coking has fairly well advanced may be represented by Fig. 2: *c* is the portion already coked, *d* is the fused zone merging into an adjacent zone *e*, which, being in a state of incipient fusion, is more viscous; *f* is the uncoked coal.

The actual thickness of the fused zone is probably not over ½ in. The drop of temperature across this narrow zone is very great, and the interior of the oven remains compara-

[1] Chemie der Steinkohle.

[2] Journal für Gasbeleuchtung, vol. 45, (1902), p. 617.

[3] Stahl und Eisen, 1910, p. 1240.

[4] Grundlagen der Kokschemie, Berlin, Julius Springer, 1914.

tively cool, [illegible] at about [illegible] the coking process. Simmersbach's experiment[1] [illegible] Koppers oven of 500 mm. (19.7 in.) mean width [illegible] 29 hours' coking time with a final maximum temperature of 1100 deg. cent., showed that the temperature in the middle of the oven, 1 meter above the floor, remained about 100 deg. cent. for 2.5 hours after charging, then rose to 100 [illegible] and remained at this temperature until [illegible] hours after charging. At 20 hours the temperature was only 410 deg. cent.

The rate of advance of the two zones toward the center of the oven depends principally upon the temperature of the walls A and B. In present practice, with ovens 18 in. wide and wall temperatures about 1000 deg. cent., the average rate is about [illegible] in. per hour. The initial rate is, however, much more rapid than this, and decreases as the center of the oven is approached.

Fig. 4 Coke in By-Product Oven Just After Removing Door

As the coking progresses, cracks or joints develop perpendicular to the walls of the oven, thus determining the blocks of coke as they are eventually formed when the oven is discharged. These cracks form avenues of escape for a large percentage of the gases, hence the amount of deposited carbon is greater in proportion on the surfaces of the blocks than in the interior. Eventually the two zones merge at the center of the oven (Fig. 3), and, with the practically complete expulsion of the last of the volatile matter, the coking process is finished. There is always a distinct parting in the center of the oven, so that the length of the blocks is equivalent to about half the width of the oven. Fig. 4 shows a view of the coke as it appears when the door of the oven is removed. Most of the coke immediately adjacent to the walls of the oven is covered with a skin of carbonized pitch. The true form of the blocks may be seen in a few places where this has been broken away.

Fig. 5 Blast-Furnace Coke, Atlantic District

Fig. 5 shows a view of a typical coke. In this figure the individual blocks may be seen distinctly. A few characteristic blocks are shown in Fig. 6. The three smaller pieces in this figure are cross-sections. The end of the block (Fig. 7) originally adjacent to the wall of the oven may always be distinguished by its cauliflower-like appearance and dense layers of deposited carbon. We shall designate it as the wall end and shall call the other extremity the center end, for want of a better term. The structure of the coke toward the center end is always more open, and occasionally is somewhat spongy.

The shape of the coke is quite characteristic, depending upon the coal from which it is produced, and also, to a considerable extent, upon the method of heat treatment. The coke-oven man classes his product as either *blocky* or *fingery*, coke of the former character being preferred. Some typically fingery coke is shown in Fig. 8. As a rule, the coke from coals of over 30 per cent volatile matter is apt to have a fingery tendency—and this becomes highly pronounced if the coal has a high oxygen content. By coking such coals very slowly at temperatures somewhat lower than used in ordinary practice, the fingery tendency may be disguised or in many cases entirely eliminated. By disguising it, we mean that the product will actually appear to form large, massive blocks,

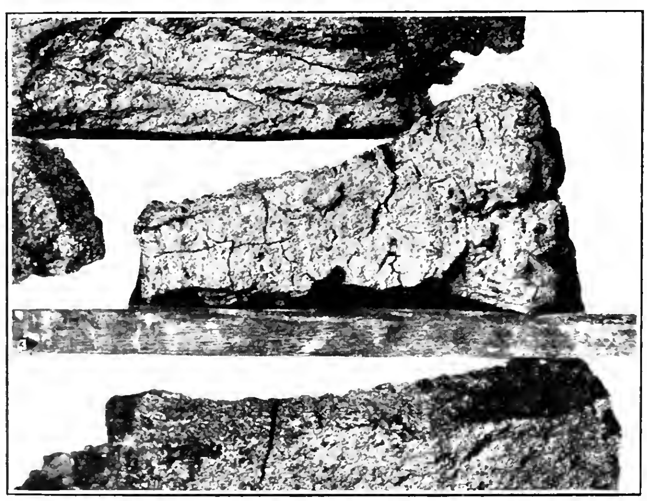


Fig. 6 Typical By-Product Coke

[1] Stahl und Eisen, June 11, 1914, p. 974.

but these blocks, if closely examined, will be found actually to be bundles of slender pieces more or less firmly cemented together. However, if the heat treatment be very carefully regulated during the coking process—especially in ovens designed and adapted to this particular type of coals—genuine, firm, blocky coke may be made from many coals usually regarded as producing only the fingery variety.

The size of the blocks is affected to a certain extent by almost all the conditions pertaining to the manufacture of coke. The length is, of course, dependent upon the width of the oven, the average being, on account of shrinkage, a little less than half the width of the oven. The blocks from the top of the oven are usually (especially with high-volatile coals) shorter than those from the bottom. Overcoking and high temperatures tend to produce small-sized coke.

Coming now to an examination of the natural surfaces of the blocks, we may, in the first place, disregard the color as being relatively unimportant. It depends largely upon the method of quenching, and, to some extent, on the quality of the water used, the use of large amounts of water causing a dark color, while with the careful use of a minimum quantity of water a light gray color can always be preserved. The majority of cokes produced from the standard coking coals rich in hydrocarbons and low in oxygen have close-textured, even surfaces, with possibly a few narrow, transverse zones of slightly larger cell openings interspersed between the two extremities. Many cokes from coals of the Connellsville (Pa.) type show the same silvery, glossy skin that used to be so much prized in beehive coke. This is probably indicative of a very heavy deposit of carbon, especially favored by slow and uniform evolution of a very rich gas.

Other cokes fully equal in value to the above are characterized by a peculiar shaggy appearance, as if they were covered with blotches of dark moss. This appearance is usually found in cokes produced from mixtures of eastern coking coals with the somewhat more highly oxygenated coals of the central field. Oddly enough, both types of coal usually make smooth coke if carbonized separately.

Certain cokes present transverse pebbly seams—usually not more than two or three. These seams are very narrow and quite coherent, and may be shown to be composed of small globules of quite pure carbon, with no apparent cellular structure. This phenomenon again appears to be characteristic of the more highly oxygenated coals.

The surfaces always show more or less transverse and longitudinal cracks, significantly at right angles—either parallel or perpendicular to the wall of the oven. Naturally these are an element of weakness, and their presence to any excessive degree is one of the surest "first-hand" indications of an inferior grade of coke that we have. The amount [illegible] can be controlled to a surprising extent [illegible] heat treatment.

By breaking a piece of coke [illegible] faces we find revealed the cellular structure [illegible] istic of all cokes and which can [illegible] opment simply by inspecting the [illegible] surfaces. No definition of coke is complete that does not take this cellular structure into account.

The usual way—and the easiest—to examine the cell structure is to break a piece of coke crosswise and note the appearance of the fresh surfaces. Great care must, however, be taken, in comparing one coke with another by this method, to break the pieces at approximately the same distance from the wall end, since the cells are apt to increase considerably in size from the wall to the center. Oddly enough, in many cokes there is a characteristic difference in the two surfaces of a break. No matter where the piece is fractured, the surface on the wall side has always a granular appearance, with a steel-gray luster and well-defined cell openings. The opposite surface (i.e., looking toward the center of the oven) has a characteristic graphitic luster, with the cell openings flatter and possibly not so sharply defined.

Although this difference is rather hard to depict photo-

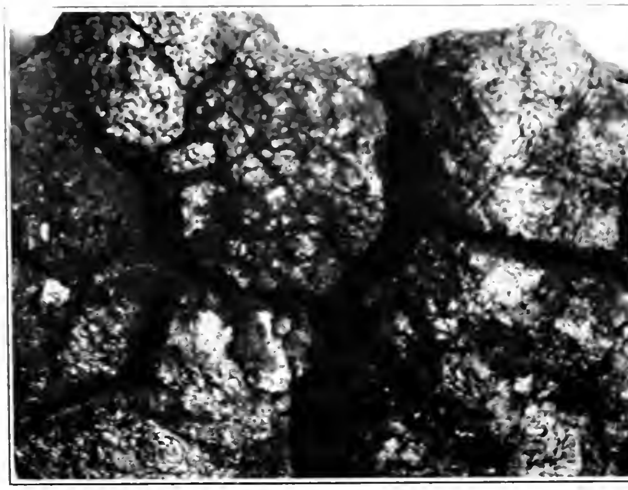


Fig. 7 Wall End of a Block of Coke

Fig. 8 Fingery Coke and Sponge (Colorado Coal)

graphically in a satisfactory manner, we have attempted to show in Figs. 9 and 10, which will also show the variation in the sizes of cells from wall and to center. The sections have been made with a 1/16-in. emery wheel at 2, 4, and 6 in. from the wall end of the block of coke. This is a standard blast-furnace coke made from a mixture of West Virginia and Pennsylvania coals, and is the same as shown in Fig. 15.

For any accurate comparison of the cell structure of different cokes we prefer to make longitudinal sections with a thin emery wheel—such sections as are shown in Figs. 12 to 17. If this is done, the danger of confusing sections made at different distances from the wall will be largely eliminated. It must be mentioned that *breaking* a piece of coke longitudinally so as to reveal the real cell structure is a decidedly difficult matter. Almost always the break will be found to be made along the plane of a natural longitudinal fracture.

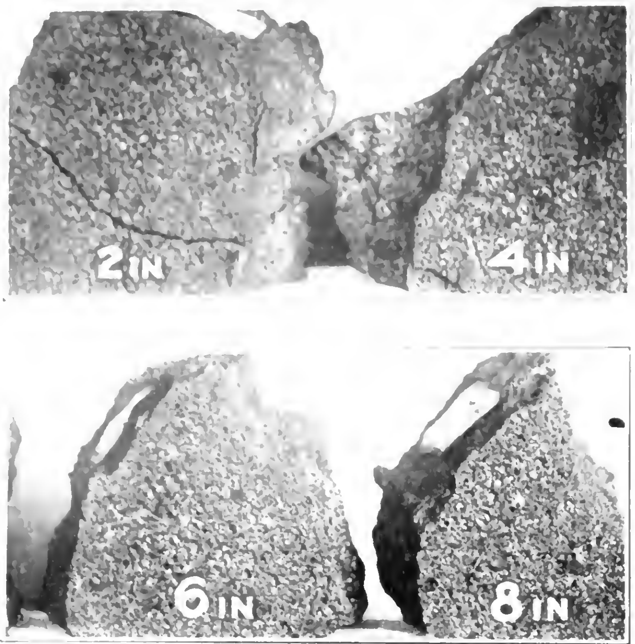


FIG. 9 CROSS-SECTIONS OF COKE SHOWING SURFACES TOWARD CENTER
(At marked distances from wall)

and the exposed surfaces will be found to be covered with deposited carbon.

Great importance has been attributed to the cell structure of coke by all authorities on the subject, and especially by blast-furnace operators, and yet the subject is very poorly defined and no standards of comparison have been established. We have recently begun the use of a simple system, analogous to the scale of hardness used in the study of metals, which we hope may come into general favor. At present we employ a set of four standards, shown in Fig. 11. These are all longitudinal sections, cut from blocks of typically different cokes.

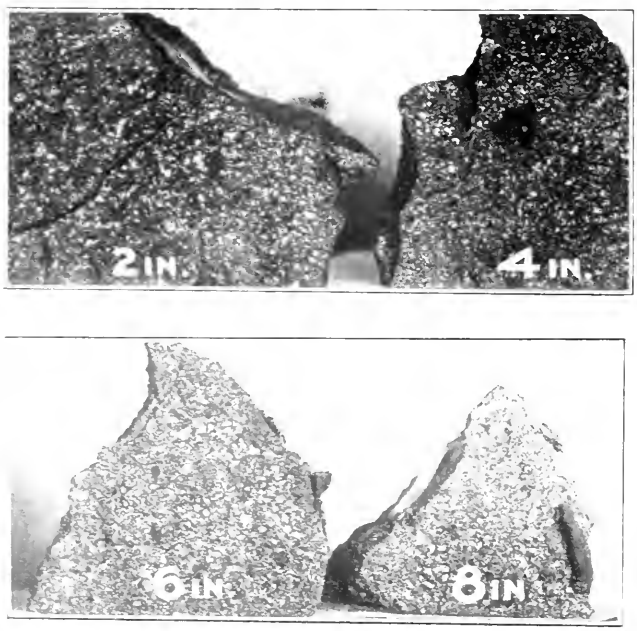


FIG. 10 CROSS-SECTIONS OF COKE SHOWING SURFACES FACING TOWARD WALL
(At marked distances from wall)

The sections are the same length, and each is cut beginning 1 in. from the wall end. The sections are numbered 1 to 4 in order of increasing cell size. With such a set of standards it is easy to grade any coke according to its cell structure, and the grading will convey a much more definite idea than the loose terms of "dense," "close," "rather close," "fairly open," "medium," etc., hitherto used.

In addition to grading cokes according to size of cells, we may also classify them as regular or irregular in cell structure. The standards would all be considered as regular in structure. This does not mean at all that the cells are of the same size,

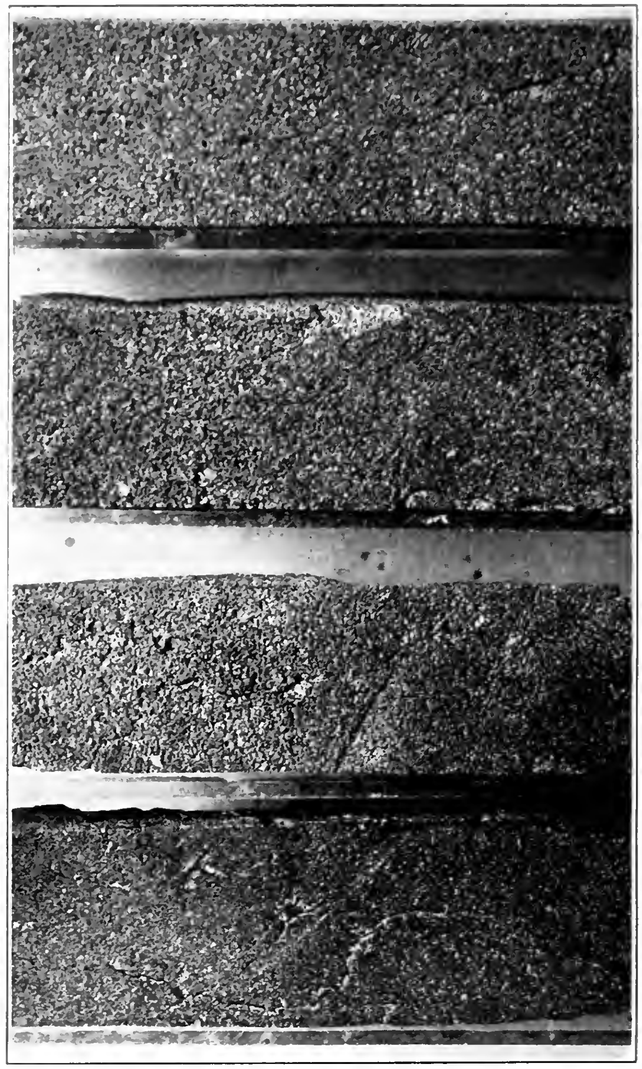


FIG. 11 STANDARDS FOR GAGING CELL STRUCTURE
(No. 1 at bottom; No. 4 at top)

but their general arrangement gives an easily perceived impression of regularity. What we mean by irregular structure is illustrated by the sections shown in Fig. 12. This sort of coke has alternate patches of close and open texture, and is frequently produced by the more highly oxygenated class of coking coals, as well as by mixtures of coals having decidedly different characteristics.

It might possibly be thought now that an interesting table could be prepared grading the cell structure of cokes produced from various typical coals. Such a table would be well-nigh valueless unless the data were carefully qualified by details regarding preliminary treatment of each coal, dimensions of ovens, temperatures, coking time, and several other

factors, each of which plays a part in the development of cell structure. It may be more profitable to show a few sections

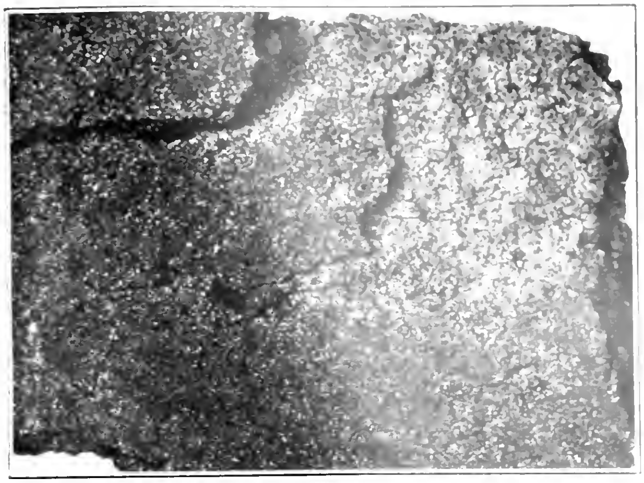


Fig. 12 Coke from Elkhorn Coal [illegible] Per Cent Pocahontas

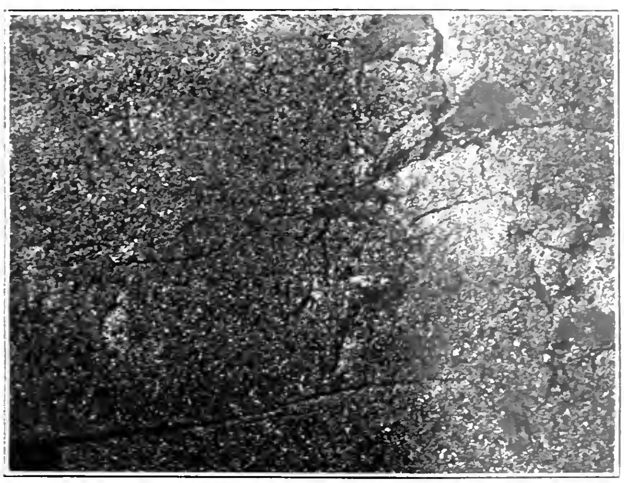


Fig. 13 Coke from Mixture of Pennsylvania and West Virginia Coals

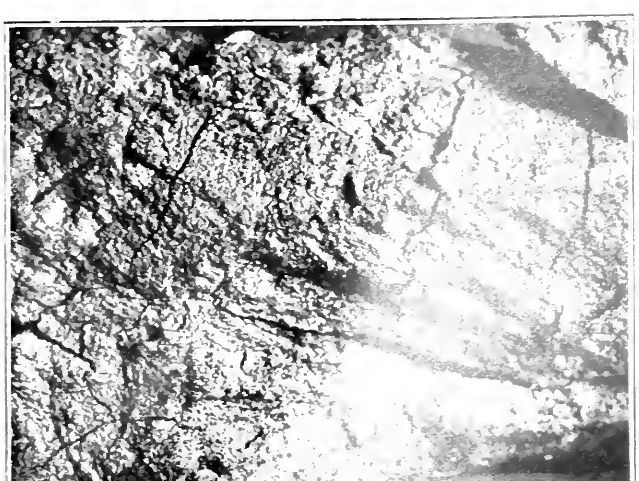


Fig. 14 Coke [illegible] Coals

of different cokes that have [illegible] successful results in blast-furnace and foundry practice in various parts of the country

Figs. 12 to 17, inclusive, illustrate some specimens carefully selected to be as representative as possible.

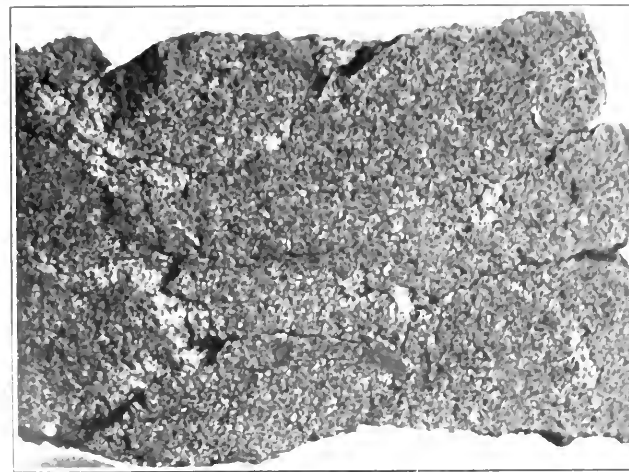


Fig. [illegible] Coke from Kentucky Coal, with 15 Per Cent Pocahontas

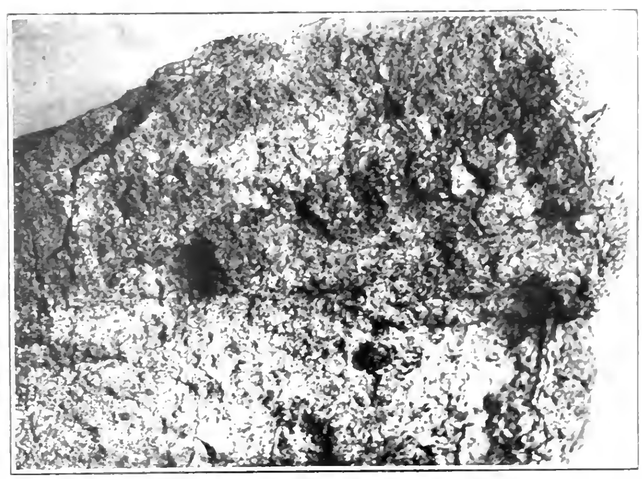


Fig. [illegible] Coke from Pittsburgh Coal, with 20 Per Cent Pocahontas

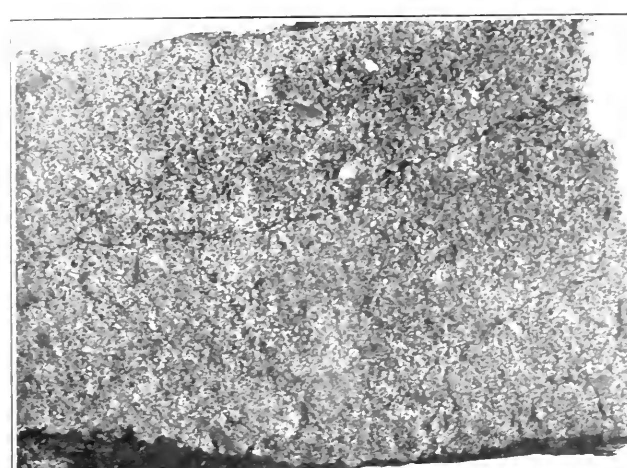


Fig. 17 Coke from Pittsburgh Coal, with 40 Per Cent Pocahontas

Sometimes too much reliance is placed in the determination of the specific gravity and porosity of coke. Figures as to

Fig. 18 Standard No. 1 Enlarged 10 Diameters

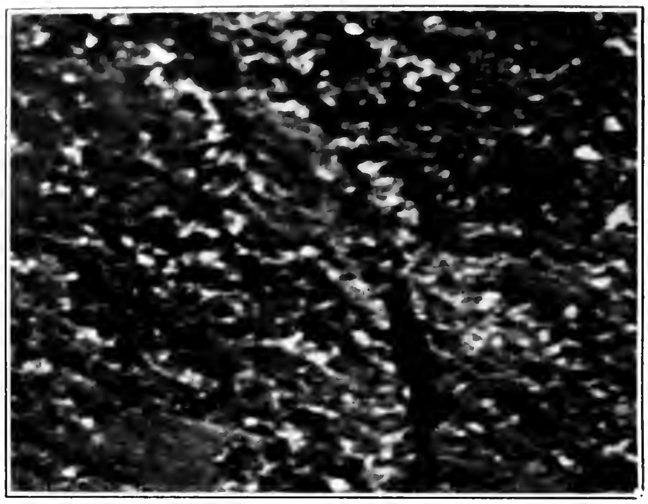


Fig. 19 Standard No. 2 Enlarged 10 Diameters

porosity or the percentage of cell space in the total volume of coke are almost valueless unless supplemented by an examination of the actual size of cells and thickness of cell walls. A coke of close texture and thin walls may have the same percentage of cell space as one having large cells and relatively thick walls. As John Fulton[1] the pioneer investigator of coke, said, 34 years ago: "Mere cellular space . . . cannot be used as an element in the practical determination of the value of cokes for blast-furnace use. Furnace gases cannot act on cell spaces; they can only act on exposed surfaces." It is the cell walls and surfaces that are the most important. Cell space and porosity, which is the measure of it, are merely incidental.

Table 3, which gives the specific gravities and porosities of coke specimens, will show that there is really no relation between cell structure and porosity.

For ordinary purposes in grading cell structure magnification is unnecessary. Photographic enlargement gives some interesting information as to the character of the cell walls. Figs. 18, 19, 20 and 21 show portions of standards Nos. 1, 2, 3, and 4, respectively, each enlarged 10 times. There is considerable apparent irregularity of cell diameter, due to the fact that the cells are cut in different planes, but the comparison of the four types of coke is fairly good.

[1] Bull. Am. Inst. Min. Eng., October, 1883.

In passing from this subject of the examination of coke sections we would take occasion to point out the interesting field

TABLE 3 SPECIFIC GRAVITIES AND POROSITIES OF COKE SPECIMENS

Cell grading	Figure	Apparent specific gravity	True specific gravity	Porosity
1 (Standard)	11	1 097	1.917	42.8
1		0.924	2.006	53.7
1.5	12	0.974	1.891	48.5
2 (Standard)	11	1.007	2.028	50 4
2	14	1.138	1.948	41 6
2.5		0.857	1.979	56.7
3 (Standard)	11	1.071	1.831	41.6
3	16	1.053	1.917	45.1
3	17	0.854	1.862	54.1
4 (Standard)	11	0.943	1.988	52 6
4	13	0.943	1.988	52 6
4	15	0.917	1.921	52 3

open here for the application of petrographic methods to an exhaustive investigation of the material. The actual chemical and physical state of the carbon produced from various coals under various conditions is an important matter from a practical standpoint. Differences in the true specific gravity of coke are frequently found that cannot be explained by varia-

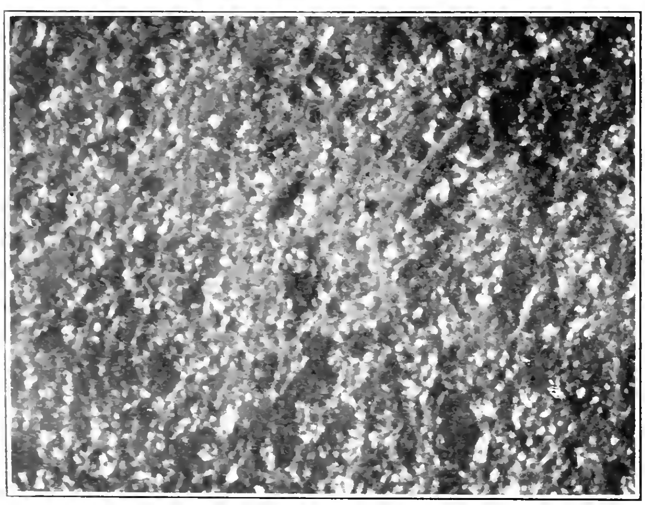


Fig. 20 Standard No. 3 Enlarged 10 Diameters

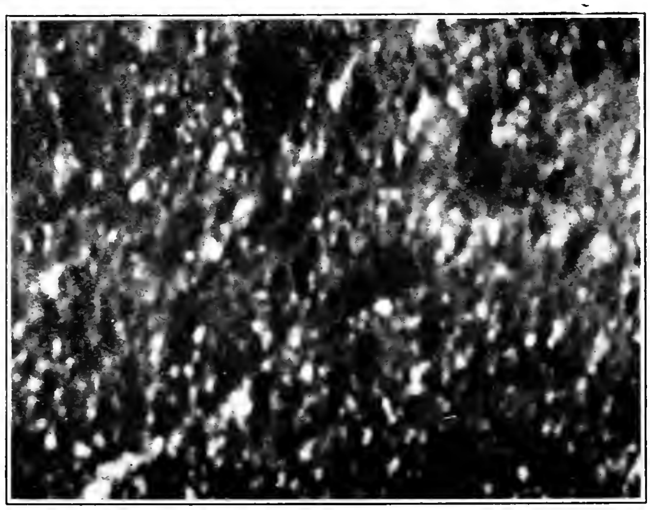


Fig. 21 Standard No. 4 Enlarged 10 Diameters

tion in the content of inorganic matter. The actual condition of this inorganic matter after carbonization, the amount of reduction of the various oxides, the possible effect of the finely disseminated mineral matter in strengthening or weakening the cell walls are all very important. Inorganic matter does not necessarily constitute an element of weakness. Large particles, especially if segregated, are injurious, but finely divided mineral matter may actually strengthen the cell walls. High-ash cokes are frequently stronger than low-ash cokes from the same kind of coal. Some experiments in washing and coking coals of moderate ash content have shown that where the original coal gave a strong coke, the washed coal gave a weaker coke, the difference being undoubtedly due, to some extent, to the removal of some of the mineral matter, although the high moisture content of the washed coal might have had some effect. Simmersbach gives some evidence to show that iron present in combination with carbon and silicon, and silicon present as a silicon carbide, may be the cause of the remarkable hardness of some coke.

Studies of this character will, however, be largely of academic interest unless correlated with studies of the behavior of different types of coke in the blast furnace and in other types of apparatus in which the material is used. Let us choose the blast furnace for consideration here on account of its tremendous industrial importance.

There is at present some disagreement among blast-furnace men as to the exact function of the coke in the most efficient and economical reduction of iron ore. The majority probably still accept Grüner's theory of ideal working, viz. (as stated by Richards[1]), "All the carbon burnt in the furnace should first be oxidized at the tuyères to CO, and all reduction of oxides above the tuyères should be caused by CO, which thus becomes CO_2." It is well known that the reduction of iron oxide by carbon monoxide is the most efficient from the standpoint of heat economy. Richards, however, has pointed out that the direct reduction of iron oxide by carbon is three times as efficient from the standpoint of carbon required as the indirect reduction, and says:

"The ordinary furnace produces at the tuyères, in order to get heat enough to melt down the charges, more CO gas than is needed to abstract all the oxygen from the charges; under these conditions it is uneconomical to oxidize any carbon at all above the tuyères. The exceptional furnace, because of pure ores, small amount of slag, pure fuel, high temperature of blast, or dry blast, gives heat enough at the tuyères to melt down the charges without producing enough CO gas to reduce all the charges; under these conditions, more or less reduction is effected by solid carbon and with the greatest economy in quantity of carbon required in the furnace."

About a year ago H. P. Howland prepared an interesting paper,[2] entitled Calculations With Reference to the Use of Carbon in Modern American Blast Furnaces, calling attention to the fact that many furnaces are actually operating with higher economy of coke than would be calculated from Grüner's theory; in fact, his calculations on the performance of 26 furnaces seem to show that what Richards regarded as the exceptional furnace is the rule rather than the exception in modern practice.

Howland's tabulation of data on these 26 furnaces is so interesting and pertinent to the subject that a portion of it is reproduced in Table 4.

Note incidentally the performance of the once-despised by-product coke in modern practice. Of the 19 furnaces using less than a ton of coke per ton of pig iron, 13 are burning by-product coke and 6 beehive coke.

Howland calculates that all the furnaces burning less than 1350 lb. of carbon at the tuyères are not making enough CO to reduce all the Fe_2O_3 and hence some of the latter must be reduced directly by carbon. He concludes: "It seems clear therefore, that in low-coke furnaces one of the most important (if not the most important) functions of the carbon burned at the tuyères is to produce heat to enable the carrying on of the direct reduction, rather than to produce CO for indirect reduction.

"On this basis, it becomes very essential that our carbon shall burn instantaneously to CO in order that the resulting heat may be localized where needed. This should not be a question of seconds, but of a fraction of a second. If our carbon is of such a nature that this burning to CO is a comparatively long process, more of it will be required than of the quick-burning carbon in order to obtain the same concentration of heat at the desired point.

"We would, therefore, say that the most desirable thing about a coke is that quality in the carbon which will allow of its being instantaneously burned to CO and thus result in the maximum concentration of heat where needed."

W. H. Blauvelt, in a discussion of Howland's paper,[3] says: "In studying the combustion of coke in the furnace, it is clear that the production of the maximum quantity of heat is not of the first importance in blast-furnace operation, or in the utilization of the fuel charged into the furnace. To my mind, the production of a high thermal head at the tuyères is of the first importance, and the best coke is that which reaches the tuyères in proper condition to produce the highest temperature at the tuyères, and in just sufficient quantity to do the amount of work required there under the conditions produced by this

TABLE 4—PART OF HOWLAND'S DATA ON AMERICAN BLAST FURNACES

Furnace No.	Pounds coke per ton iron	Tons iron per day	Carbon in coke, per cent	Kind of method of manufacture	Coke operation	Total charged	Gasified in furnace	Gasified at tuyères	Per cent total carbon	Per cent gasified carbon
1	2,615	301	86.3	BH	Stonega	2,254	2110	1868	82.8	....
2	2,551	272	84.4	BP	Solvay	2,153	2049	1751	81.4	86.6
3	2,472	482	86.1	BH	Conn.	2,128	1996	1728	81.2	86.8
4	2,247	450	87.1	BH	Conn.	1,957	1846	1605	82.0	87.0
5	2,198	499	86.9	BH	Conn.	1,908	1810	1494	78.7	82.6
6	2,123	541	88.3	BH	Conn.	1,875	1764	1498	79.8	84.9
7	2,115	360	84.3	BP	Solvay	1,782	1683	1427	80.1	84.8
8	1,996	490	86.3	BP	Koppers	1,722	1611	1298	75.4	80.6
9	1,936	376	85.7	BP	Solvay	1,659	1557	1305	78.8	83.7
10	1,905	393	88.7	BP	Solvay	1,690	1575	1252	74.1	79.5
11	1,901	517	85.5	BP	Koppers	1,625	1524	1280	78.8	84.1
12	1,863	504	86.6	BP	Koppers	1,614	1513	1230	76.2	81.3
13	1,780	426	84.9	BP	Koppers	1,511	1414	1124	74.4	79.5
14	1,742	503	84.6	BP	Koppers	1,474	1382	1133	76.9	82.0
15	1,716	542	87.1	BH	Benham	1,494	1396	1194	80.0	87.0
16	1,715	585	84.6	BP	Koppers	1,451	1357	1114	76.6	82.2
17	1,702	543	87.5	BP	Koppers	1,490	1388	1130	75.9	81.5
18	1,699	572	87.0	BP	Koppers	1,479	1387	1155	78.2	83.4
19	1,673	580	88.6	BH	Benham	1,482	1384	1182	79.9	85.0
20	1,658	590	88.3	BH	Benham	1,464	1366	1182	80.8	86.5
21	1,636	442	89.5	BP	Koppers	1,463	1369	1124	76.8	82.1
22	1,635	593	88.5	BH	Benham	1,447	1349	1124	77.7	83.4
23	1,624	592	87.3	BH	Benham	1,417	1317	1118	79.0	85.0
24	1,623	457	89.6	BP	Koppers	1,454	1360	1090	75.0	80.2
25	1,589	605	88.3	BH	Benham	1,403	1307	1100	78.5	84.2
26	1,584	466	89.2	BP	Koppers	1,413	1324	1057	74.8	79.9

NOTE—BH = Beehive. BP = By-product. Conn. = Connellsville.

[1] Metallurgical and Chemical Calculations, p. 248.

[2] Bull. Am. Inst. Min. Eng., March, 1916, p. 627.

[3] Bull. Am. Inst. Min. Eng., October, 1916.

FIG. 22 COKE FROM STRAIGHT HIGH-VOLATILE COAL, SHOWING SPONGE

FIG. 23 COKE FROM SAME COAL AS FIG. 22, WITH 20 PER CENT POCAHONTAS

maximum temperature. The combustion of a much larger amount of fuel at the tuyères, under conditions that will fall short of producing the highest possible temperature, cannot produce as good results, either in fuel economy or output. . . . Nothing is more fatal to obtaining the highest temperature than an excess of combustion. In the blast furnace an excess of air dilutes and cools the products of combustion, reducing the maximum thermal head at the tuyères, and the larger volume carries the high temperature zone too high in the furnace. . . . It will probably be generally admitted that furnace coke should be of nearly uniform size, and many furnace managers are eliminating all coke below $^3/_4$ in. and above 4 or 4½ in.; also, that the best coke is that which is sufficiently strong to resist undue abrasion and crumbling by attrition with the stock, and of an open porous structure that will permit the most rapid combustion when it reaches the tuyères. Many large users agree that the coke should never be overcoked beyond the point of producing a sufficiently strong structure, as overcoking quickly reduces the combustibility.

"If Grüner's ideal gives the best furnace operation, we should want a coke that is resistant to the oxygen in the ore, but easily combustible at the tuyères, which is a contradiction of qualities. If my argument is correct, that the furnace man wants the greatest thermal head at the tuyères rather than the production of the greatest quantity of heat in the furnace as a whole, then he is willing to sacrifice some coke by solution in the oxidizing gases in the upper part of the furnace, provided he can obtain a sufficient quantity of coke at the tuyères, of a quality that will permit rapid combustion with the minimum amount of air, thereby giving him the maximum thermal head."

The desirability of the condition which Blauvelt aptly terms *a high thermal head* in the zone of the tuyères will be readily granted even by those who adhere to Grüner's theory. This condition should be attained even at a sacrifice of some carbon by solution loss ($CO_2 + C = 2CO$), and we are of the opinion that the importance of this solution loss is frequently overestimated. Most laboratory experiments made to determine the loss undergone by different cokes have been of little value, because they have been mostly made with pulverized samples, so that their original physical condition has been greatly altered.

We have lately tested the resistance of a number of cokes to the action of CO_2 at temperatures of 800 and 900 deg., and find the loss of coke pulverized to 40 mesh to be very much greater than the same coke prepared in small test pieces, ⅜ in. by ⅜ in. by 1½ in., so as to retain the original structure.

As furnace conditions are better understood, the possibility

FIG. 24 COKE FROM COLORADO COAL, SHOWING SPONGE

FIG. 25 COKE FROM SAME COAL AS FIG. 24, PROPERLY MADE

of the use of coke of a wider instead of a more restricted range of quality will become better recognized, with the express limitation that the supply for each furnace must always be absolutely uniform in quality. This requirement of uniformity cannot be too strongly emphasized, and it is almost equally necessary for the proper operation of the coke plant as the blast furnace; but this does not mean that there is one standard grade of coke to which all plants should conform so far as possible. As a matter of fact, the range of cokes that successfully qualify in practical operation is continually being extended, through necessity of one sort or another, with little general realization of the fact. In Figs. 12 to 17 we have already shown the cell structure of some cokes that are giving good results in different American blast furnaces, and the difference is fairly remarkable.

However, for each kind of coke there is evidently some limiting size for efficient service, i. e., just large enough to offer such a minimum surface of attack for CO_2 that the loss on this account is negligible, and small enough so that complete combustion may be effected in a minimum of time at the tuyères. Hardness of body is usually—though possibly not necessarily—proportional to the resistance of a given coke to oxidation by CO_2 or oxygen. The harder grades of coke should be used in smaller sizes—and this is a compensation automatically provided to some extent by the operation of the by-product oven. Similarly, cokes of close cell structure are more resistant to oxidation, but this may be offset to a large extent by softness. The coke of more open cell structure will probably require less rigid attention to sizing than the denser coke. The important thing is to determine the practical limits of these elements of size, hardness, and cell structure. It may be found that a coke of such structure as No. 1 of our scale may be unsuitable, no matter what may be its size or softness; but this ought to be proved by actual test and not taken for granted.

These considerations are of the utmost importance and encouragement to the coke-oven man, because, with a reasonable choice of coal, his control over the quality of his coke is almost unlimited, and, even with a very restricted source of supply, the possibilities of conforming to the desired standard by proper oven construction and regulation are still remarkably great. We propose to conclude this paper by showing two or three examples of what can be accomplished in the way of control of this sort.

One proposition that frequently presents itself is that of eliminating sponge. Sponge is a characteristic honeycombed mass formed in the center of rich volatile matter. It seems to be caused by an excess of pitchy material moving along with the fused zone in the coking process, and finally [illegible] in the center of the oven, where it is eventually [illegible] the production of this light porous material. Sometimes [illegible] sponge is found in loose, detached masses scattered [illegible] coke as it lies on the wharf after quenching, or [illegible] be found adhering very closely to the ends of [illegible] coke, and sometimes blending, without any clear [illegible] cation, into the body of the coke itself.

Although the amount of this sponge [illegible] very large, it is so bulky that its actual [illegible] is small. In one case where the amount of sponge seemed to be very large it was actually found [illegible] to 1.65 per cent of the total coke. Small amounts of sponge probably do no harm, most of the material being soon broken up in the operations of handling the coke, but the presence of the material undoubtedly occasions a certain loss of carbon, and so we usually try to get rid of it. The customary remedy—and one that always works—is to mix with the high-volatile coal sufficient low-volatile coal, which has the effect of absorbing the excess of bituminous material and eliminating the conditions of sponge formation. Pocahontas coal is the standard low-volatile coal that is employed by many of our plants. It is to be noted that different coals require considerably different percentages of Pocahontas coal to completely eliminate the sponge. Fig. 22 shows a coke from unmixed high-volatile coal (about 34 per cent volatile matter). A large amount of sponge is readily apparent. Fig. 23 shows the coal from a mixture containing 80 per cent of this same coal with 20 per cent of Pocahontas. The sponge is entirely eliminated and the structure of the coke improved.

Frequently it is too expensive a proposition to buy low-volatile coal for the sake of eliminating a little sponge, and

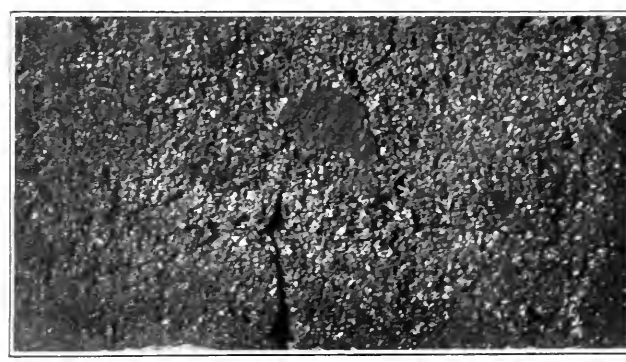


Fig. 26—Same Coal Mixture Coked at Different Plants Under Different Conditions

sometimes the low-volatile coal may be altogether inaccessible for practical purposes. This does not, however, leave us at the end of our resources. By proper methods of control, sponge may be eliminated from a wide variety of coals that produce it under ordinary conditions. If the oven is correctly designed and proportioned, and the temperature and coking are carefully regulated, very satisfactory results may be obtained without the necessity of making a special coal mixture. Fig. 24 shows the coke from one coal which was made in a type of oven unsuited to it, and coked at unfavorable temperatures. Fig. 25 shows coke made from the same coal under proper conditions. The sponge has been entirely eliminated.

Occasionally one of the most difficult problems to be overcome is that of too great density of cell structure. Here, again, we can approach the problem in two ways: one, by mixing in one or more other coals that have a tendency to the production of a more open cell structure, and the other way by suitable preliminary preparation of the coal, careful heat

[illegible] and special design of the ovens. Fig. 26 shows coke made from the same coal mixture coked at different plants under different conditions. The dense coke shown in the lower part of the figure was greatly improved upon when the nature of the coal was better understood, and the excellent product shown in the upper part of the figure was then made when the coal was treated in the right kind of ovens and under proper conditions.

To insure the best results a special study must be made of each kind of coal it is proposed to use, and it would be well, in all cases where a new plant is contemplated, to make this study previous to design of the plant, because the results may suggest some necessary changes in design that would not otherwise be foreseen.

Technical Education in Great Britain[1]

IN THE early days of our Institution most engineers were trained entirely in the shops. Theoretical knowledge was uncalled for, and even held to be antagonistic to practical success. There was no supply of scientific engineers. It was only in 1840 that the chair of engineering was established at Glasgow University. There were engineering courses in London at King's College, and courses dealing more particularly with mining and shipbuilding at the School of Mines and at the School of Naval Architecture. In the provinces there were a few technical colleges. It was not till 1877 that the livery companies of London appointed a committee to consider a national scheme of technical education. The City and Guilds Central College was the result. Then came the appointment of the Royal Commission, which reported in 1884, the formation of the National Association for the Promotion of Technical Education in 1887, and the Technical Education Act of 1889, which refused to the schools it governed the means of teaching the practice of any trade. In 1890 only was a real foundation laid by the transfer of the control of technical education from the school boards to the local authorities.

The result has been a vast expenditure on technical schools, ranging from the technical school of the small borough to institutions of university rank like the Municipal School of Technology in Manchester. Besides these we have provided engineering courses in most of our older universities, and endowed new ones. To Oxford, Cambridge, St. Andrews, Glasgow, Aberdeen, Edinburgh, Dublin, Durham, London, we have added Manchester, Wales, Birmingham, Liverpool, Leeds, Sheffield, Bristol, Belfast, and the National University of Ireland.

With all these schools and colleges, the problem of educating engineers and engineering workmen has not been solved. Our innate conservatism ties us too much to traditions. Many still fail to understand that the manual training which enabled an apprentice to become a master craftsman does not suffice to turn a schoolboy into an engineer. Moreover, differentiation is needed in training. Designers and scientific advisers require a knowledge and experience which managers and business organizers can forego, etc. This lack of differentiation seems to be one cause of the inefficiency of our technical education. Another certainly is insufficient preparation of those entering the technical schools.

The education available for the higher ranks seems fairly satisfactory; at all events, it has produced men capable of solving many problems presented by the war. I would give one caution and make one complaint. There are many Englishmen of the best type with initiative, ability to organize, etc., but incapable of assimilating much book learning, especially higher mathematics. Do not let us force these men through the same collegiate course as men of different mentality, but keep them to more elementary work and require a high standard in examination. We must not underrate these men. Many of them are of our very best. The Institution recognizes their value by admitting them without examination at 30 years of age.

My complaint is against retaining Greek as a compulsory subject at Oxford and Cambridge Universities.

The education provided for the workmen is most unsatisfactory. Trade apprentices who enter the shops at 14 years of age seldom have subsequent opportunities for learning other than at evening classes. I have seen in some paper that technical education in England and Wales is provided in 6,876 evening and similar schools, but that the average attendance is about one hour per week. The workman must have better education to qualify him to rise if capable, and to give those who have not the ability to rise some interests outside their daily work and football matches. Unless an antidote be provided, the monotony of repetition work will crush initiative and mental vigor, and instead of skillful workmen we shall breed incompetent machines.

The interests of engineers require two classes of institutions giving technical instruction, each with its definite purpose: (1) technical "colleges," (2) technical "schools" (senior and junior). The technical "colleges" should be of university rank, and should be departments or faculties of universities, like the Municipal School of Technology in Manchester, not independent of them, as in Germany. They should provide two courses, one for the scientific advisers and designers, the other for the managers and business organizers. They would receive their students mainly from the higher secondary schools. The gate should be opened only to those capable of profiting by the teaching. The idea of university education for the million is most pernicious nonsense. The technical "schools," both senior and junior, should also have two courses, one for men likely to become foremen or supervisors, the other for those likely to remain manual workers. These courses should not be purely technical. The schools would receive their students from the elementary and lower secondary schools. They should remain under the local authorities, so that the technical teaching might be varied in accordance with the local trades.

Another desideratum is coördination, especially between the higher secondary schools and the technical colleges, and between the elementary and lower secondary schools and the technical schools, so that pupils passing from the one to the other would be properly prepared for the change.

[1] From Presidential Address, Institution of Mechanical Engineers, April 20, 1917, by Michael Longridge.

The U. S. Bureau of Mines has received an offer of the complete laboratories and working staffs of the Minnesota School of Mines, Minnesota Mines Experiment Station, New York State School of Clay Work and Ceramics, Department of Chemistry, University of Texas, University of Cincinnati, Department of Chemistry, Louisville University, State Board of Health Laboratory, Ohio State University, and the Johns Hopkins University.

Commercial and other laboratories have also offered their services, among them being the Mellon Institute for Industrial Research; the General Electric Company; the Central Testing Laboratory, New York; the Fuel Engineering Society, New York.

PREPAREDNESS

By A. M. LOCKETT, NEW ORLEANS, LA.

Member of the Society

THE word *Preparedness* carries the idea of doing something in advance of an expected event in order that such event may be successful. Preparedness for the defense of the nation at a time of peace and with no immediate prospect of war is an abstract proposition which may be properly discussed as such. But when the nation is in a state of war, preparedness is no longer an abstract proposition but a condition which calls not for discussion but for *action*.

With this understanding of the proposition the subject becomes a question of not how we should prepare for a possible war but how we shall conduct a war which is now on our hands.

I have no technical knowledge to qualify me for advancing any views as to the manner in which military operations should be carried out. All that I can do is to give my personal views as to what I conceive to be the things which engineers can and should do to serve their country.

While it has always been the universal desire of the American people to avoid war, it certainly is also the intention of all Americans to win any war in which they are forced to engage.

It is useless now to waste time discussing the causes which led up to the war—the proposition before us is to discuss the ways and means of winning the war which is now beginning.

Many of us undertake work involving engineering design and construction varying in character and magnitude, but none of us has ever undertaken, or even conceived, of so large a contract as the American people are now called upon to execute.

This is not a job upon which we have the option of bidding or not bidding. The contract has been awarded to us and our certified check, which is nothing less than the sacred honor of our country, has been deposited and will be forfeited unless the job is successfully carried out.

The plans for this undertaking have been made by the Army and Navy. It is not for us, the American people, to find fault with these plans; our work is to carry them out with dispatch and completeness. The men who have made these plans have been trained from their boyhood in this line of work, and it would be foolish for us to assume that these plans are in any degree defective or incomplete. Therefore, the first duty in my opinion for all the people of this country is to get behind the Army and Navy and back them up to the absolute limit if we hope to execute the work successfully.

Every citizen of the United States is in theory, and in fact, in the service of the Government, whatever may be his occupation, or even if he has no occupation whatever. Every American citizen recognizes the obligation of coming to the defense of the nation in time of war, and if he is of sound mind he must know that such defense, to be effective, must be preceded by the necessary preparations.

In war patriotic fervor and enthusiasm play a prominent part, but the real work must be done by the men who have a clear understanding of the task, a full knowledge of the sacrifices to be made and a grim determination to carry out the program whatever the cost.

All men desire to win in any contest in which they engage. They may regard with equanimity the possibility of defeat when the penalty involves only loss of money or personal prestige, but when defeat involves loss of national integrity or national honor, no patriotic citizen can ever entertain the thought of defeat.

This being the case, any man who deliberately blocks or attempts to prevent the carrying out of any measure of preparedness which in any degree reduces the danger of defeat, is no more nor less than a traitor.

There may be differences of opinion as to whether a certain measure may in fact improve the chances of victory, but when all men agree that if certain things are done the probable outcome of this war is more to our advantage, to gamble upon the possibility of such measures not being needed is the height of folly.

It is fortunate for us in this emergency that we have had the opportunity to witness the practical demonstration which has been taking place in Europe for more than two years, because many theories previously advanced on the subject of military preparedness and national security have been proved untenable.

Germany has been able, by reason of the preliminary arrangements which we call Preparedness, to resist with marked success enemies many times more numerous, and it would be foolish for this country to fail to profit by her example in so far as practical preparations with respect to land operations are concerned. Likewise the British Navy has demonstrated that superiority of equipment is absolutely conclusive with respect to naval operations. We are confronted with a war which may involve both land and naval operations, and it is our duty to profit by what we have learned from these other great nations.

No comprehensive plan of preparedness can be carried out without the full coöperation of the whole people. The people will not back up any project which they do not believe sound in principle and necessary for the good of the country. There are some propositions involving merely economic policies upon which the people will take sides and follow leaders, more or less blindly, although they may not fully understand the principles involved; but when it comes to the question of war which calls for the sacrifice of all they hold dear, even to their lives, they must be roused not only to understand the necessity but they must have such a deep-seated conviction of the righteousness of the cause as they have in their religion.

It devolves upon us who are converted to convert those who have not yet seen the light, and one of the purposes of this paper is to attempt to point out the way the non-military engineers can assist in bringing the people to a proper understanding of the situation so that they will do what they should do.

In determining what is the duty of us engineers in this

Presented at a Joint Meeting of the New Orleans Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, and the Louisiana Association of Members of the American Society of Civil Engineers, on April 2, 1917.

mergency I make the suggestion that we can serve in two capacities: one as ordinary citizens, having an equal part with other citizens in influencing the actions of Congress, and the other in the capacity of engineers having technical knowledge and practical experience in work closely allied to the operations of the military engineers.

I believe that as citizens we should take the lead in the campaign of converting the people in general to a full realization of the situation, because we are qualified by our training to gather together in intelligible shape the facts and figures bearing upon the subject and to present them to the public in a manner which may be more easily understood by the average citizen than if those same facts and figures were included in a more or less technical explanation such as would ordinarily be made by military engineers.

As I have already said, the people will not get behind this movement with the proper spirit unless they are thoroughly convinced, first, that the preparedness movement is sound in principle, and second, that the actual necessity now exists.

I take it that no man who has made any attempt to post himself regarding the actual condition of this country with respect to preparedness, denies that the country is not prepared to bring to a successful conclusion a war with a first-class power.

If there be any who have any doubt upon this subject, I refer them to the report of a board of officers and civilians made through the War Department to the U. S. Senate in the early part of January, this year. This committee consisted of three Army officers and two civilians appointed by Congress to investigate the subject of the feasibility, desirability, and practicability of the Government manufacturing arms, munitions, and equipment, and certain other allied questions.

This committee made examinations of all the Government arsenals and the principal private plants capable of manufacturing the class of articles required by the Army and Navy, held conferences with heads of leading industrial institutions, and through all practicable sources sought information not only upon the question of whether the Government could manufacture its own arms, munitions, and equipment, but secured accurate data as to the supply of such articles now on hand and the time necessary to secure such supplies from all sources in the case of an emergency.

The report of this committee is in much detail and is very complete.

What I gather from the facts brought out is as follows:

1 The various departments of the Government have on hand at the present time the necessary equipment only for the present regular army and the militia
2 That to properly equip an army of 500,000 men will require six months
3 To equip an army of 1,000,000 men will require one year
4 To equip an army of 2,000,000 men will require 18 months

These are facts and are not open to argument, and the thing for the American people to do is to accept them as facts and to act accordingly. Every military and naval authority allowed to express an opinion publicly has in the most unqualified terms testified in general, and in detail, to the fact that we are pitifully unprepared. If it requires six months to prepare the equipment for an army of 500,000 men, we must start now.

Every engineer ought to post himself as to the actual facts in this connection and use his very best efforts to convince the public in general of the absolute necessity of backing up the Army and Navy in their plans, and should bring such pressure to bear upon Congress that the necessary legislation shall be promptly passed. The great trouble with the people of this country is that they are suffering with that fatal complaint designated by Mr. Homer Lea as "the valor of ignorance."

The average American has the mistaken idea that one American soldier is equal to at least six soldiers of any other nation, when as a matter of fact six American soldiers insufficiently trained and improperly equipped would not be equal to one soldier of any other nation not handicapped by these deficiencies.

In olden times, when men fought hand-to-hand conflicts with various kinds of weapons, the strong and brave could easily conquer the weak, but in modern warfare battles are won by machinery and implements which can be handled only by men trained to a high degree, and personal bravery as well as physical strength go down in defeat when pitted against intelligence and experience armed with modern engines of war.

It is gratifying to be able to say that some very important steps have been taken toward national preparedness, and while up to the present time very little has been actually accomplished in the way of definite and positive results, we can, with some degree of truth, at least say that so far as the plans for mobilization of the great industries of the country for the backing up of the Army and Navy operations are concerned, they have been well prepared and the actual results will quickly follow if the proper coöperation is shown by Congress.

As all of you know, the engineers and chemists of the United States completed and delivered to the Naval Consulting Board on the first of September last, an inventory of the industrial resources of the United States.

As Chairman of the Board for the State of Louisiana I have been in close touch with this work, and I can say that while the information obtained was not as complete as was desired, it was sufficiently accurate to enable the Naval Consulting Board to formulate plans which, when carried out, will accomplish the purpose intended.

I desire to take this opportunity to express to the engineers of Louisiana, 144 of whom volunteered to assist, and did in fact give their time liberally to this work, that I believe it is quite probable we will again be called upon to do other work of this same character; and I hope that our efforts will be clothed with sufficient Governmental authority to require, where necessary, the industrial plants which show the disposition either to withhold information or to take the matter lightly, to answer all questions put up to them, the answers to which will be of value to the Government.

Now, coming down to the definite proposition of what you and I, as engineers, can and should do in the present emergency, it seems to me the first step for us to take is to furnish to the Government full information regarding our qualifications, and the Government should then point out to us the department of the Army or Navy to which our services should be offered.

DISCUSSION

COMMODORE V. S. NELSON. Last August, Congress passed an act establishing a naval reserve corps, which act was approved on the 29th of August, for the purpose of filling out the Navy, of expanding the Navy during time of war.

It seems that a great many people do not understand the difference between the Naval Reserve and the regular Navy. They do not understand what they have to do. When they enlist in the Navy, for instance, they agree to serve for four years. They are sent to sea immediately, and they have to stick out that full time. When they enroll in time of peace, they simply obligate themselves to enter the Navy in time of war. They leave their address with the commandant of the naval district in which they enroll, and they agree to come in for service whenever he calls for them, and he would not call for them unless the President had decided that a state of war, or some other national emergency, existed.

The man enrolling in the Naval Reserve in time of peace is not subject to the laws and regulations of the Navy, except during the time that he is on actual duty—in actual service. While it is the desire of the Navy Department that every man or officer enrolled should serve at least three weeks, they are enrolled for four years, and they are supposed to serve at least three months during that four years. The three months can be served in one year, or three weeks in each year, but in time of peace they are not compelled to serve at all. They simply agree to come in in case of war. But everybody believes that the people who enroll now will have to come in.

It is our object to get in as many men as possible. Of course, if the war lasts a short time, the people who enroll in the Naval Reserve will be allowed to go home and attend to their business, but as long as the war lasts they will be in the Navy, just as much as those people enlisted in the Navy.

Congress has established six classes in the Naval Reserve: The first class is composed of those officers and men who have been honorably discharged from the service, or who have resigned, or who have been discharged for other reasons; but the men who have been discharged must be American citizens. For the last ten or fifteen years nobody has been taken in the Navy except American citizens, but before that, there were some good men in the Navy who were not American citizens, and who received their honorable discharge, but they are not eligible to enroll now. They must be American citizens—take the oath of allegiance to the United States, and pass physical examination before a naval doctor who will be detailed for that duty.

The second class is known as the Naval Reserve—the first-class officers and men who have already served, and the second-class Naval Reserve, and that is composed of officers and men who have had experience at sea. A man to be enrolled as an officer must have had two years' service at sea, as an officer in a lake-going or sea-going vessel, and must pass a certain examination. He must also have had experience at sea, and must pass an examination in order to establish his rating. Officers are enlisted at ages from 21 to 35 years, and the men go in from 18 to 35 years. That is the second class.

The third class is the Naval Auxiliary Reserve. That class is composed of men and officers who are serving on American merchant vessels, who are suitable for naval purposes—naval auxiliaries in time of war, and they must have served, and must be serving, on board of ships of that class. Now, in order to secure a commission as an officer, a man must have, in some way, served on one of those ships, or be serving now, that is, to be enrolled in that class. The intention is not to make those officers enroll from those merchant vessels to serve in the regular navy unless they desire to do so, but to have these men who enroll for the auxiliary service serve in the same kind of ships that they have been serving in before they are enrolled.

The fourth class is what we call the Coast Defense Naval Reserve. This is composed of men who have not necessarily had any experience at sea, but who can be of some service to the Navy, either at sea or on shore. They could serve, for instance, in the coast-defense vessels, in scout vessels and in patrol vessels—the harbor patrol and the outside patrol—or they may serve as radio operators, paymasters, clerks ashore —almost any duty a man can perform will be of use to the Navy and will entitle him to enroll in this class.

Then we have the fifth class, which is composed of men in the flying corps. I don't think there is much flying done around here, but most of them have been taught in the naval schools, and these amateurs who have had experience are eligible as officers.

Then there is the class of volunteers who simply volunteer to come in in case of war. They don't have to come in and serve during peace times. But as we are now at war, everybody ought to be prepared to serve in some capacity or another.

It will take a great many men to man patrol boats, submarine chasers, and all these smaller boats in the coast-defense service. Take, for instance, this New Orleans district, which extends all the way from Tampa to the mouth of the Rio Grande. Patrol boats must be obtained to patrol that whole coast, and men have to be found to man those boats; and what we want to do as much as possible is to get men to enter the service—if they won't enter directly into the Navy, to enter into the reserve navy.

There will be a retainer paid every man and officer. They will get $12 a year, simply a nominal sum. Then, after three months' service, the men and the officers are given provisional appointment for the first time, until they have done three months' service. After that, the officers are examined by a board appointed by the Secretary of the Navy, and they are given the rank which they are qualified to fill, and then they receive a commission from the President and are regularly commissioned in the Naval Reserve. The men are examined in the same way, and rated in the rating which they are able to fill—as machinists, or firemen, or ordinary seamen, or whatever they can do, they are so graded. After they have been confirmed, that is, after they have done the three months' service, both the men and the officers, while they are on active duty, receive the same pay and allowances as the regular officers in the Navy, and the retainer pay in addition.

Now, of course, it is going to be necessary to find men to man all of these patrol boats, mine layers, mine planters, mine sweepers, to sweep for mines and protect the mines we plant ourselves—if it is necessary to plant any—and patrol the harbors, or the river here, and patrol all the coasts. We think that this section of the country certainly ought to provide men to help guard the coast on this side. Of course, New Orleans cannot do it all. All those sections along the coast ought to furnish men to patrol the coast.

MAJOR J. L. SCHLEY. I think the two things which Mr. Lockett brought out which are very, very important are, first, the work organizations, and second, a means of getting before the Government some method of procedure whereby they can get at the members of the organizations who are qualified to do certain kinds of work. Those are the two points which are most important for you to carry away with you. The first of those he mentioned in a way that would lead you to believe that a great many people are not cognizant of the facts as they exist today; that is, that we are unpre-

period, and we are so badly unprepared that we have got to make haste quickly to get it in proper shape. And the first thing, of course, to do is to persuade a man that this is a fact, and I think that probably an engineer takes things more in a matter of fact way and sees them as they exist better, probably, than members of other professions. In his daily work he meets with problems in which he must place on the one side the things which he has to build, to construct, and on the other side he is opposed by the laws of nature; and he knows that in order to accomplish something he must face those problems, and if anything goes wrong, the laws of nature, he knows, will come into play. For that reason, he brushes aside the unessentials, and usually arrives at a solution of the problem. Therefore, the engineers throughout the country have probably weighed the question on one side and the other, and have probably come to a conclusion in their own minds that something should be done, and each man has probably reached a conclusion more or less definitely as to what should be done. So I think the first point to be emphasized is that of convincing people who have not looked at things from our point of view of the actual conditions, and that something must be done and done promptly.

The second point of great value is to formulate the method of making it possible for the Government, as you might say, to put its finger on the individual and assign him to the work of a mechanic, or any other position to which he is especially adapted.

If each engineer should write personally to any one of the Government offices, for instance, the office of the Chief of Engineers, you can imagine what a mass of correspondence would be presented, and what a problem it would be to attempt to get anywhere with it; whereas, if an organization of this kind would, through a committee, get in touch with some one and present the names of men who are willing to do something in their particular lines, it would be very much more simple for the Department to assign some work to each group of men, or to each institution, or each organization. In other words, it is the difference between an organization and a mob. In a mob it is difficult to get hold of the individual, whereas in the well-organized army, or well-organized industry, through the different means of control and supervision, each man is assigned to the work which he can do best, and the results are to gather together to a common end, and I think that through your associations forming organizations for that purpose you can get in touch with the Government and the Government can get in touch with the individuals.

Captain H. A. Drum. I appreciate very much the honor of being given this opportunity to carry out a duty which has been assigned to me. General Pershing has sent me to this part of his department in order to interest you in training camps. The training camp, as you are well aware, started in New York, about two years ago, through the patriotism and the individual realization of a national duty by a number of men in New York. It came to them suddenly that there was going to be a time when they would have to respond to their individual duty to the nation. They felt that when that time arrived they wanted to know something about the profession of soldiery. A few of them, about four hundred, gathered together and asked the regular Army to give them some of this training. That was based first on patriotism, second on an individual realization of a national duty.

Before taking up the details of the camp, I want to bring home one or two little points to you about the citizens' training. The President, in his message of December, 1914, stated that this country, in time of peril, should not depend on a standing army, or on a reserve army, but should depend upon a citizenry trained and accustomed to arms. If any of you will go back into our past history and study it carefully, you will find that has been our policy. If you go into the history of Europe and of other nations, you will find that has been the policy of the European nations. They have depended upon a citizenry accustomed to arms. This means a citizenry trained for and accustomed to the duty of defending the country. It cannot have any other meaning in a country like ours, in a country that is governed for the people and by the people. I don't see anything that can be more democratic than that the citizenry should defend the nation.

With these two thoughts in your minds, I would like you to think what your duty as a citizen of the nation is. I believe, first of all, your duty is to have adopted a policy of defending the nation for the people, of the people, and by the people. Second, if you agree to that, I think you should have a policy of having your Government train you for the defense of the nation. If one is true, the other is true also.

Certain civilians with whom I have talked about universal service have seemed to have the impression that the young man entered the service at about eighteen and stayed there until he was forty-five—spent his whole life in military service. That is not so. The General Staff Bill provides for one period of eleven months and three periods of two weeks each, practically a total of one year of actual service, except service in time of war.

This is nothing new to us, this conscription, this actual service by compulsion. In the Civil War we had it. The Confederacy adopted it in the first year of the war, and the North adopted it in 1862. If you analyze what universal service means, it is nothing more than producing a citizen army instead of a standing army. It is nothing more than having an army to defend your nation whose interests are peace, whose hopes are peace, and whose vote will be for peace as long as, in their judgment, the nation's honor and duty are safeguarded. It seems to me that it is the most democratic thing that you could have. It seems to me that it brings the rich and poor, capital and labor, on the same level in the defense of the nation. It brings them down to a common level of duty, and is the production of an army of the people, for the people, and by the people.

As to the past, we have never as a nation been prepared for any war, principally because the people of the nation have never made it their business to look into it. We are a democracy, and the basis of all democracy, the essence of democracy, is that movements shall start from the bottom and work up; that is, they will start from the people; whereas in an autocracy it is the opposite; they start from the top and are imposed on the nation below. The United States, except in one case, has never carried a war to a conclusion in which it has not had to use at least two men to the enemy's one. In the Revolutionary War we employed, all told, 395,000 men. The enemy had a total in this country of 150,000. In the War of 1812 we passed through our ranks 575,000 men; the total force of the enemy in this country was 67,000. In the Mexican War we had 140,000 men; the total Mexican force was 46,000. In the Civil War the North employed a little over two and a half millions, and the South a million. It seems to me that the marked difference in the numbers and the success on both sides in that war was due to the early adoption of conscription by the South. The only exception was the Spanish-American War, in which we had under

arms 280,000 men. There were, all told, in the Spanish forces—not in this country, but in the whole forces—not over 220,000.

If you will look back in the history of the Navy you will see that the Navy has been successful all through. It has had very few reverses, first and foremost because it has been an absolute Federal force. It has nothing to do with the forty-eight subordinate Governments. Second, it has had practically the same officers, the same skilled men in peace as in war. The expansion of the Navy for war is generally from the bottom.

The fine, large preparedness movement all over this country stirred people in an industrial way, worked up mobilization of tools, materials and all that, but it lacked one thing. Have you heard of any organization being formed for the mobilization of the fighting man-power of the country? Have you joined any organization for producing the fighting man-power of the country? There is where we have fallen down. It certainly is essential that we work on the production of munitions and mobilization of the industrial forces of our country. But there is one essential element and that is the fighting man.

We are now called upon to organize an army of a million men, and will need from 30,000 to 40,000 officers. We have today in the army a little over 8000. Where are we going to get the others? You cannot go ahead and organize an army without first having officers, and you cannot pick officers off the trees any more than you can pick engineers off the trees. You have to have men who have the fundamentals of education, whose brains have been developed in such a way that they are receptive and can pick up something new, work on it and get something tangible out of it. The point has been brought up here as to what the engineer can do. It is not a question of all of you staying home and working up the industries—the majority of you should get into that society of the fighting man-power and prepare to be officers. And the means for training men to be officers are these training camps. So the regular Army has put itself at the disposal of the citizens, to give you everything there is in us, and try to make you into the best officers you can be in the short time that we have.

Now, I claim that that disposition on our part throws a duty on you. Your duty is to come or to send some one to us, and we give you everything we have if you will come there to receive the training. These camps are primarily for the infantry. After that, they are for the training of every other branch of the service—cavalry, artillery, signal corps, and engineer corps. The medical corps have their training in these camps too. So if you want to start in the same line in which you have started your civil profession you can get your training in these military camps as a starter. The camps are free. There is no expense about them. The Government furnishes your transportation from your home to the camp, furnishes your food and uniform and equipment while at the camp. The only requirement is that you will deposit, on arrival at the camp, $10 as guarantee for the return of the equipment that the Government furnishes you. You are authorized to buy your uniform, according to the regulation standards, and the Government will reimburse you at the rate of one-third of the cost for each camp that you attend. The uniform will cost you about $15. One camp lasts for thirty days. The only obligation that you have to take upon yourself is an oath of enrollment, that you will serve the President of the United States and the officers over you during the thirty days of instruction at the camp. The camp which you go to is designated in the oath. After those thirty days are over, you are through.

Lieutenant E. S. Moses. A few days ago Mr. Lockett was talking to Commodore Nelson, and he was very anxious to find some definite points that the engineers could start on, for work. So I wrote a few notes for Mr. Lockett, and I didn't expect to speak tonight; I thought he would bring that out. The first point was: start at once intensive training for young men who are ready to go ahead with actual preparedness but do not wish to bind themselves until they have maturely determined the work for which they are best fitted.

The second point was this: study facilities for a motor-boat repair base at the mouth of the river and the personnel for same. Also a supply system for boats operating at the mouth of the river—fuel, food and stores, as well as plans for medical attention. No doubt the Quarantine Station can furnish the personnel, but the Red Cross can probably aid with special equipment or nurses. Accommodations may have to be enlarged and provision made for taking care of people suffering from exposure in open boats.

I understand it will take several motor boats to form a scouting ring around the mouth of the river, and if there is anything sunk out there we will need large facilities for repair work and hospital work, and also in order to keep a steady chain of supplies going.

Third, thoroughly canvass aero resources. If practicable, have the Country Club finance as many aeroplane instructors as can be obtained and have as many members as possible qualify as air pilots. My suggestion of the Country Club is only for illustration, but I consider it practical for some group of wealthy men or women to start such a movement, and its immense importance is obvious.

You all know the relation of supply and demand of people who can operate aeroplanes and man aeroplanes. We can make the aeroplanes, but we cannot make our pilots.

Now, the next point that is particularly interesting to engineers—and to any wholesale dealers and manufacturers here—is to establish and maintain a perpetual stock-card system, showing the material actually on hand and ready for immediate delivery. This is a large order, but its benefit to the city under normal conditions would be so great that it is well worth while to press the matter in the present emergency, both as a patriotic measure and as an economical advantage to the city, so that the local dealers will get their share of war business. The Association of Commerce should be able to handle this.

The next point is developing a transportation system for immediate delivery of material. At the time of writing, a case is brought to my attention of material ordered from the stock of a local firm seven days ago, which is yet undelivered. The large volume of business now being done at the Naval Station would seem to justify the city dealers in coöperating by having a large motor truck leave the corner of Canal and Camp Streets at 9:00 a. m. and 1 p. m. daily, call at each of the dealers subscribing to its maintenance, and thence to the Navy Yard. This is only a suggestion of one of the thousands of details of rapid transportation which must be solved now that we are at war. I suggest the appointment of local transportation committees to devise some means of transporting stores and men from one place to another.

The concluding paragraph in my letter to Mr. Lockett is this: "I presume your Committee has gone very thoroughly into the question of increasing the production capacity of the

plants now in existence. I trust that you have gone into the question of assignment to individual plants constant production repeat orders in order to reduce the variety of work in existing plants. An efficient organization should be formed to control output so that there will not be an excess of one product and a scarcity of another equally important. I doubt if it will be practicable to exercise the necessary authority over individual plants by any private combination, but much advance work can be done to plan a scheme of control should it become necessary for the Government to take over all plants. The question of standardizing gages, fixtures, etc., comes under this general head, and if it is at all practicable I think it would be well worth while to call in the service of an efficiency engineer to make a general industrial survey."

General A. Perilliat. The talks we have had this evening from gentlemen who are well posted in their professions in the art of war have shown how much is to be done, and I fear how much is to be done very quickly, and at once. All of us knew that there was a gigantic work in front of us, but these gentlemen who belong to the profession of the soldier have thrown a little additional light on how much has to be done by this nation and this country to meet the crisis now on our hands. It goes without saying that every man in this room, from a sense of patriotism, from his love of his country, is going to do everything in his power to help out the situation.

We engineers are going to give the best that there is in us. Mr. Lockett has outlined very wisely and with a great deal of thought what we might do. Major Moore has stated that, after all, the man on the front has to be a soldier. He has to know what to do with the things that are given to him to fight with. Sir Douglas Haig has said that for every man on the firing line it took five men to equip him and to keep him furnished with supplies, munitions, quartermasters, commissary department, things which are needed for him to fight successfully.

We are about to raise an army of one million men. It will become necessary, then, to select various kinds of men. It will be necessary to see that men do not go on the firing line when they are better equipped to remain behind the firing line and do the work of these five men who are necessary to prepare and furnish the fighting man with what is necessary to accomplish or win his fight. I am told that in England, at the beginning of this war, thousands and tens of thousands of men volunteered and went to the firing line, and then it was found that they were better fitted, better suited, to be at home, preparing munitions and supplies and supplying the army with that which was needed to fight. I think I see a little daylight through the various talks which we have had before us this evening. The only dark spot, and that is very dark, indeed, is time. It takes time to do things, to accomplish things.

The work of selection and making a census of the industries which would be useful and necessary in the conduct of war has been very ably performed, in this case, by Mr. Lockett and his committee. The Government at Washington has a very complete record of the plants and factories that can be converted into the manufacture of that equipment which is necessary to an army. Something, however, is very necessary in addition to this, and I think Major Moore has touched upon it. Mr. Lockett has also touched upon it. We want a census of men who can do things, and we want to know what they can do. We want to know the name, the address, the age, the capacity of every civil engineer, of every mechanical engineer, of every chemist, of every mechanic, of every electrician. We want that so that when the call comes the right men will find their right places and their proper places without the necessity of first sending them to the wrong place and then bringing them back to do the work for which they are best fitted.

I think that the societies of engineers, both mechanical and civil, should, by the nature of their profession, come in touch with technical men of all kinds, that our Society could easily, under the direction of a committee, of its president, resolve itself into committees, not only in the city, but throughout the State, and make a census. It is quite possible that the Government has already issued instructions for this. If the Government has issued instructions, we can place ourselves subject to the officers of the United States Army or of the Government, to work in that direction. In that way we can be immediately useful. Upon our shoulders, or upon the shoulders, perhaps, of the older men of our profession, will devolve the duty of finding, of equipping, of directing the efforts of these five other men who are necessary to supply the one man on the firing line. The duty of organization of the work behind the firing line is going to be an immense undertaking, and the training of engineers, the training which we have received in our profession, I believe, renders us especially fitted to perform this work, under the direction, of course, of the military heads, who must command and direct everything.

Professor C. S. Williamson. I realize perfectly well that men must be had, and that trained men must be had, officers must be had, patrols must be maintained on our coasts, patrols must be maintained on land at certain points, but back of all of that is the serious side, that we must furnish the material which has been spoken of here tonight, with which these men who patrol may actually carry out the patrol. Now, we have a survey which has been spoken of also, that was made by the Naval Consulting Board, through its various State organizations, in which 144 of us have participated in this State, and we have that on file in Washington, as a fairly complete survey; but even with that there is yet a serious consideration that some of those materials in that survey are not inexhaustible in the United States. It may become necessary for us as engineers to be called into service in the actual manufacturing of certain supplies very much more intensively than we have spoken of tonight.

I don't think this is the time to lay bare any actual facts and figures, but there are some commodities which we do not produce in the United States which are absolutely essential to either land or naval warfare. There are certain commodities which are at hand and can be readily put into use. I know one plant in this state that has a certain by-product that goes into the sewers, that with a very small equipment could be turned into one of the essentials for making cordite. I know one other concern here that could turn another by-product to a useful purpose which is not listed in our survey—and was not so stated. These are by-products which have not been actually thought of as being turned into use.

Now, the point I want to bring out is this: there are certain manufacturing plants that could be turned to immediate use if it became necessary. We have not a sugarhouse in the State of Louisiana that could not be turned to the manufacture of materials to be used in making explosives. We have one certain product that could be made in our sugarhouses here. We have a second product which could be made in the sugarhouse which is absolutely essential to the manufacture of explosives. We have here in Louisiana a natural resource for the manufacture of explosives which has not been exploited, which I believe could be put up and operated on fairly short notice, a certain product which could be manufactured here.

TENTATIVE DRAFT OF A CODE OF SAFETY STANDARDS FOR POWER-TRANSMISSION MACHINERY[1]

Rules and Requirements for the Protection of Industrial Workers from Hazards Commonly Presented by Mechanical Equipment Used for Transmitting and Distributing Power from the Prime Movers to the Various Power-Utilizing Machines, Tools and Devices

NOTE—The use of properly designed, constructed and installed individual motor-driven equipment with electrical power distribution not only eliminates many of the hazards demanding this Code, but also gives an uninterrupted distribution of natural and artificial light, and a greater flexibility and range of speeds than is possible with mechanical power-distributing systems.

The following specifications describe standard guards for all power-transmission equipment hereinafter mentioned, and apply to all main shafting, jack shafting, drive shafting and countershafting, and their belts and other attachments up to but not including belts actually driving machines.[2]

2 *Class A Guards:* If the clearance between the guard and the guarded part is less than five (5) inches, a metal guarding material that will not admit objects larger than one-half ($\frac{1}{2}$) inch in diameter, strong enough to withstand loads to which it may be subjected, durable enough to withstand ordinary wear and tear, substantially fabricated and erected, and free from sharp points and edges.

3 *Class B Guards:* If the clearance between the guard and the guarded part is five (5) inches or more, a metal guarding material that will not admit objects larger than two (2) inches in diameter, strong enough to withstand loads to which it may be subjected, durable enough to withstand ordinary wear and tear, substantially fabricated and erected, and free from sharp points and edges.

4 *Handrails:* If the clearance between the guard and the guarded part is fifteen (15) inches or more (measured horizontally from extreme parts within six (6) feet of floor), a handrail forty-two (42) inches in height with at least one intermediate rail, supported at least every eight (8) feet, substantially fabricated and erected, with no sharp points or edges.

5 If constructed of pipe, the rails and posts shall be at least equal in strength to one and one-fourth (1¼)-inch standard-weight pipe.

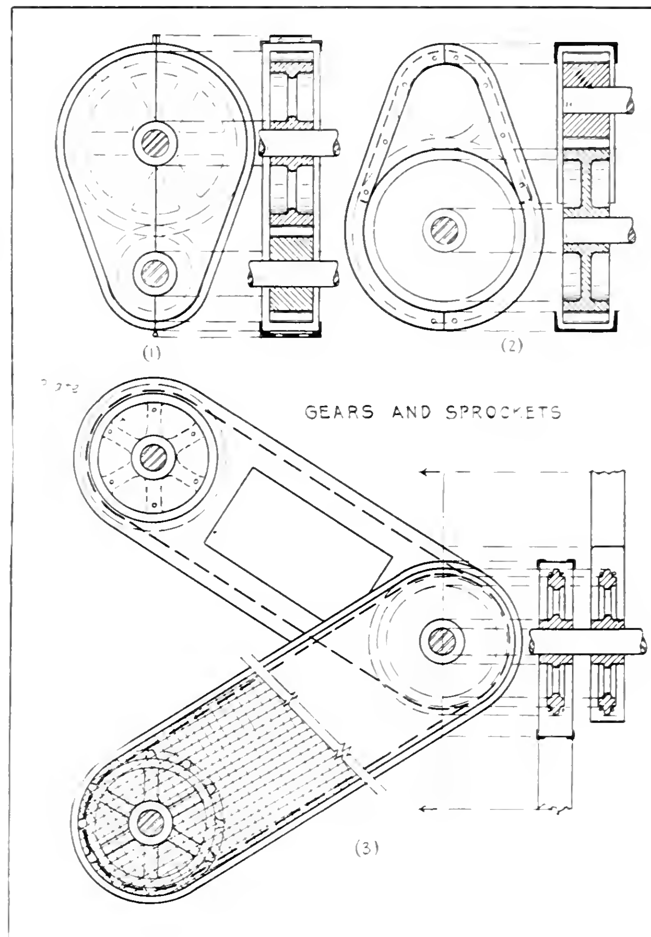
6 If constructed of structural metal, the rails and posts shall be at least equal in strength to two by two by one-fourth (2 x 2 x ¼)-inch angles.

7 If constructed of wood, the top rail shall be two inches by four inches (2 x 4), the center rail one inch by four inches (1 x 4), and the posts four inches by four inches (4 x 4), all straight-grained lumber dressed on four sides, or other construction of equal strength.

8 *Toe Boards.* When power-transmission equipment extends through floors or into pits, Class A and B guards shall extend to the floors, or toe boards six (6) inches in height shall be provided around the floor opening in addition to standard handrails. (See Figs. 6, 7, 11, 14, 30, 31, 34, 48.)

9 *Sanitary Bases.* Class A and B guards, for power-transmission equipment not extending through floors, shall enclose exposed sides to two (2) inches below the bottom of the lowest moving part when the clearance between that part and the floor is less than eight (8) inches; or when the clearance between the lowest moving part and the floor is eight (8) inches or more, the guards shall be closed on the bottom, or extended on all sides down to six (6) inches above the floor. (See Figs. 15, 26, 36-40, 42, 43, 49-54.)

10 *Gears and Sprockets.* All power-driven gears and sprockets shall be completely enclosed on exposed sides with standard guards as specified in Class A or B, except in cases where the design and operation of the parts to be guarded make a complete enclosure clearly impractical: in which case the face of the gears or sprockets shall be covered with a band guard surrounding all exposed teeth, with flanges on both sides extending inward beyond the roots of the teeth, and there shall be a continuous smooth web cast or fitted between the hubs and rims of the gears or sprockets. (See Figs. 1, 2, 3.)



FIGS. 1 TO 3 GUARDS FOR GEARS AND SPROCKETS

11 *Vertical and Inclined Belts, Ropes, Chains.* All vertical and inclined belts, ropes and chains used for transmitting or

[1] Compiled and presented by Carl M. Hansen and Rufus W. Hicks, under the direction and with the approval of the Committee on Health and Safety, National Association of Manufacturers. Submitted by the Sub-Committee on the Protection of Industrial Workers for the consideration of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[2] Belts actually driving machines will be considered "machine belts," and therefore a subject for machine codes.

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distributing power (except belts traveling less than 120 feet per minute, or transmitting so little power that accidental contact therewith could cause no accident) shall be provided with standard guards as specified in Class A or B, six (6) feet high on exposed sides, or on exposed sides and top, or with a standard handrail on exposed sides. (See Figs. 4 to 46, inclusive.)

12 *Horizontal Belts, Ropes, Chains.* All horizontal belts, ropes and chains used for transmitting or distributing power (except belts traveling less than 120 feet per minute, or transmitting so little power that accidental contact therewith could cause no accident) shall be guarded as follows:

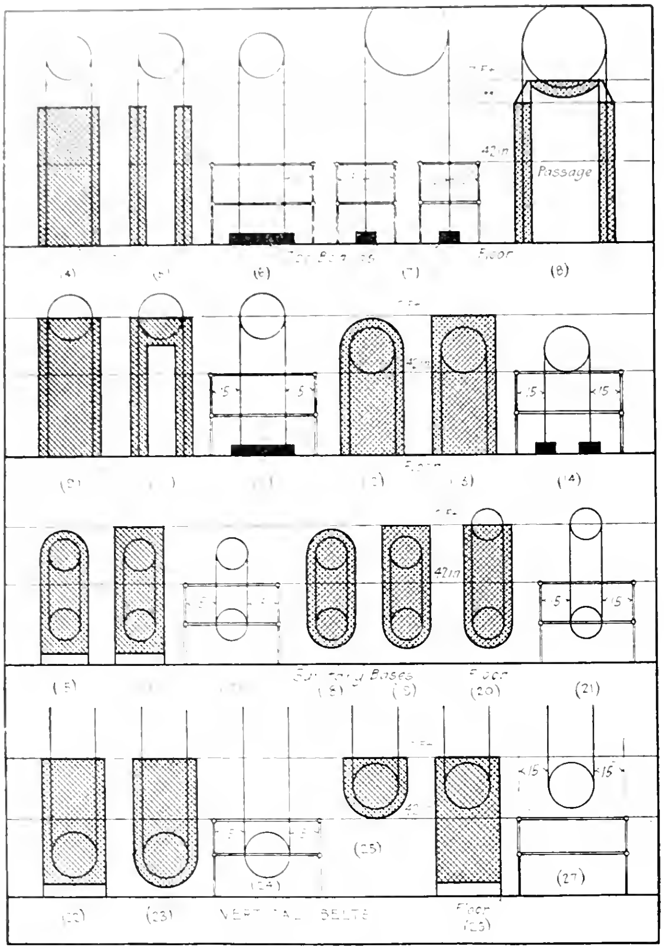
13 *Low Belts.* If the upper part of the belt is lower than

and bottom, or with standard handrail on exposed sides. (See Figs. 59, 60.)

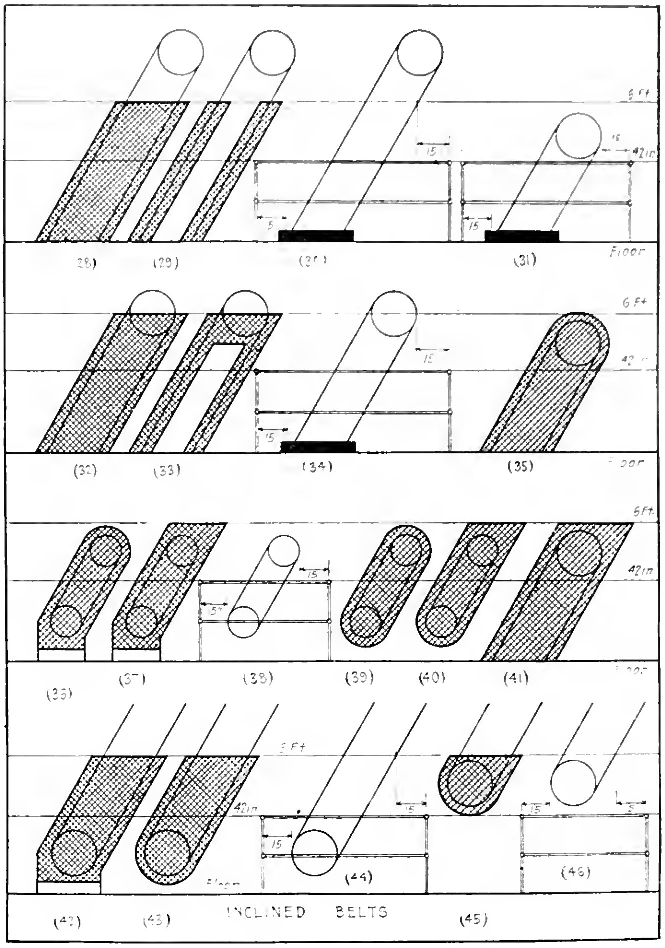
16 *Belts over Driveways.* Where a horizontal belt is located over a driveway or passageway, the highest floor of any wagon or truck passing beneath the belt shall be considered a working platform.

17 *Belt Fasteners.* All belts not provided with guards as specified in Class A or B and within seven (7) feet of the floor or working platform shall be free from metal lacings and metal fasteners.

18 *Belt Shifters.* Belt shifters shall be provided for all tight- and loose-pulley belts, and shall be so designed and constructed that ordinary vibrations or accidental contact will not



Figs. 4 to 27 Guards for Vertical Belts



Figs. 28 to 46 Guards for Inclined Belts

six (6) feet above the floor or working platform, it shall be provided with standard guards specified in Class A or B, six (6) feet high on exposed sides, or on exposed sides and top, or with a standard handrail on exposed sides. (See Figs. 47-50.)

14 *Medium Belts.* If the upper part of the belt is higher than six (6) feet above the floor or working platform and the lower part of the belt is lower than six (6) feet above the floor or working platform, it shall be provided with standard guards as specified in Class A or B, six (6) feet high on exposed sides, or with a standard handrail on exposed sides. (See Figs. 51-58.)

15 *High Belts.* If the lower part of the belt is higher than six (6) feet above the floor or working platform and lower than seven (7) feet above the floor, it shall be provided with standard guards as specified in Class A or B, on exposed sides

alter the set position, and shall have a controlling handle conveniently located. (See Figs. 61-63.)

19 *Pulleys.* Pulleys belted from above or from the side in such a way as to allow passage beneath the pulley, and within seven (7) feet of the floor or working platform and not completely enclosed by standard belt guards or handrails, shall be guarded to the top of the pulley or to a height of seven (7) feet above the floor or working platform on exposed sides and beneath by guards as specified in Class A or B, or be enclosed on exposed sides by standard handrails. (See Figs. 64-67.)

20 *Bearing Clearance.* The clearance on shafting between pulleys and bearings or between pulleys and fixed objects shall be not less than thirty-six (36) inches and wider than the belt, or the pulleys shall be guarded on the near side with stationary guards as specified in Class A or B, and all revolving ob-

jects in the clearance shall be smooth, cylindrical and concentric with shafting. (See Figs. 68-73.)

21 *Belt Clearance.* The clearance on shafting between pulleys and pulleys, collars, couplings or other revolving attachments shall be wider than the widest belt used, or the pulleys shall have flanges or guards to prevent the belt from dropping into the clearance. (See Figs. 68-73.)

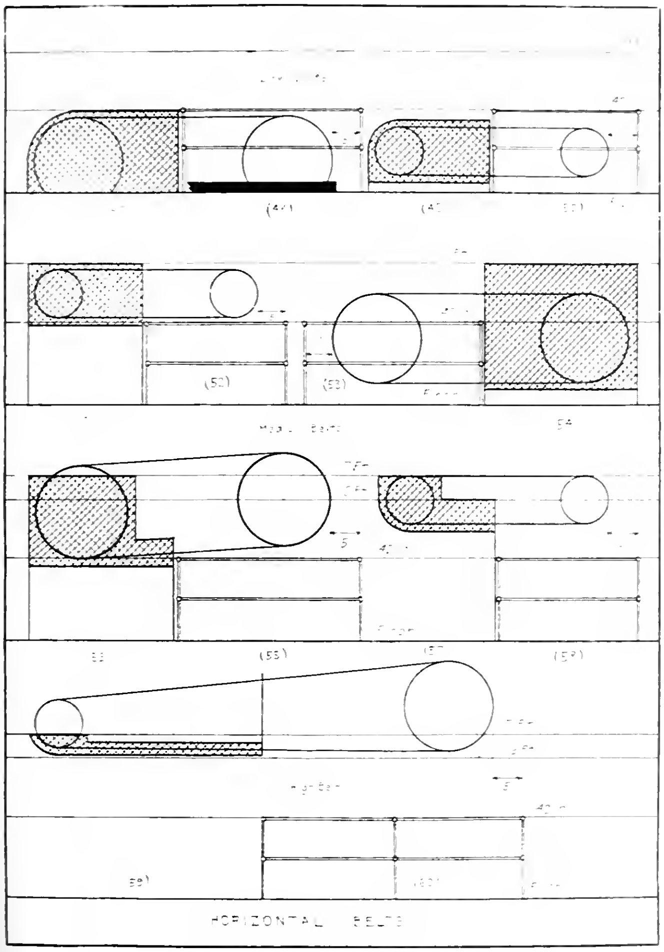
22 *Abandoned Pulleys.* Pulleys without belts shall be guarded as though belted, or removed from revolving shafts.

23 *Clutches.* Friction clutches, jaw clutches and compression clutches within seven (7) feet of the floor or working platform or within thirty-six (36) inches of a bearing shall have their operating mechanism completely enclosed in stationary guards as specified in Class A or B, or in smooth, concentric revolving guards of solid construction with no projecting parts or attachments.

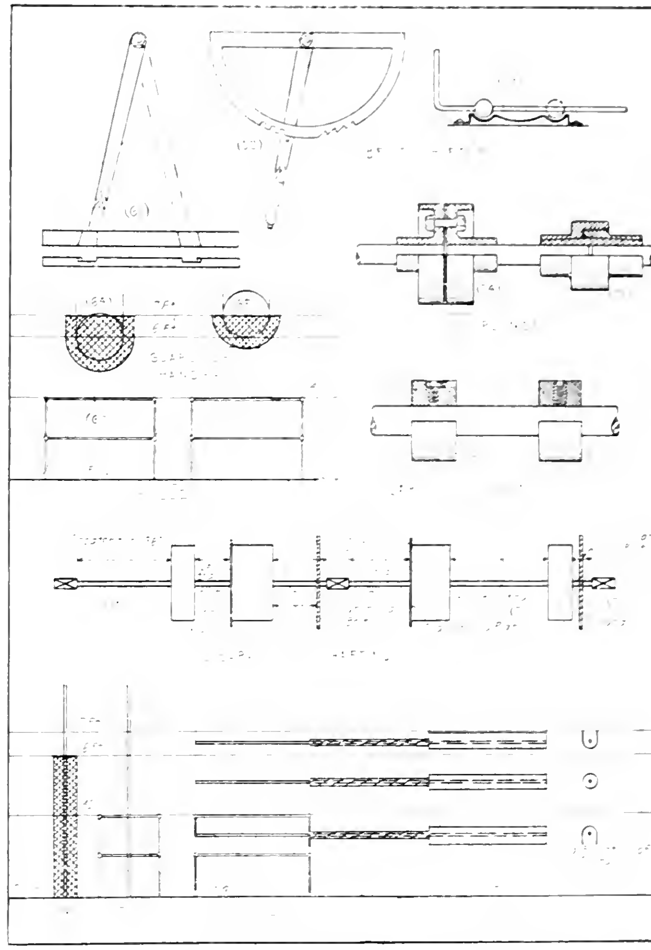
24 *Couplings.* All couplings within seven (7) feet of the floor or working platform or within thirty-six (36) inches of a bearing shall be guarded as follows:

25 *Rigid Couplings.* Sleeve couplings and flange couplings shall be cylindrical and concentric with the shafting and with no parts or attachments projecting beyond the largest periphery of the coupling or its projecting flanges. (See Figs. 74, 75.)

26 *Flexible Couplings.* Flexible and universal couplings shall be completely enclosed in standard stationary guards as specified in Class A or B, or in smooth concentric revolving guards of solid construction.



Figs. 47 to 60 Guards for Horizontal Belts



Figs. 61 to 82 G[illegible]

27 *Clamp Couplings.* Clamp couplings and makeshift devices of irregular shape or unknown strength are prohibited on power-driven shafting.

28 *Collars.* Assembled collars shall be smooth, cylindrical and concentric with shafting, with no projecting parts or attachments. (See Figs. 76, 77.)

29 *Set Screws.* All set screws in revolving parts not enclosed by standard guards as specified in Class A or B shall be flush with or countersunk below the periphery of the part retaining the set screws. (See Figs. 76, 77.)

30 *Keys.* All keys or keyways in revolving shafting not enclosed by standard guards as specified in Class A or B shall be made flush with the end and periphery of the shaft or enclosed by smooth, cylindrical, concentric guards.

31 *Vertical Shafting.* Vertical shafting with or without collars, couplings, clutches, pulleys, or other attachments shall be enclosed on exposed sides with standard guards as specified in Class A or B to a height of six (6) feet above the floor or working platform, or with a standard hand rail. (See Figs. 78, 79.)

32 *Horizontal Shafting.* Horizontal shafting with or without collars, couplings, clutches, pulleys, or other attachments, including dead ends, within seven (7) feet of the floor or working platform, shall be enclosed on all exposed sides with standard guards as specified in Class A or B or with standard hand-rail, or with freely revolving tubing. (See Figs. 80-82.)

33 *Shafting over Driveways.* Where horizontal shafting is

erected over driveways or passageways, the highest floor of a wagon or truck passing beneath, the flatting shall be considered a working platform.

34 *Emergency Stop Stations.* A station or stations shall be provided in each room, story or department to stop immediately all power-transmission equipment therein. Such station or stations shall be properly marked and easily accessible and provided with means for locking in "stop" position.

35 *Bearings.* Where possible, bearings shall be of a self-oiling type with reservoir capacities for at least 24 hours' running or shall have other methods of oiling which do not bring the oiler in the danger zone, and shall have necessary drip cups and pans securely fastened in position.

36 *Lubrication.* Oiling which brings the oiler in a danger zone shall be done only by an authorized person, and while the machinery is not in motion.

37 *Oiler's Clothes.* The oiler must not wear loose or flowing clothing.

38 *Oiler's Lock.* The oiler shall be provided with a lock and key or with a key to the locks at the emergency stop stations, and with a warning sign to display at the stations when at work on machinery controlled by that station. He shall be required to lock the station in a "stop" position and display the sign before going to work, and unlock and remove the sign when the work is completed and all men have left dangerous places.

39 *Starting Signals.* Ample notice should be given by means of an effective alarm or signal in all departments before power-transmission equipment is started.

40 *Inspection.* All power-transmission equipment should be carefully inspected at frequent and regular intervals by foremen or authorized inspectors, and defective equipment should be reported for repair and records kept of inspections.

41 *Repairs and Adjustments.* Repairs and adjustments to power-transmission equipment or guards therefor shall be made only when the power is cut off from that equipment, and guards shall be replaced in protective position before the power is cut on.

42 *Removing Guards.* Guards installed in accordance with this Code shall not be removed or rendered ineffective.

Respectfully submitted.

John Price Jackson, *Chairman* John H. Barr Melville W. Mix M. W. Alexander Wm. P. Eales G. R. Olshausen John W. Upp William A. Viall Carl M. Hansen	Sub-Committee on the Protection of Industrial Workers

Corrosion Research Laboratory in England

A new corrosion research laboratory has been equipped from a grant from the Department of Scientific and Industrial Research in England at Brighton, and the Royal School of Mines, with the purpose of prosecuting further the investigation begun by Capt. G. B. Bengough and Dr. O. F. Hudson under the auspices of the Corrosion Research Committee.

From explanations given by Capt. Bengough to some technical journalists it appears that at the present time the work is being concentrated on the causes of corrosion in condenser tubes. Copper-zinc tubes are being subjected to investigation chiefly with the view of determining the causes that lead to dezincification, which is the beginning of many corrosive troubles. Ordinary 70:30 tubes were exhibited which showed dezincification arising from spills in the wall, the presence of oxide in the metal annealing at wrong temperatures, improper pickling, and the presence of swarf holes. Capt. Bengough also showed a sample made from an alloy which was prepared in such a way that an oxide-free tube was drawn from it, another which was 90 per cent copper and 10 per cent nickel, and a third of 92.5 per cent copper and 7.5 per cent aluminum. These special tubes were under experimental tests and were kept under close observation and extremely valuable information was expected from the investigation. It was known that 98:2 copper-nickel was unsuitable for condenser work; likewise an 80:20 alloy, since they failed in the laboratory to attack a 90:10 tube and intended to transfer that experiment shortly to Brighton.

Among other things which, according to *Page's Engineering Weekly* of April 20, 1917, were shown by Capt. Bengough to the technical journalists, was an optical instrument designed for determining the position of every discernible surface flow in each tube that is put into the experimental condenser; also an annealing furnace and the sea-water tanks in which the preliminary corrosion tests are made.

New Malleable Castings Method

According to the *Iron Age,* April 19, 1917, a new method of making malleable-iron castings, doing away with the air furnace, will be used in the plant now being built by the National Malleable Castings Company, Cleveland. The metal will be melted in a cupola and a portion of the melted charge, depending on the amount of carbon and other impurities to be removed (usually about one-fifth of the total), will then be run into a side-blow bessemer converter, in which the carbon, manganese and silicon will be partially or wholly blown out. The treated metal is then to be combined in a ladle with the remainder of the metal from the cupola, and the charge transferred to an electric furnace in which the refinement of the metal will be completed. If such complete refinement is not required the metal may be cast without being subjected to the final refinement in the electric furnace. The melting equipment will consist of four 72-in. Whiting cupolas, bessemer converters built by the company, and four 6-ton Heroult electric furnaces.

The method of pouring will also be a radical departure from the usual practice. Instead of pouring directly into small ladles, the metal will be poured from the electric furnaces into ladles of 12,000 to 14,000 lb. capacity and carried a considerable distance with traveling cranes and then poured into small ladles. From the latter the metal will be poured into the molds. This practice will necessitate the installation of a greater number of cranes than would otherwise be required. Twelve or fourteen traveling cranes, up to 20 tons capacity, will be provided. The plant is expected to be ready for operation about January 1, 1918.

The seventh Edison Medal, awarded to Nikola Tesla for meritorious achievements in his early original work in polyphase and high-frequency electric currents, was presented to him at the annual meeting of the American Institute of Electrical Engineers in the Auditorium of the Engineering Societies Building, New York, on the evening of May 18. President H. W. Buck presided and addresses were made by Dr. A. E. Kennelly, Chairman of the Edison Medal committee, Charles A. Terry, and B. A. Behrend, Mem.Am.Soc.M.E.

REVISION OF BOILER CODE

The Council of the Society has directed that the proposed changes in the Boiler Code be published in The Journal with the request that any desired discussion on the proposed changes be mailed to the Boiler Code Committee for consideration. These proposed changes embody suggestions made at the meetings held at the Society headquarters December 8 and 9, 1916, at which all those interested were invited to attend and participate in the discussions.

At the last meeting of the Boiler Code Committee it was decided to publish all revisions so far agreed on by the Committee. There are other revisions which will be published later on, with the request that they also be discussed. This will make it possible for any one to discuss the proposed revisions before they are brought to the final form and presented to the Council of the Society for approval.

Note. *Only such portions of the Code as are subject to revision are here presented, with references to their proper paragraph numbers.*

PAGE 8

Par. 12. Change Par. 12 to read as follows:

12 Cast iron shall not be used for nozzles or flanges attached directly to the boiler at any pressure or temperature. Cast iron shall not be used for boiler and superheater mountings such as connecting pipes, fittings, valves and their bonnets, for steam temperatures of over 450 deg. fahr.

Par. 13. Change Par. 13 to read as follows:

13 Water-leg and door-frame rings of vertical fire-tube boilers, and of locomotive and other type boilers, shall be of wrought iron or steel, or cast steel of Class A or Class B grade, as designated in the Specifications for Steel Castings. The OG or other flanged construction may be used as a substitute in any case.

PAGE 9

Par. 19. Change Par. 19 to read as follows:

19 The minimum thickness of butt straps shall be given as in Table 1. Intermediate values shall be determined by interpolation. For plate thicknesses exceeding $1\frac{1}{4}$ in., the thickness of the butt straps shall be not less than three-quarters of the thickness of the plate.

PAGE 11

Par. 25. Make the following changes in Par. 25:

Strike out the word "Copper" in the table, and under "Firebox" strike out "not over 0.0[illegible] per cent."

PAGE [illegible]

Par. 123. Make the following changes in Par. 123:

Change the percentage of yield point from 0.6 tensile strength to 0.5.

PAGE [illegible]

Par. 141. Make the following change in Par. 141:

Change the percentage of yield point from 0.6 tensile strength to read 0.5 tens. str.

PAGE 40

Par. 164. Make the following change in Par. 164:

In Par. 164 after the word "knobbled" insert a comma.

Par. 167. Change Par. 167 to read as follows:

167 *Flange Test.* *a* For tubes not more than 6 in. diameter a test specimen not less than 4 in. in length shall have a flange turned over at right angles to the body of the tube without showing cracks or flaws. This flange as measured from the outside of the tube shall have a width of from $\frac{1}{8}$ in. to $\frac{1}{2}$ in. The width between these limits to be not less than 10 per cent of the outside diameter of the tube. For tubes more than 6 in. diameter the flange test is not required.

b In making the flange test, the flaring tool and die block as shown in Fig. 7, may be used.

PAGE 41

Par. 169. Change Par. 169 to read as follows:

169 *Hydrostatic Tests.* Tubes under 5 in. in diameter shall stand an internal hydrostatic pressure of 1000 lb. per sq. in. and tubes 5 in. in diameter or over, an internal hydrostatic pressure of 800 lb. per sq. in., provided that the fibre stress does not exceed 16,000 lb. per sq. in. in which case the test pressure shall be determined by the following formula

$$P = \frac{32{,}000}{D} \times t$$

where t is the wall thickness in inches; D is the inside diameter in inches. Lapwelded tubes shall be struck near both ends, while under the test pressure, with a 2 lb. steel hand hammer, the blow to be equivalent to 2 lb. falling 2 ft.

PAGE 42

Par. 174. Change Par. 174 to read as follows:

174 *Workmanship.* Finished tubes $3\frac{1}{2}$ in. or under in outside diameter shall be circular within 0.02 in. and the mean outside diameter shall not vary more than 0.015 in. from the size ordered. For tubes over $3\frac{1}{2}$ in. in outside diameter, these variations shall not exceed 0.5 per cent of the outside diameter. All tubes shall be carefully gaged with a B.W.G. gage and shall not be less than the gage specified. Tubes on which the standard slot gage, specified, will go on tightly at the thinnest point, will be accepted. The length shall not be less, but may be 0.125 in. more than that ordered.

PAGE 44

Par. 184. Change Par. 184 to read as follows:

184 *Circumferential Joints.* *a* The strength of circumferential joints of boilers, the heads of which are not stayed by tubes or through braces, shall be at least [illegible] per cent of that required for the longitudinal joints of the same structure.

b When 50 per cent or more of the load which would act on an unstayed solid head of the same diameter as the shell, is relieved by the effect of tubes or through stays in consequence of the reduction of the area acted on by the pressure and the holding power of the tubes and stays, the strength of the circumferential joints in the shell shall be at least 35 per cent of that required for the longitudinal joints.

c In circumferential joints of horizontal return tubular boilers the shearing strength of the rivets shall be not less than 50 per cent of the full strength of the plate corresponding to the thickness at the joint.

PAGE 45

PAR. 186. CHANGE PAR. 186 TO READ AS FOLLOWS:

186 *Welded Joints.* The ultimate strength of a joint which has been properly welded by the forging process, shall be taken as 28,500 lb. per sq. in., with steel plates having a range in tensile strength of 47,000 to 55,000 lb. per sq. in. Autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the requirements of the Code and where the safety of the structure is not dependent upon the strength of the weld. Autogenous welding shall not be used in place of caulking or girth joints.

PAR. 187. CHANGE PAR. 187 TO READ AS FOLLOWS:

187 *Riveted Longitudinal Joints.* The riveted longitudinal joints of a shell or drum which exceeds 36 in. in diameter, shall be of butt and double-strap construction. This rule does not apply to the portion of a boiler shell which is staybolted to the firebox sheet.

PAR. 190. CHANGE PAR. 190 TO READ AS FOLLOWS:

190 In horizontal return tubular boilers with lap joints no course shall be over 12 ft. long. With butt and double strap construction longitudinal joints of any length may be used provided the tension test specimens are so cut from the plate that their lengthwise direction is parallel with circumferential seams of the boiler and the tests meet the standards prescribed in the specifications for boiler plate steel.

PAR. 194. CHANGE THE FIRST SECTION OF PAR. 194 TO READ AS FOLLOWS:

194 *Domes.* The longitudinal joint of a dome 24 in. or over in diameter shall be of butt and double-strap construction irrespective of pressure. When the maximum allowable working pressure exceeds 100 lb. per sq. in. the flange of a dome 24 in. or over in diameter shall be double riveted to the boiler shell.

PAGE 49

PAR. 195. ADD AFTER NOTATION FOLLOWING FORMULA IN PAR. 195:

Where two radii are used the longer shall be taken as the value of L in the formula.

ADD AT THE END OF PAR. 195:

When a dished head has a manhole opening, the thickness as found by these Rules shall be increased by not less than $\frac{1}{8}$ in. over that called for by the formula.

PAGE 50

PAR. 199. ADD THE FOLLOWING TO THE LIST OF VALUES OF C IN PAR. 199:

$C = 150$ for stays screwed through plates or made a taper fit and having the heads formed on the stays before installing them and not riveted over, said heads being made to have a true bearing on the plate and the diameter of the heads being not less than 1.4 times the diameter of the stays.

REVISE MATTER FOLLOWING LIST OF VALUES OF C TO MAKE IT READ AS FOLLOWS:

If flat boiler plates not less than $\frac{3}{8}$ in. thick are strengthened with doubling plates securely riveted thereto and having a thickness of not less than 2/3 t, then the value of t in the formula shall be three-quarters of the combined thickness of the boiler plate and doubling plates but not more than one and one-half times the thickness of the boiler plate, and the values of C given above may also be increased 15 per cent.

When two sheets are connected by stays and but one of these sheets requires staying, the value of C is governed by the thickness of the sheet requiring staying.

PAR. 200. CHANGE PAR. 200 TO READ AS FOLLOWS:

200 *Staybolts.* The ends of screwed staybolts shall be riveted over or upset by equivalent process. Staybolts must be hollow or the outside ends of solid staybolts shall be drilled with a hole at least 3/16 in. diameter to a depth extending at least $\frac{1}{2}$ in. beyond the pressure side of the plates, except on boilers having a grate area not exceeding 15 sq. ft., or the equivalent in gas or oil fired boilers, where the drilling of the staybolts is optional. Flexible staybolts of either the jointed or ball and socket type need not be drilled.

PAR. 201. ADD TO PAR. 201 THE FOLLOWING:

If the outstanding legs of the two members are fastened together so that they may act as one member in resisting the bending action produced by the load on the rivets attaching the members to the head of the boiler, and provided that the spacing of these rivets attaching the members to the head is approximately uniform, the members may be figured as a single beam uniformly loaded and supported at the points where the through braces are attached.

PAGE 51

PAR. 203. CHANGE PAR. 203 TO READ AS FOLLOWS:

203*a* The maximum spacing between centers of rivets or between the edges of tube holes and the centers of rivets attaching the crowfeet of braces to the braced surface, shall be determined by the formula in Par. 199, using 135 for the value of C.

b The maximum distance between the edges of tube holes and the centers of other types of stays shall be determined by the formula in Par. 199 using the value of C given in Par. 199 which applies to the thickness of plate and type of stay used.

c The maximum spacing between the inner surface of the shell and lines parallel to the surface of the shell passing through the centers of the rivets attaching the crowfeet of braces to the head shall be determined by the formula in Par. 199, using 175 for the value of C.

d The maximum distance between the inner surface of the shell and the centers of braces of other types shall be determined by the formula in Par. 199 using a value of C equal to 1.3 times that value of C in Par. 199 which applies to the thickness of plate and type of stay as therein specified.

e In applying these rules and those in Par. 199 to a head or plate having a manhole or reinforced opening, the spacing applies only to the plate around the opening and not across the opening.

UNDER TABLE 3 INSERT:

For the application of Pars. 205, 206 and 207, see Appendix (Par. . . .) (illustrations in Case No. 13).

PAGE 53

PAR. 214. CHANGE PAR. 214 TO READ AS FOLLOWS:

214 *Areas of Segments of Heads to be Stayed.* The area of a segment of a head to be stayed shall be the area enclosed by lines drawn 2 in. from the tubes and a distance d from the shell as shown in Figs. 13 and 14. The value of d shall be the larger of the following values but not less than 3 in.

(Note:—Dimensions marked 3″ in Figs. 13 and 14 to be changed to d.)

(1) d = the outer radius of the flange not exceeding eight times the thickness of the head

(2) $d = \dfrac{5 \times t}{\sqrt{P}}$

Where

d = distance in inches
t = thickness of head in sixteenths of an inch
P = maximum allowable working pressure in lb. per sq. in.

PAR. 215. CHANGE PAR. 215 TO READ AS FOLLOWS:

215 When drum heads of water tube boilers are 30 in. or less in diameter and the tube plate is stiffened by flanged ribs or gussets, no stays need be used if a hydrostatic test to destruction of a boiler or unit section built

in accordance with the construction, shows that the factor of safety is at least 5.

PAR. 216. CHANGE PAR. 216 TO MAKE IT READ AS FOLLOWS:

216 Stays shall be used in the tube sheets of a fire tube boiler if the distance between the edges of the tube holes exceeds the maximum pitch of staybolts for the corresponding plate thickness and pressure given in Table 3. That part of the tube sheet which comes between the tubes and the shell need not be stayed if the nearest tangent common to two tube holes when measured on any radius of the tube sheet that intersects the tangent between the holes does not exceed this maximum pitch by more than 3 in. The tube holes to which a common tangent may be drawn in applying this rule shall not be at a greater distance from edge to edge than the maximum pitch referred to.

PAGE 54

PAR. 218. ADD THE FOLLOWING TO PAR. 218:

The distance in the clear between the bodies of the braces, or of the inside braces where more than two are used, shall not be less than 10 in. at any point.

PAR. 220. CHANGE PAR. 220 TO READ AS FOLLOWS:

220*a* The full pitch dimensions of the stays shall be employed in determining the area to be supported by a stay and the area occupied by the stay shall be deducted therefrom to obtain the net area. The product of the net area in square inches by the maximum allowable working pressure in lb. per sq. in. gives the load to be supported by the stay.

b Where stays come near bounding surfaces and special allowances are made for the spacing, the load to be carried by such stays shall be determined by neglecting the added area provided for by these special allowances. For example, if the minimum pitch by Table 3 would make a staybolt come 6 in. from the edge of the plate and a special allowance would make it come 7 in., the distance of 6 in. should be used in computing the load to be carried.

c The maximum allowable stress per square inch net cross sectional area of stays and staybolts shall be as given in Table 4.

d The length of the stay between supports shall be measured from the inner faces of the stayed plates. The stresses are based on tension only. For computing stresses in diagonal stays, see Pars. 221 and 222.

TABLE 4. ADD LINE AFTER ITEM *b* IN TABLE TO READ AS FOLLOWS:

c Steel through stays exceeding $1\frac{1}{2}$ in. diameter	10,400	9000

CHANGE PRESENT ITEM *c* IN TABLE TO ITEM *d*.

PAGE 55

PAR. 223. CHANGE PAR. 223 TO READ AS FOLLOWS:

223 ***Diameter of Pins and Area of Rivets in Braces.*** All rivet and pin holes shall conform with the requirements in Par. 253 and the pins shall be made a neat fit. To determine the sizes that shall be used proceed as follows:

1. Determine the "required cross-sectional area of the brace" by first computing the total load to be carried by the brace, and dividing the total load by the values of stresses for unwelded stays given in Table 4.

2. Design the body of the brace so that the cross-sectional area shall be at least equal to the "required cross-sectional area of the brace" for unwelded braces. Where the braces are welded, the cross-sectional area at the weld shall be at least as great as that computed for a stress of 6000 lb. per sq. in. (see Table 4).

3. Make the area of pins to resist double shear at least three-quarters of the "required cross-sectional area of the brace."

4. Make the combined cross-section of the eye at the side of the pin (in crowfoot braces) of at least 25 per cent greater than the "required cross-sectional area of the brace."

5. Make the combined cross-sectional area of the rivets at each end of the brace at least one and one-quarter times the "required cross-sectional area of the brace."

6. Design each branch of a crowfoot to carry two thirds the total load on the brace.

7. Make the net sectional areas through the sides of the crowfoot, tee irons, or similar fastenings at the rivet holes at least equal to the required rivet section, that is, at least equal to one and one-quarter times the "required cross-sectional area of the brace."

8. Make the cross-sectional areas through the blades of diagonal braces where attached to the shell of the boiler at least equal to the required rivet section, that is, at least equal to one and one-quarter times the "required cross-sectional area of the brace."

PAGE 58

PAR. 231. CHANGE PAR. 231 TO READ AS FOLLOWS:

231 *Maximum Allowable Working Pressure on Truncated Cones.* *a*. Upper combustion chambers of vertical submerged tubular boilers made in the shape of a frustum of a cone when not over 38 in. diameter at the large end, may be used without stays if figured by the rule for plain cylindrical furnaces (Par. 239) making D in the formula equal to the diameter at the large end.

b When over 38 in. in diameter at the large end, that portion which is over 30 in. in diameter shall be fully supported by staybolts or gussets to conform to the provisions for staying flat surfaces. In this case the top row of staybolts shall be at a point where the cone top is 30 in. or less in diameter.

In calculating the pressure permissible on the unstayed portion of the cone, the vertical distance between the horizontal planes passing through the centers of the rivets at the cone top, and through the center of the top row of staybolts shall be used as L in Par. 239, and D in that paragraph shall be the inside diameter at the center of the top row of staybolts.

PAGE 61

PAR. 239. CHANGE FIRST PARAGRAPH OF PAR. 239 TO READ AS FOLLOWS:

239 *Plain Circular Furnaces.* Unstayed furnaces *more than* 18 *in. diameter* when riveted or of seamless construction or such furnaces when lapwelded by the forging process shall have walls not less than 5/16 in. thick. The maximum allowable working pressure for such furnaces shall be determined by one or the other of the following formulæ:

MAKE DEFINITION OF L READ AS FOLLOWS:

L = total length of furnace between centers of head rivet seams (not length of a section), in.

INSERT AFTER THE FORMULA AND JUST PRECEDING THE EXAMPLE IN PAR. 239, ELIMINATING THE PRESENT SENTENCE:

Where the furnace has a riveted longitudinal joint, it may be of the lap type for inside diameters not exceeding 30 in. but shall be of butt and strap construction for inside diameters exceeding 30 in. The efficiency of the joint shall be greater than:—

$$\frac{P \times D}{1250 \times T}$$

PAGE 64

PAR. 246. CHANGE PAR. 246 TO PAR. 246*a*

PAR. 247. CHANGE PAR. 247 TO PAR. 246*b*

CHANGE PAR. 247 TO READ AS FOLLOWS:

247 Where it is impossible to calculate with a reasonable degree of safety the strength of a boiler structure or any part thereof, a full sized sample shall be built by the manufacturer and tested to destruction in the presence

of the Boiler Code Committee or a representative of the Boiler Code Committee appointed to witness such test.

Par. 250. Change Par. 250 to read as follows:

250 A fire-tube boiler shall have the ends of the tubes substantially rolled and beaded, or rolled and welded, at the firebox or combustion chamber end.

PAGE 65a

Par. 253. Change Par. 253 to read as follows:

253 *Riveting.* Rivet holes shall be drilled full size or they may be punched not to exceed 1/4 in. less than full diameter for material over 5/16 in. in thickness, and 1/8 in. less than full diameter for material not exceeding 5/16 in. in thickness, and then drilled or reamed to full diameter.

Par. 255. Add to Par. 255 the following:

Forms of rivet heads that will be acceptable are shown in Fig. 17*a*.

PAGE 65b

Par. 257. Change Par. 257 to read as follows:

257 *Calking.* The calking edges of plates, butt straps and heads shall be beveled. Every portion of the sheared surfaces of the calking edges of plates, butt straps and heads shall be planed, milled or chipped to a depth of not less than 1/8 in. Calking shall be done with a round-nosed tool.

PAGE 67

Par. 266. Change Par. 266 to read as follows:

266 A vertical fire-tube boiler, except boilers of steam fire-engines, or boilers 24 in. or less in diameter shall have not less than seven handholes, located as follows: Three in the shell at or about the line of the crown sheet; one in the shell at or about the water-line or opposite the fusible plug when used; three in the shell at the lower part of the waterleg. A vertical firetube boiler, submerged tube type, shall have two or more handholes in the shell, in line with the upper tube sheet. All boilers 24 in. or less in diameter, shall have at least one opening for inspection and one opening in addition to the blow-off, for washing out the boiler, these openings to be fitted with brass plugs.

PAGE 68

Par. 268. Change Par. 268 to read as follows:

268 *Threaded Openings.* An opening in a boiler for a threaded pipe connection 1 in. in diameter or over shall have not less than the number of threads given in Table 7.

INSERT TABLE HERE

If the thickness of the material in the boiler is not sufficient to give such number of threads, there shall be a pressed steel flange, bronze composition flange, steel-cast flange or steel plate, so as to give the required number of threads.

Par. 269. Change Par. 269 to read as follows:

269 *Safety Valve Requirements.* Each boiler shall have two or more safety valves, except a boiler for which one safety valve 2 in. size or smaller is required by these Rules; in which case one or more may be used.

PAGE 69

Par. 273. Change Par. 273 to read as follows:

273 Each safety valve shall be plainly marked by the manufacturer. The markings may be stamped on the body, cast on the body or stamped or cast on a plate or plates riveted to the body and shall contain the following:

a. The name or identifying trademark of the manufacturer

b. The nominal diameter with the words "Bevel Seat" or "Flat Seat"

c. The steam pressure at which it is set to blow

d. The lift in inches of the valve disc from its seat, measured at a pressure 3 per cent higher than that at which the valve is set to blow

e. The weight of steam discharged in pounds per hour at a pressure 3 per cent higher than that for which valve is set to blow

PAGES 70-71-72

Table 8. Table 8 to be omitted.

PAGE 73

Par. 275*a*. Change Par. 275*a* to read as follows:

275 Safety valve capacity may be checked in any one of three different ways, and if found sufficient, additional capacity need not be provided:

a. By making an accumulation test, that is, by shutting off all other steam discharge outlets from the boiler and forcing the fires to the maximum. The safety valve equipment shall be sufficient to prevent an excess pressure beyond that specified in Par. 270.

Par. 279. Add to Par. 279 the following:

279 Where discharge pipes are used ample drainage shall be provided at or near the safety valve.

PAGE 74

Par. 282. Change Par. 282 to read as follows:

282 For purposes of inspection and to insure the valve being free, each safety valve used on a boiler shall have a substantial lifting device by which the valves may be raised by an amount equal to one-twentieth of the nominal diameter of the valve up to the maximum limit of 1/16 in. when there is no pressure on the boiler.

Par. 283. Add to Par. 283 the following:

The seats and discs of safety valves shall be non-ferrous material. The seat of a safety valve shall be fastened to the body of the valve in such a way that there is no possibility for the seat to lift.

Add to Par. 284 the following:

Springs used in safety valves shall not show a permanent set exceeding 1/32 in. ten minutes after being released from a cold compression test closing the spring solid. And the spring shall be so constructed that the valve can lift from its seat one-tenth the diameter of the seat before the coils are closed or before there is other interference.

Par. 286. Change Par. 286 to read as follows:

286 All dimensions shall conform to the American Standard given in Tables 15 and 16 of the Appendix for the pressure therein specified, except that the face of the safety valve flange and the nozzle to which it is attached shall be flat and without the raised face for pressures up to and including 250 lb. per sq. in. For higher pressure, the raised face shall be used.

PAGE 75

Par. 291. Add to Par. 291 the following:

The lowest permissible water level for various classes of boilers is given in Par. 430 of the Appendix.

Par. 292. Change Par. 292 to read as follows:

292 No water glass connection shall be fitted with an automatic shut-off valve, except when the automatic shut-off valves are so constructed that the two connections to the water glass can be blown through separately and the steam connection cannot be entirely closed thereby.

Par. 296. Add to Par. 296 the following:

Where the use of a long pipe becomes necessary a shut-off valve or cock arranged so that it can be locked or

sealed open may be used near the boiler. Such a pipe shall be of ample size and arranged so that it may be cleared by blowing out.

PAGE 76

Par. 299. Change Par. 299 to read as follows:

299 *Nozzles and Fittings.* Flanged cast iron pipe fittings used for boiler parts, for pressures up to and including 160 lb. per sq. in. shall conform to the American Standard given in Tables 15 and 16 of the Appendix, except that the face of the flange of a safety valve as well as that of a safety valve nozzle, shall be flat and without the raised face. For pressures above 160 lb. per sq. in., steel cast and wrought steel fittings shall be used for boiler parts with exceptions specified in Pars. 9 and 12. An allowable variation of 20 per cent from the flange thickness required by Tables 15 and 16 may be made for steel cast and forged steel fittings, leaving the drilling of bolt holes unchanged. For pressures above 250 lb. per sq. in., the flange thickness and the thickness of the bodies shall be increased to keep within the same deflection limits and to give at least the same factor of safety as the fittings specified in Tables 15 and 16. The face of the flange of a safety valve, as well as that of a safety valve nozzle, shall have a flat face for pressures up to and including 250 lb. per sq. in. and shall have raised face at higher pressures. Tables 15 and 16 do not apply to flanges on the boiler side of steam nozzles or to flanges left by the manufacturer as part of the boiler, and do not apply to fittings designed as part of the boiler.

Par. 307. Change Par. 307 to read as follows:

307 *Blow-Off Piping.* A surface blow-off pipe shall not exceed $1\frac{1}{2}$ in. pipe size and shall form a continuous passage with the blow-off pipe external to the boiler. The internal and external pipes shall be separate with clearance between their ends and arranged so that the removal of either will not disturb the other. A brass or steel bushing as shown in Fig. 19, or flanged connection shall be used.

PAGE 77

Par. 311. Change Par. 311 to read as follows:

311*a*. When the maximum allowable working pressure exceeds 125 lb. per sq. in., on all boilers except those used for traction and portable purposes, each bottom blow-off pipe shall have two valves, or a valve and a cock, and such valves, or valve and cock, shall be extra heavy, except that on a boiler having multiple blow-off pipes, a single master valve may be placed on the common blow-off pipe from the boiler, in which case only one valve on each individual blow-off is required.

b. On all traction and portable boilers when the maximum allowable working pressure exceeds 125 lb. per sq. in., each bottom blow-off pipe shall have one extra heavy valve.

Par. 315. Make the last sentence of Par. 315 read as follows:

The feed pipe shall be carried through the head or shell near the front end in the way specified for a surface blow-off in Par. 307 and be securely fastened inside the shell above the tubes.

PAGE 79

Par. 325. Change Par. 325 to read as follows:

325 Lugs or brackets, when used to support boilers of all types shall be properly fitted to the surfaces to which they are attached. The shearing and crushing stresses on the rivets used for attaching the lugs or brackets shall not exceed 8 per cent of the strength given in Pars. 15 and 16.

Par. 328. Change Par. 328 to read as follows:

328 A water tube boiler which is fired by hand shall have the firing door or doors of the inward opening type unless such doors are provided with substantial and effective latching devices to prevent them from being blown open by pressure on the furnace side.

PAGE 80

Fig. 20. Change Fig. 20, Par. 332, to read as follows:

(Name of State)
..................STD
Year put into service.
Safe Working Pressure.
(Name of Builder)
....

PAGE 81

Par. 339. Change Par. 339 to read as follows:

339 A boiler to be used exclusively for low pressure steam heating may be constructed either of cast iron, steel cast, or wrought iron or steel or any combination of these, but in all cases the connecting rods and bolts shall be wrought iron or steel.

PAGE 82

Par. 343. Change Par. 343 to read as follows:

343 In a *hot-water* boiler to be used exclusively for heating buildings or hot water supply, when the diameter does not exceed 60 in. and the grate area does not exceed 10 sq. ft., or equivalent, as defined in Pars. 359 and 360, longitudinal lap joints will be allowed.

When the grate area exceeds 10 sq. ft., or equivalent, as defined in Par. 360, and the diameter of the boiler does not exceed 60 in. longitudinal lap joints will be allowed, providing the maximum allowable working pressure does not exceed 50 lb. per sq. in.

PAGE 84

Table 9. Title of Table 9 to be changed to read as follows:

Allowable Sizes of Safety Valves for Steam Heating Boilers, of Water Relief Valves for Water Heating Boilers, and of Hot Water Supply Boilers.

PAGE 85

Pars. 359 and 360. Insert the following center head:

GRATE AREA

Par. 359. Change Par. 359 to read as follows:

359 *Double Grate Down Draft Boilers.* In boilers of this type the grate area shall be taken as one and one-quarter times the area of the lower grate.

Par. 361. Change Par. 361 to read as follows:

361 *Steam Gages.* Each *steam* boiler shall have a steam gage connected to the steam space or to the water column or its steam connection, by means of a syphon or equivalent device of sufficient capacity to keep the gage tube filled with water and so arranged that the gage cannot be shut off from the boiler except by a cock placed near the gage and provided with a tee or lever handle arranged to be parallel with the pipe in which it is located when the cock is open. Connections to gages shall be of brass, copper or bronze composition. The dial of a steam gage for a *steam* heating boiler shall be graduated to not less than 30 lb.

PAGE 86

Par. 365. Change Par. 365 to read as follows:

365 *Damper Regulators.* When a pressure damper regulator is used, it shall be connected to the steam space of the boiler.

PAGE [illegible]

PAR. [illegible]. CHANGE PAR. [illegible] TO READ AS FOLLOWS:

[illegible] *Hot water boilers* for a maximum allowable working pressure not exceeding 30 lb. per sq. in. used exclusively for heating buildings or for hot water supply, when constructed of cast iron, steel cast, or wrought iron or plate steel or any combination of these, shall be subjected to a shop test of 60 lb. per sq. in. hydrostatic pressure applied to the boiler or the section thereof.

PAR. 371. CHANGE PAR. 371 TO READ AS FOLLOWS:

371 A maximum allowable working pressure in excess of 30 lb. per sq. in. will be allowed on a hot water boiler constructed of cast iron, steel cast, or wrought iron or plate steel or any combination of these, used exclusively for heating buildings or for hot-water supply, provided such boilers or their sections have been subjected to a shop hydrostatic test of two and one-half times the actual working pressure.

PAR. 377. CHANGE PAR. 377 TO READ AS FOLLOWS:

377 *Name.* All boilers referred to in this section shall be plainly and permanently marked with the manufacturer's name and the maximum allowable working pressure.

All heating boilers built according to these rules may be marked A.S.M.E. standard.

PAGE 91

PAR. 391*a*. CHANGE PAR. 391*a* TO READ AS FOLLOWS:

391 Safety valve capacity may be checked in any one of three different ways, and if found sufficient, additional capacity need not be provided:

a By making an accumulation test, that is, by shutting off all other steam discharge outlets from the boiler and forcing the fires to the maximum. The safety valve equipment shall be sufficient to prevent an excess pressure beyond that specified in Par. 270.

PAGE 93

PAR. 402. CHANGE PAR. 402 TO READ AS FOLLOWS:

402 When the maximum allowable working pressure exceeds 125 lb. per sq. in., the blow-off pipe shall be extra heavy from boiler to valve or valves, and shall run full size without reducers or bushings. All fittings between the boiler and valve shall be steel or extra heavy fittings of bronze, brass, malleable iron or cast-iron.

PAGE 107

PAR. 421. CHANGE PAR. 421 TO READ AS FOLLOWS:

421 *Method of Computing Discharge Capacity.* The required discharge capacity of a safety valve or valves for a boiler may be based either on the heat units in the fuel consumed or on the amount of steam generated.

The number of heat units that each safety valve will handle, for valves of the ordinary types in which the discharge capacity is proportioned to the lift, may be obtained as follows:

$U = 161{,}000 \times P \times D \times L$ for Bevel Seats at 45 deg.
$U = 227{,}500 \times P \times D \times L$ for Flat Seats

The amount of steam that a valve will discharge may be found as follows:

$W = 110 \times P \times D \times L$ for Bevel Seats at 45 deg.
$W = 155 \times P \times D \times L$ for Flat Seats

Where

U = Number of heat units per hour that a safety valve will handle, B.t.u.
W = Quantity of steam that a safety valve will handle per hour, lb.
P = Absolute boiler pressure or gage pressure plus 14.7 lb. per sq. in.
D = Inside diameter of valve seat, in.
L = Vertical lift of valve disc, measured with 3 per cent excess pressure, in.

PAR. 422. CHANGE PAR. 422 TO READ AS FOLLOWS:

422 The maximum quantity of fuel C that can be burned per hour at the time of maximum forcing is determined by a test. The maximum number of heat units per hour, or $C \times H$ is then determined, using the values of H given in Par. 427. The weight of steam generated per hour is found by the formula:

$$W = \frac{C \times H \times 0.75}{1{,}100}$$

The sum of the safety valve capacities marked on the valves shall be equal to or greater than W.

PAGE 108

PAR. 423. REPLACE MATTER AFTER STATEMENT OF EXAMPLE BY:

$$C \times H = 2150 \times 12{,}100 = 26{,}015{,}000$$
$$W = C \times H \times 0.75 \div 1100 = 17{,}740$$

A $3\frac{1}{2}$ in. bevel seated valve with 0.11 in. lift would discharge in heat units

$$U = 161{,}000 \times 239.7 \times 3\tfrac{1}{2} \times 0.11 = 14{,}858{,}000$$

and in weight of steam

$$W = 110 \times 239.7 \times 3\tfrac{1}{2} \times 0.11 = 10{,}150$$

From which it can be seen that either method indicates that two such valves will give the proper relieving capacity.

PAR. 424. REPLACE MATTER AFTER STATEMENT OF EXAMPLE BY:

$$C \times H = 2000 \times 6400 = 12{,}800{,}000$$
$$W = C \times H \times 0.75 \div 1100 = 8730$$

A bevel seated $3\frac{1}{2}$ in. valve is marked by the manufacturer 0.11 in. lift and discharge capacity for 100 lb. pressure = 4840 lb.; hence two such valves would be required.

PAR. 425. REPLACE MATTER AFTER STATEMENT OF EXAMPLE BY:

$$C \times H = 1000 \times 18{,}500 = 18{,}500{,}000$$
$$W = C \times H \times 0.75 \div 1100 = 12{,}620$$

A bevel seated $2\frac{1}{2}$ in. valve is marked by the manufacturer 0.08 in. lift and discharge capacity for 275 lb. pressure = 6350 lb.; hence two such valves would be required.

PAR. 426. REPLACE MATTER AFTER STATEMENT OF EXAMPLE BY:

$$C \times H = 3000 \times 960 = 2{,}880{,}000$$
$$W = C \times H \times 0.75 \div 1100 = 1960$$

A bevel seated 2 in. valve is marked by the manufacturer 0.07 in. lift and discharge capacity for 150 lb. pressure = 2500 lb.; hence one such valve would be required.

PAGE 109

PAR. 427. CHANGE PAR. 427 TO MAKE FIRST SENTENCE READ AS FOLLOWS:

For the purpose of checking the safety valve capacity as described in Par. 422, the following values of heats of combustion of various fuels may be used.

ALSO CHANGE HEADINGS IN TABLES WHICH FOLLOW TO MAKE THEM READ:

H = B.t.u. per lb.

and

H = B.t.u. per cu. ft.

PAGES 113-114

PAR. 430. MAKE FIRST LINE OF PAR. 430 TO READ AS FOLLOWS:

430 Each boiler may have one or more fusible plugs located at the lowest permissible water level as follows:

ADD AT THE BOTTOM OF P. 114 (PAR. 430):

r Fire Engine Boilers are not usually supplied with fusible plugs. Unless special provision is made to keep the water above the firebox crown sheet other than by the natural water level, the lowest permissible water level shall be at least 3 in. above the top of the firebox crown sheet.

Society Affairs

Engineering Survey

Prizes for Technical Papers

JUNE 30 is the last day for submitting papers for consideration by the Committee on Award of Junior Prizes for the Cash Prize of $50 and Engraved Certificate, available for the best paper of the year by a Junior Member, and for consideration by the Committee on Award of Student Prizes for the two Cash Prizes of $25 each and Engraved Certificates, available for the two best papers of the year by enrolled members of Student Branches of the Society.

The prizes will be awarded for the papers adjudged best from the standpoints of originality of matter, applicability (practical or theoretical), value as a contribution to technical literature, logical development of contents, conclusiveness, completeness, conciseness, or such standpoints as the Committees may determine.

Papers must be the bona fide production of their authors. In the case of papers by Junior Members, they must not have been previously contributed to, nor published by, any other society in whole or in part. Papers by members of Student Branches, however, may have been presented before a regular meeting of a branch.

Manuscripts should be preferably typewritten in doublespacing, on sheets of uniform size, say, 8½ x 11 in., with illustrations neatly drawn and tabular matter clearly arranged.

Full information regarding these prizes and the rules of their award is published on pp. XXVI and XXVII of the 1917 Year Book, and the Rules of Award are given on pp. 508 and 509 of the same volume.

Membership in the Am. Soc. M. E.

C 9 A Member shall be an Engineer or Teacher of Applied Science of thirty-two years of age, or over, and shall have been in the active practice of his profession for at least ten years and in responsible charge of important work for five years, and shall be qualified to design as well as to direct engineering work. Fulfilling the duties of a professor of engineering who is in charge of a department in a college or school of accepted standing shall be taken as an equivalent to an equal number of years of active practice. Graduation from a school of engineering of recognized standing shall be considered as equivalent to two years of active practice.

C 10 An Associate shall be thirty years of age or over. He need not be an Engineer, but must have been so connected with some branch of Engineering or science, or the arts, or industries, that the Council will consider him qualified to coöperate with Engineers in the advancement of professional knowledge.

C 11 An Associate-Member shall be a professional engineer not less than twenty-seven years of age, who shall have been in the active practice of his profession for at least six years, and who shall have had responsible charge of work as principal or assistant for at least one year. Graduation from a school of engineering of recognized reputation shall be considered as equivalent to two years' active practice.

C 12 A Junior shall be twenty-one years of age or over. He must have had such engineering experience as will enable him to fill a subordinate position in engineering work, or he must be a graduate of an engineering school.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

THE SPRING MEETING AT CINCINNATI

THE largest audience at any Spring Meeting of the Society was present at the joint meeting with the Machine Tool Builders' Association on Tuesday afternoon, May 22. The meeting was addressed by Dean Herman Schneider, of the University of Cincinnati, on The Trend in Engineering Training, and by Dr. Otto P. Geier, social physician of the Cincinnati Milling Machine Company, on The Human Potential in Industry.

Dean Schneider outlined various educational plans for bringing the student in contact with practical work in the industries and with the workmen. He illustrated with lantern slides the work of his own students of the University of Cincinnati, under the well-known coöperative plan which he has so successfully carried out with Cincinnati firms for regular employment in the shops during the college course.

Dr. Geier's address was an inspiration in showing the important service which the social physician can render in maintaining the health of the workers and removing physical causes leading to lack of interest or loss of time; and by developing intimate relations in a way to be genuinely helpful to the employees.

The two addresses were delivered to indicate the attention which industrial Cincinnati is giving to the human side of industrial problems. The visitors were urged to remain longer in the city in order to study these methods at first hand.

The meeting concluded with some excellent and unusual moving pictures of the manufacture of 9.2 shells, arranged for and contributed by the publishers of *Machinery*.

Notes

Council Meeting. The Council directed the issuing of a questionnaire to the membership, to provide for the enlisting of members in the public service in the present emergency, and also for the future needs of the Society.

Business Meeting. Amendments to the Constitution proposed by the Constitution and By-Laws Committee were announced. It was stated by the President that the Council, as expressing the obvious desire of the whole membership, had voted to invest in Liberty Bonds part of the money necessarily needed in the running of the Society, even at some possible inconvenience.

General Session. President Hollis, Vice-President Benjamin and Manager Toltz presided alternately. At the close, Mr. Toltz spoke of his recent trip to Honolulu and his reception by the A.S.M.E. members there and the Hawaiian Engineering Association. He brought the greetings of the latter to the Society. Attendance about 220.

Registration. Indications are, at time of going to press, that the registration will exceed that at any previous Spring convention. The total number of members registered at end of the second day was 370, and the total of guests 490. Attendance at previous largest Spring Meetings: Chicago (1904), 350; Pittsburgh (1911), 305.

At the Machine Shop Session there were 200 in attendance throughout, many standing in the room.

An enthusiastic conference of delegates from local Sections was held, at which each man from each city recited briefly the experiences of his organization for the year and outlined plans of future work. Sections Committee Chairman Yarnall described plans of the Sections Committee to make the Sections the strongest factor in the Society work. Both President Hollis and Secretary Rice told the delegates frankly that their first aim should be service to their communities. The delegates accorded a rising vote of thanks of the Sections to the Cincinnati Local Committee for the splendid arrangements for the Spring Meeting.

The University of Cincinnati Student Branch held an enthusiastic meeting at the University on Tuesday evening. About 75 were present. Secretary Rice opened the meeting. President Hollis, Mr. William Kent, Mr. Carl G. Barth, and Mr. L. P. Alford gave good talks to the men. These were followed by an entertainment and smoker, arranged for and carried out by the students.

THE SECRETARY'S MONTHLY LETTER

THE coöperation of the Society with the Government, as was outlined in last month's Journal, is developing still more intimately. Calls from the departments directly and by firms responding to Government emergency orders are frequent.

As an outgrowth of the activity of members of our Society in their relation as citizens of Fairfield County, Connecticut, in the Fairfield County Resource Mobilization Committee, a meeting of The American Society of Mechanical Engineers from not only Bridgeport but all of the surrounding towns was held this month, attended by the members of the Sections Committee with the result, as elsewhere reported in this issue, that an Organization Committee has been appointed with representatives from each of the big centers in Connecticut, to draw up a plan whereby the whole State of Connecticut will be provided with section meetings. With this as a precedent, it is hoped to extend the Society organization through many other similarly thickly populated districts so that the benefits of membership will be still further extended.

As is stated in another place, and of such importance that it should be repeated here, the National Academy of Sciences has just elected four engineers, which, so far as I am informed, is the first time that an engineer as such has been elected to the highest body of men of science of any country.

Science are physicists and chemists, the reason always being here because of the sharp distinction drawn between pure and applied science. The two members of our Society who were elected are Prof. W. F. Durand and Dr. S. W. Stratton, the member of the Mining Engineers was Dr. Henry M. Howe, and of the Electrical Engineers, Mr. J. J. Carty. It has been indicated previously and particularly in the last number of THE JOURNAL that the engineering societies are closely coöperating through the Engineering Foundation with the National Research Council appointed by the President of the National Academy of Sciences. This coöperation is destined to be very close, and in fact the resources of the entire Society will sooner or later be called on by the Research Council.

The sole ambition of the Society is to render the greatest possible service to the Government, under all circumstances.

As an outcome of the extraordinary activity of the Government in munition manufacture, several pieces of standardization work, which are now especially urgent, will undoubtedly be started or revived, and the coöperation of the members of the Society is specially urged for the sake of the country. Obviously, inconvenience and perhaps some actual loss of stocks will follow the processes of standardization, but with the proper attitude on the part of all, these losses can be minimized and the greatest good secured.

The Secretary also wishes to ask the assistance and the coöperation of the membership in the Industrial Census supplementing that taken last year but undertaken now under the auspices of the states. The members are requested to kindly notify the Secretary of all such requests so that the machinery of the Society can always be availed of to the fullest extent.

CALVIN W. RICE,
Secretary.

Council Notes[1]

THE following members were present at the meeting of the Council on April 20: Ira N. Hollis, *President,* John H. Barr, C. E. Benjamin, R. H. Fernald, W. F. M. Goss, A. M. Greene, Jr., F. R. Hutton, W. B. Jackson, D. S. Jacobus, C. T. Main, C. T. Plunkett, John A. Stevens, and Calvin W. Rice, *Secretary.* Louis C. Marburg, member of the Sections Committee, and F. R. Low, chairman of the Publication Committee, were also present by invitation.

In view of the present national emergency, it was voted that authority be given to the President to nominate, subject to confirmation of the Council, such additional committees and representatives as may be requested from time to time by either the Council of National Defense or the National Research Council.

Council of National Defense. In response to an invitation from the Advisory Commission of the Council of National Defense, it was voted that the President and Secretary be nominated to represent this Society on the Commission's Committee on Science and Research, including Engineering and Education.

Engineering Committee of National Research Council. In response to the invitation of the National Research Council, W. F. Durand and Charles D. Young were nominated to represent this Society on the Engineering Committee of the Council. The Secretary announced that John R. Freeman had been elected a member-at-large on the National Research Council.

Advisory Committee on Gunmounts. The Council acknowledged and accepted as a command from the Secretary of War, the appointment of President Hollis and Past-President Jacobus to act on a special advisory committee on gunmounts.

Conserving Engineering Resources. Dr. Jacobus spoke of the desirability of placing on record an opinion that for the best interests of the country effort should be made to conserve the engineering talent as represented in the colleges of the country, both in graduate and undergraduate bodies, and to prevent if possible too hasty enlistment in the regular army and naval militia service. It was voted that Dr. Hollis Godfrey be invited to address a letter to the various colleges, informing them of the best use to which students and graduates can be put at this time, and advising that these men be conserved for the special fields in which their training would be especially useful and adaptable.

Engineer Officers' Reserve Corps. The name of the Joint Committee on Engineer Officers' Reserve Corps was changed to Committee on National Defense, the committee to coöperate with similar committees of the other societies. The committee has recently addressed instructions to the members of the Society who contemplate enlistment in the Army or Navy.

Military Engineering Committee. In response to the request of the chairman, and uniform with the action of the other three national engineering societies, the members of this Society now serving on the Military Engineering Committee of New York were authorized and appointed to represent the Society. These members are: Messrs. Gano Dunn, Alexander C. Humphreys, D. S. Jacobus, John W. Lieb, Ralph D. Mershon, Calvin W. Rice, W. L. Saunders, Bradley Stoughton, and W. H. Wiley.

National Academy of Sciences. The Secretary announced that Prof. W. F. Durand had been elected a member of the Academy.

U. S. Bureau of Mines. In response to a request from the Bureau of Mines for the appointment of a special Advisory Committee to the Bureau, and two sub-committees on Fuel and Mine Equipment, the Research Committee was appointed as the Special Advisory Committee.

Engineering Council. Amendments to the By-Laws of The United Engineering Society, creating The Engineering Council, "to consider means for more intimate relations between engineers for discussion of questions of general interest and for united action," were approved.

Constitution and By-Laws. Important changes in the Constitution and By-Laws of the Society were proposed by the Committee on Constitution and By-Laws and will be presented at the Council meeting to be held at Cincinnati on May 21, in connection with the Spring Meeting.

Membership Committee. The Secretary reported difficulty and embarrassment on the part of the Membership Committee to meet regularly, on account of the extraordinary pressure of personal business and national affairs, and it was voted that a statement be made in THE JOURNAL that on account of present conditions the matter of election to membership must necessarily proceed more slowly than usual.

A.S.M.E. Boiler Code. Interpretations in cases Nos. 136 to 145 were approved and ordered published in THE JOURNAL. They were included in the May issue.

Sections. The formation of a Section in Toronto, Canada, to include all members residing within a radius of sixty miles but not outside the Province of Ontario, and in the following cities in Ontario: Ashburnham, Collingwood, Cobourg, Oril-

[1] The May JOURNAL went to press before the April meeting.

ha, Palmerston, Port Dover, Peterborough, and Waterford, was approved.

Oscar Elsas, chairman, Cecil P. Poole, secretary, Earl F. Scott, Robert Gregg, and J. N. G. Nesbit were approved as the Executive Committee of the Atlanta Section, to continue in office until July 1, 1918.

P. N. Engel was appointed secretary of the Chicago Section, to succeed R. F. Thayer.

George I. Rockwood, chairman, R. G. Williams, secretary, V. P. Edwards, H. P. Fairfield, and F. W. Parks were appointed as the Executive Committee of the Worcester Section, to take office July 1, 1917.

Spring Meeting, 1918. It was voted to accept the invitation of the City of Worcester, Mass., to hold the Spring Meeting, 1918, in that city.

Graphics Committee. H. E. Crampton, representing the American Genetic Association, and Henry H. Norris, representing the Society for the Promotion of Engineering Education, were appointed as members of the Joint Committee on Standards for Graphic Presentation.

Calvin W. Rice,
Secretary.

Past-Presidents in Hawaii

We have now received an account of the visit of Past-Presidents Brashear, Swasey, and Freeman to Hawaii, in connection with their tour of the Orient. The party was entertained by the Hawaiian Engineering Association at a number of affairs. They were met by a committee from the association, consisting of Messrs. W. G. Hall, Mem.Am.Soc.M.E., Carl B. Andrews, R. R. Hind, Mem.Am.Soc.M.E., S. T. Carr, B. F. Howland, J. M. Young, Mem.Am.Soc.M.E., and E. Köpke, Mem.Am.Soc.M.E.

Their stay at the Island is best described in the following letter from Mr. Swasey, just received:

My Dear Mr. Rice:

Our excursion to the Hawaiian Islands was especially interesting, made doubly so by Messrs. B. F. Howland and E. Köpke, who were delegated by the Hawaiian Engineering Society to accompany us.

We first stopped at the Island of Maui, and there visited the Crater of Haleakala (House of the Sun), the largest extinct volcano in the world. The crater is about 7½ miles long; 2½ miles wide, and ½ mile deep. We went by automobile to the Half-way House, about 5,000 ft. in elevation, and Mr. Brashear remained there all night. The rest of us took ponies and went on to the summit. We were fortunate in having a beautiful view, and we remained over night, returning to the Half-way House about noon the next day, and then on down to the sea level.

We also visited one of the most up-to-date sugar refineries on the island, and were given every opportunity to see the most advanced methods and processes for extracting sugar from the cane.

That night we went by boat to Hilo, on the Island of Hawaii, where a special train was awaiting us for a trip along the coast, through interesting sugar plantations, a distance of about 35 miles. Returning to Hilo, we took autos and went to the volcano of Kilauea, about 30 miles distant, and about 4,000 ft. high, which is one of the most wonderful sights of the world. The crater is about 1,200 ft. in diameter, and the lake of fire is about 125 ft. from the top. When I was there about six years ago, it was about 450 ft. from the top. We remained at the Volcano House over night, and thus had a chance to see the crater by night. It is even more wonderful then than by day.

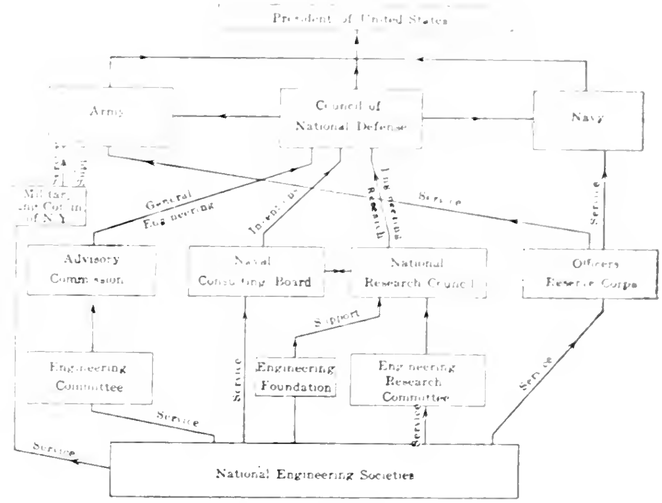
The next morning we returned to Hilo, and then took the boat for Honolulu, arriving there Saturday morning. The whole trip, extending from Monday afternoon until Saturday morning, was extremely interesting, and gave us an opportunity to see something of the wonderful productive possibilities of these rich islands. The ten days we spent in Honolulu and in visiting the various islands were among the most pleasant of our entire trip and I shall ever have happy memories of the good friends who did so much for us while we were there.

Very truly yours,
(Signed) Ambrose Swasey

To add to the distinction of having our three past-presidents at the islands, Mr. Max Toltz, member of the Council of the Society, was also at Honolulu, and he too was the guest of the local engineering association.

Engineers and the Government

Last month we published an account of the agencies through which the membership of the national engineering societies is in contact with the Government in the present emergency. We reproduce herewith a chart which visualizes the relationship of these agencies.



Connections Between the Government and the Engineers

The Military Engineering Committee of New York, shown on the left of the diagram as connecting the societies directly with the Army, is the outcome of the military engineering lectures organized in New York City some twelve months ago in the interest of Preparedness. The committee is organizing a regiment of engineers in the metropolis to be sent to France as soon as equipped.

The members of our Society on this committee are Messrs. Gano Dunn, Alex C. Humphreys, D. S. Jacobus, John W. Lieb, Ralph D. Mershon, Calvin W. Rice, W. L. Saunders, Bradley Stoughton, and W. H. Wiley.

There has also just been organized by President Hollis a Committee of our Society on Military Personnel. This committee will procure and classify information regarding the qualifications of the members, particularly with reference to their ability to serve the country.

Engineers Elected to Academy

The National Academy of Sciences has conferred a distinct honor upon the engineering profession by electing to its membership four engineers: Prof. W. F. Durand, Mem.Am.Soc.M.E., Dr. S. W. Stratton, Mem.Soc.M.E., Dr. Henry M. Howe and Mr. J. J. Carty. The Academy has also conferred upon Dr. Stratton the Public Welfare Medal.

The Academy is not so well known, perhaps, among engineers, but the significance of these elections may be judged from the facts that new members are chosen from the most distinguished men of the United States, and that the Academy is analogous to the Royal Society of London.

The Academy was incorporated in 1863 for the purpose of examining and investigating any subject of science or art and for making reports of special investigations at the call of the United States Government. It has about 150 members and 45 foreign associates, and a number of standing committees, including mathematics, physics and engineering, and weights, measures and coinage.

A new president of the academy has just been elected, Dr. Charles D. Walcott, secretary of the Smithsonian Institution, who succeeds Prof. William H. Welch. Dr. A. A. Michelson has been elected to the vice-presidency to fill the vacancy caused by this election.

The Academy is now in contact with the Government through the National Research Council which was recently appointed at the request of President Wilson. An account of the formation and work of the council was given in the last issue of THE JOURNAL.

Presentation of the John Fritz Medal

The John Fritz Medal, awarded to Dr. Henry Marion Howe, in January of this year, for "his investigations in metallurgy, especially in the metallography of iron and steel," was presented to him in the Auditorium of the Engineering Societies Building, New York, on the evening of Thursday, May 10. A full account of the ceremonies will appear in the July issue of THE JOURNAL.

Patriotic Dinner at Providence

The second annual dinner of the Providence Engineering Society, affiliated with the Am.Soc.M.E., held on the evening of May 2, was characterized as an expression of "rampant patriotism." At the head tables were representatives of Belgium, Canada, France and the United States. Each speaker received his full meed of praise, but it fell to the lot of Capt. M. de Jarny, a French military officer sent to this country after 18 months' service in the trenches to instruct the Harvard training camp, to receive round after round of applause. A few minutes later, Capt. Nathan Horowitz, representing the United States Army, received almost as enthusiastic a reception. Prof. Albert Van Hecke, of the University of Louvain, spoke for Belgium and showed motion pictures of efficiency methods adopted in the refugee camps in Holland, and which had been worked out by himself.

On the stage, behind the speakers' table, was a representation of a bivouac, with stacked rifles, shelter tents, packs and other military equipment. Also in evidence was a new projection machine, given to the society by John R. Freeman, Mem.Am.Soc.M.E.

Mayor Gainer was the first speaker, after R. W. Adams, the vice-president of the society, had presented Col. H. Anthony Dyer as toastmaster. The Mayor welcomed the distinguished guests of the evening.

Captain de Jarny followed, saying in part:

"The United States, the greatest engineering country in the world, is sure to play a great part in the war because it is an engineers' war. Here in Rhode Island, engineering has been developed to a greater extent than in any other part of the country, for it is here that are built those delicate machines, without which we would not have been able to continue the war.

"One of your most important duties is to supply all the Allies with materials, and I feel sure that your work will be well done."

Captain Horowitz declared that the word "engineer" is a synonym for efficiency, and that efficiency must guide every action taken by the citizens of this country, so that all our resources may be used to the best advantage.

President Hollis was also among the speakers and said on behalf of the United States:

"Many of the young men have asked me during the last few weeks how they could do their share. Our country must provide a man for every place, and we must have an agency of the Government to allot the men to the places where they can best serve. We serve best, in this funeral procession on the way to the burial of the divine right of kings, when we fit into the place where we can do the most good."

Professor Van Hecke closed the evening with a vivid portrayal of the part Belgium has played in the war.

Spring Meeting of Boston Section

THE Spring Meeting of the Boston Section of the American Society of Mechanical Engineers was held on Thursday afternoon and evening, May 17, 1917.

It was originally planned to make this a machine-tool meeting, but the crisis in the life of the country made it appear that a staid, theoretical discussion would be rather out of place at the present hour. The program was therefore devoted to one of the most vital subjects in the scheme of National Defense: namely, heavier-than-air flying machines.

In the afternoon the Section, on special train, visited the works of The Burgess Company at Marblehead, Mass., where the visitors were shown about the plant and given very frank and thorough explanations by the engineers of the company.

The Burgess Company was originally started by Mr. Burgess to manufacture, in this country, the Dunn self-stabilizing aeroplane, but is now making aeroplanes for The Curtiss Company, practically exclusively on orders from the Federal Government and units affiliated with it.

The visiting engineers were shown all over the place, and had a chance to inspect, both in their final shapes and in various stages of construction, hydroaeroplanes and land machines of various types. In the water, just ready to start for its altitude test previous to acceptance by the Federal Government, was a huge Dunn-type hydroaeroplane specially built for carrying out experiments with the John Hays Hammond method for the wireless direction of torpedoes. And right by, in the shed, suspended from the ceiling, was what is probably the smallest seaplane in the world, a tiny machine in which every other consideration except safety is sacrificed for speed, and which can develop 95 miles an hour without much trouble.

While the explanations were given by Mr. Russell, Engineer of the Burgess Company, and various questions of the members answered, a big Dunn machine appeared in the air and circled overhead at a speed estimated at about 70 miles an hour. The interesting feature of that particular flight was the fact that, as stated by Mr. Russell, the pilot in it had only three hours of preliminary training.

The evening program comprised the meeting of the Section at Wentworth Institute, Boston, Prof. A. L. Williston, Mem. Am.Soc.M.E., in the chair.

Maj. W. P. Wooten, of the Corps of Engineers, U. S. A., was scheduled to speak, but was prevented through illness, and instead Judge M. J. Murray gave an impassioned talk on national unpreparedness, the conditions which confronted the United States expeditionary force in Mexico, and which confront its military establishment now. In conclusion, he called upon the engineers to stick to their work, but at the same time try to acquire the information which would prove useful to them, if called to actual service.

This address was followed by a talk on Wings for the American Eagle, by W. B. Stout, Chief Engineer, Aircraft Division, Packard Motor Car Company, Detroit. Mr. Stout called attention to the great change which the automobile wrought in the state of mechanical education of the average public. Twenty years ago the average man hardly knew what a monkeywrench was used for, and let his wife oil the sewing machine. At present, there are actually in the country hundreds of thousands of men in various walks of life who can understandingly take care of the rather complicated mechanical and electrical equipment of an automobile. The automobile not only educated the public in the fundamentals of machinery, but also taught alertness to men who were formerly largely dreamers. The aeroplane is going to continue what the automobile began and, in fact, is already teaching its users entirely new conceptions of space and motion. Man is rapidly becoming a real three-dimensional being; and as the speaker expressed it, a new heaven is being opened through the aeroplane, just as a new earth was made by the automobile.

In the course of his address Mr. Stout gave some interesting statistical data on the present aircraft activities in Europe. He stated that aeroplanes are now made to climb steadily at the rate of 1000 ft. per min. and upward and there is in the field a small Italian machine which can climb at an angle of 45 deg. The development of aeroplane construction is so rapid that a new type of aeroplane is created on the average of about every eleven weeks, and it is by no means rare that when a batch of machines come from the factory, on orders placed only three or four months before, the planes are found to be antiquated to such an extent that they are simply burned up without being used at all. The production of machines has reached the impressive figure of 1000 machines a week, and the only real limitation to a still greater production is the problem of the engines.

ROLL OF HONOR

THE Committee on Engineer Officers' Reserve Corps, now the Committee on National Defense, has just issued to the membership two circulars giving instructions to those who contemplate offering their services in the Army and Navy. The Committee requests that those members who apply for appointments in the national service, report this fact to the Society, so that their names may be included in the Roll of Honor and so that the Committee may keep track of the men.

Last month we published the first list of those members of the Society who had enlisted in the national service, and we supplement that with the following names since received:

BARKER, GEORGE S., Coast Artillery, Officers' Reserve Corps.*
BELCHER, P. W., First Lieutenant, Engineer Officers' Reserve Corps.
CATTELL, WILLIAM A., Major, Engineer Officers' Reserve Corps.
CAMPBELL, E. D., Captain, Engineer Officers' Reserve Corps.
CONARD, FREDERICK U., Second Lieutenant, Engineer Officers' Reserve Corps.
CRONEMEYER, HENRY C., Captain, Engineer Officers' Reserve Corps.*
ENNIS, WILLIAM D., Major, Officers' Reserve Corps (Ordnance Dept.).
FARRINGTON, THOMAS H., Captain, Engineer Officers' Reserve Corps.*
FRANCIS, HARRIS S., Lieutenant, Engineer Officers' Reserve Corps.*
GLENN, EDWARD R., First Lieutenant, Engineer Officers' Reserve Corps.*
HARRIS, MURRAY W., Ordnance Dept., Officers' Reserve Corps.*
HECHLER, F. G., Mechanical Engineer, United States Naval Engineering Experiment Station, Annapolis, Md.
HILL, EDWARD L., Captain, Engineer Officers' Reserve Corps.*
HOBART, J. C., Jr., First Lieutenant, Engineer Officers' Reserve Corps.*
HOLCOMBE, AMASA M., Captain, Officers' Reserve Corps.
HULBURT, WYNNE D., Second Lieutenant, Engineer Officers' Reserve Corps.*
JONES, REID, Captain, Engineer Officers' Reserve Corps.*
LACY, ROBERT, Captain, Engineer Officers' Reserve Corps.*
LEISTNER, AUGUST, First Lieutenant, Engineer Officers' Reserve Corps.*
LONN, J. M., Reserve Officer, Engineer Officers' Reserve Corps.*
McNEAL, D. RAYMOND, Engineer Officers' Reserve Corps.*
MERKT, THEO. B. J., Ordnance Dept., Officers' Reserve Corps.*
MULLER, RAYMOND W., Mechanical Engineer, Engineer Officers' Reserve Corps.*
RATHJENS, GEORGE W., Captain, Engineer Officers' Reserve Corps.
RHYS, C. O., Captain, Engineer Officers' Reserve Corps.*
ROSS, HENRY B., First Lieutenant, Engineer Officers' Reserve Corps.*
STREETER, ROBERT L., Major, Officers' Reserve Corps.*
STUART, THOMAS E., Central Department, Engineer Officers' Reserve Corps.*
TAYLOR, CHARLES F., First Artillery, Officers' Reserve Corps.
THORNHILL, THEODORE W., First Lieutenant, Engineer Officers' Reserve Corps.*
TRIMMER, JAMES W., Ensign (Engineer), U.S.N.R.F., Class 2.
VAN VALKENBURGH, MERRITT, Ordnance Dept., Officers' Reserve Corps.*
WEINBERG, GEORGE S., Major, Engineer Officers' Reserve Corps.*
WIEBER, GEORGE A., Second Lieutenant, Officers' Reserve Corps.*
WILBER, DANA W., Captain, Engineer Officers' Reserve Corps.
YODER, THOMAS M., Captain, Officers' Reserve Corps.

Coöperation with Bureau of Mines

The Society's Standing Committee on Research has been appointed a Special Advisory Committee of the U. S. Bureau of Mines, and the following Sub-Committees have also been appointed to coöperate with the Bureau:

Sub-Committee on Mining Equipment:

FREDERICK K. COPELAND, *Chairman*, President, Sullivan Machinery Company, 122 S. Michigan Ave., Chicago, Ill.

FRANK H. ARMSTRONG, Mechanical Engineer, Penn Iron Mining Company, Republic Iron Company, Vulcan, Michigan.

DOUGLAS BUNTING, Chief Engineer, Lehigh & Wilkes-Barre Coal Co., Wilkes-Barre, Pa.

Sub-Committee on Fuels:

CHARLES RUSS RICHARDS, Professor of Mechanical Engineering, University of Illinois, Urbana, Illinois.

JOSEPH HARRINGTON, Advisory Combustion Engineer, 208 S. La Salle St., Chicago, Illinois.

CHARLES J. BACON, Engineering Department, E. I. du Pont de Nemours & Co., Wilmington, Delaware.

Our Members and National Service

The members of this Society, in common with those of the three other Founder Societies, received during the past month from the Joint Engineer Committee on National Defense, formerly the Joint Committee on Engineer Reserve Corps, two pamphlets instructing them how best to apply for service in the military and naval forces of the United States.

Reviewing the pamphlet describing the Army service, it appears that the general place for the members of our Society is as officers in the Ordnance Department of the Officers' Reserve Corps, as the following extracts show:

ORDNANCE DEPARTMENT

Officers of the Ordnance Department of the Army are mechanical engineers especially trained for the production of war munitions. The Department offers one of the best fields in which mechanical engineers can serve as reserve Ordnance officers in the Officers'

* Acceptance of commission pending at date of latest list from War Department.

[illegible] engineers, chemists and [illegible] expert assistance to the Depart- [illegible] may therefore be of [illegible]

[illegible] definite form, it is [illegible] divided into groups, [illegible] particular arsenal which [illegible] that group, to which [illegible] during the active period [illegible]

[illegible] is charged with the duty of procuring [illegible] and distributing the necessary ord- [illegible] the Army and the Organized M[illegible] establishes and maintains arsenals [illegible] and safekeeping.

[illegible] include cannon and artillery [illegible] as the great guns used in the sea- [illegible] with their carriages, as well as the lighter guns [illegible] artillery; apparatus and machines for the [illegible] of artillery; small arms, ammunition, and [illegible] equipments and harness for the artillery, and [illegible] for cavalry and for all mounted men except those of the Quartermaster Corps; tools, machinery, and materials for the ordnance service; and all property of whatever nature supplied to the military establishment by the Ordnance Department.

The duties of Ordnance officers are generally those connected with the direction, management, control and supervision of the work of manufacture, test and repair of ordnance and ordnance stores at manufacturing arsenals and depots, with the issuing and receiving of such supplies and with the inspection and test of such materials when purchased by contract.

Applicants for the Officers' Reserve Corps, Ordnance Section, desiring technical duty should have both a theoretical and practical knowledge of steam boilers, engines, shop tools, including the handling of such tools; electricity and electrical machines, particularly dynamos and motors; and experience in the manufacture of articles composed of steel, of wood, and of leather.

They should have had practical experience in the management of shops and the handling of employees. Their experience should also be such as to enable them to take up the work of inspection of all classes of ordnance stores if manufactured by private concerns under contract, to insure that such materials are of standard design and workmanship and in accordance with Ordnance Department drawings and specifications.

Full information regarding the Corps, may be obtained from the Adjutant General, United States Army, Washington, D. C., as the pamphlet states.

The booklet describing service in the Navy states that members of the engineering societies are probably best fitted to serve in the Naval Coast Defense Reserve, full particulars of which are given in a pamphlet entitled Circular Relating to Enrollment in the Naval Coast Defense Reserve, to be obtained by addressing the Commandant of any Naval District.

The U. S. Bureau of Mines, in coöperation with the American Institute of Mining Engineers and the American Chemical Society, has undertaken a census of mining engineers, metallurgists and chemists with a view of ascertaining the qualifications of each and the line of work in which each can be of the most service to the country in time of emergency. The classification will embrace 27 specific groups of industrial chemists, 16 groups of engineering specialists, and 15 groups in the metallurgical field. By such minute classification the bureau will be in a position to furnish on short notice the names of specialists for service under the classification, so that in case of necessity these technical men can be available to industrial plans where they would be of most assistance to the country. European experience has shown that nothing is more important in time of national emergency than a knowledge of the qualifications and experience of expert technical men.

Request for January Issues

The demands for copies of the January 1917 issue of THE JOURNAL, which contains a full account of the 37th Annual Meeting, have now exceeded the supply, and this issue is temporarily out of stock. Requests for copies are still being made, however, and members who do not desire to preserve permanently their copy of the January JOURNAL are requested to return it to the Secretary, who will remit postage and cost to them.

Commission on Gunmounts

The following is the personnel of the Commission to determine the style on gunmounts for the U. S. Army: Gen. Joseph E. Kuhn (of the Line), President of the War College; Col. Charles B. Wheeler from the Ordnance Department, formerly head of the Watertown Arsenal; two representatives of the Coast Artillery, Major John W. Gulick from Fortress Monroe and Capt. Walter R. Wilson; representative from the Navy, Capt. Charles P. Plunkett; the two civilian appointees from the Am.Soc.M.E., Dr. Ira N. Hollis and Dr. D. S. Jacobus.

In an editorial under date of April 12, 1917, the *Iron Age* discusses the utilization of slags from steel-making processes. From statistics adduced it appears that each year in the United States over 2,000,000 tons of basic slag is obtained from basic open-hearth steel furnaces, and in this slag is contained not less than 111,000 tons of oxide of manganese.

The loss is estimated by one producer to amount to $8 per car for each car dumped, or a total loss of $320,000 per year if all the country's basic slag is discarded; and when it is recalled that the railroads now charge for removing all slags this matter becomes still more serious. The value of acid slag is much less.

The utilization of slag in blast-furnace burdens appears to be promising, but the writer does not think much of the use of slag as a source of metallic manganese or substitute for ferromanganese.

Lawrence V. Benet, Mem.Am.Soc.M.E., vice-president of the Société Anonyme des anciens Etablissements Hotchkiss & Cie., Paris, France, is coming to this country as the representative of the American Chamber of Commerce in Paris, of which he is president. He is accompanying M. André Tardieu, the newly appointed French High Commissioner to the United States, who has gathered elaborate statistics of the requirements of France for presenting detail information to the American authorities. M. Benet is the Paris representative of our Special Committee on International Standard Pipe Threads.

Construction of a new building for the Engineers' Club, Dayton, Ohio, will be begun shortly and is expected to be finished by January 1. It will cost about $170,000, of which $130,000 is for the building alone. It will be two stories high, with basement, of Georgian design, of buff gray brick and with carved stone trimmings.

Oil engines working at high altitudes cannot develop the same power as at sea level owing to the smaller weight of oxygen contained in the cylinder.

The Use of Bessemer Steel Boiler Tubes as a Substitute for Tubes of Open-hearth Steel as Required by the A. S. M. E. Boiler Code

As a result of the unprecedented demand for steel and its present scarcity, efforts have been made to provide for the use of boiler tubes manufactured of bessemer steel in place of the open-hearth steel tubes as required by the A.S.M.E. Boiler Code. The National Tube Company, in a letter addressed to the trade early in March, requested that wherever possible bessemer steel tubes be used in place of those made of open-hearth steel in order to relieve the pressure of demand upon this latter material. It was pointed out in this letter that the present industrial situation has led to a demand for tubes of the open-hearth material which had grown to such an extent that the company was nearly two years behind in its orders, and the use of bessemer steel was suggested as a means of relief.

The impression was given that this was an attempt to replace the material required by the Boiler Code by an inferior material. The matter was brought before the Council of the Society at a meeting on March 16, with the result that a Committee was appointed to confer with the National Tube Company. This Committee consisted of the following members:

Ira N. Hollis, President, American Society of Mechanical Engineers.

Charles S. Blake, Hartford Steam Boiler Inspection & Insurance Co.

J. B. Ennis, American Locomotive Co.

E. R. Fish, Heine Safety Boiler Co.

F. R. Hutton, American Museum of Safety (Member of Council).

Julian Kennedy, Member of Council.

Frank E. Law, The Fidelity & Casualty Co.

J. W. Lieb, National Electric Light Assn.

Geo. A. Orrok, National Electric Light Assn.

W. M. McFarland, Babcock & Wilcox Co.

H. deB. Parsons, Consulting Engineer (Member of Council).

James Partington, American Locomotive Co.

H. V. Wille, Baldwin Locomotive Works.

Dr. Hollis appointed Mr. H. deB. Parsons Chairman of the Committee.

Meetings were held by this Council Committee in conference with officials of the National Tube Company in which the entire situation was thoroughly canvassed and efforts were made to outline a proper solution of the problem. The Council Committee pointed out the unquestionable advantages of open-hearth steel as compared with bessemer steel for use in boiler tubes, and urged upon the Company the necessity of exerting its greatest effort to cope with the situation. Inasmuch as the National Tube Company had been instrumental in assisting to develop the present boiler-tube specifications contained in the Code, and as these specifications had been found to work out satisfactorily, it was felt that to abandon the requirement of open-hearth steel would be a retrograde movement. The officials of the National Tube Company explained that this suggestion was merely an effort on their part to point out a means of relief for those cases where it could be taken advantage of without conflicting with rules or requirements based on the A.S.M.E. Code. This statement was supplemented by one to the effect that efforts were being made to rush to completion additional open-hearth-steel furnaces which would undoubtedly be in operation in the middle of the summer and which would then greatly increase the open-hearth-tube-producing capacity of their works. It was further stated that the tube-manufacturing capacity of the Company was far in excess of the capacity of their sources of material supply.

The result of the conferences was a thorough understanding between the National Tube Company and the Council Committee relative to the situation. Assurances were given that there was no intent to sell tubes of bessemer material with the claim that they conform to the specifications of the A.S.M.E. Boiler Code, and a circular letter was drafted by the National Tube Company to be sent out by its branch offices to counteract any erroneous impression that may have been given. The letter was submitted to the Council Committee and with slight modifications it was agreed to by the Committee and was finally approved by the Council in the following form:

National Tube Company
Pittsburgh, Pa.

April 16, 1917.

Circular Letter No. 857

To Manager of Sales.

Gentlemen:

As you are aware, about four years ago we decided to in future manufacture all of our boiler tubes from open hearth steel. This action was taken because our experience had taught us that for locomotive boilers and for water tube boilers the open hearth steel tube was better than the Bessemer steel tube. For fire tube boilers we have never had any experience that leads us to believe one is any better than the other, but in order that our output might be satisfactory for all purposes we decided to make all tubes from open hearth steel. Later on a code was prepared by The American Society of Mechanical Engineers covering this whole question both as to material and gage. We gave our hearty coöperation to this Society to bring about the change which they proposed, and we have been coöperating with them in the various states so that this code should be the universal code throughout the United States, it being our firm conviction that boilers with all their appurtenances made under the code of that Society are preferable to those made under any other code heretofore in use. A situation has now arisen due to the war in Europe that has made it impossible for us to secure enough open hearth steel for this purpose, and we are pressed as never before for delivery of tubes. Up to the present moment we have endeavored to supply ourselves with enough open hearth steel to fill our orders for locomotive tubes and for tubes for water tube boilers, and have succeeded fairly well. We have been obliged, however, to ask many of our customers, who insisted upon deliveries that we could not make if we depended upon open hearth steel, to accept tubes made from Bessemer steel so that we could give the greatest possible service in enlarging the power of the country. The information regarding our desire to supply Bessemer steel tubes where the customer would agree to it has not been conveyed generally in the same manner, and an impression has gotten abroad that we are endeavoring to avoid the code of the A.S.M.E. and is causing us some embarrassment as well as the members of that Society. I wish therefore that you would issue this letter verbatim in circular form to your customers, one and all, that each may understand the situation just as it is. If they do, we feel quite sure that, where they are not called upon to supply boilers in accordance with the A.S.M.E. Code, they would readily agree to accept Bessemer, and if they do it will enable us, until we can supply ourselves with a full amount of open hearth steel, to run our furnaces full and for the general good. Just when we will be able to go back fully to the use of open hearth in the manufacture of boiler tubes I am unable at this writing to say, but we are rushing the construction of some additional open hearth furnaces and if nothing unforeseen occurs we expect by July to be able to supply our requirements, and if so we shall do so because we believe it altogether the best practice.

Yours truly,

1st Vice-President.

WILLIAM LODGE

WILLIAM LODGE, President of the Lodge & Shipley Machine Tool Company, of Cincinnati, Ohio, passed away at his home on Monday, April 30. His death was sudden and came as a great surprise to his many friends, since less than a week before he was in attendance at the annual convention of the National Metal Trades Association in New York City, where as usual he was one of the leading spirits.

Mr. Lodge was born in Leeds, England, in 1848, the son of George Lodge, a skilled mechanic in the textile industry. He had the advantages of what we call a common school education. After serving his apprenticeship in the shops of Fairbairn & Company, Leeds, he came to Philadelphia, where he worked for Chambers Brothers from 1869 to 1872, making paper-folding machinery. He came to Cincinnati in 1872 and worked for Steptoe, McFarlan, Nottingham & Co. for eight years, first as a journeyman machinist and later as a foreman. Having saved $1,000, he formed a partnership with William Barker, under the title of Lodge & Barker, at Fifth street at the junction of the C. H. & D. tracks, and they started in business the first day of January, 1880. Associated with them for a short time was Mr. Bechle, another Steptoe workman. Their first task was to true up a few second-hand machines which they had bought, and since they had no one in their employ, they were obliged both to secure their own orders and to execute them. Part of this first business was making some opening dies for Powell and a small turret lathe for the Lunkenheimer Company. The latter immediately ordered three more, and during the following year eighteen lathes were made and sold. Beginning with $1,000, the business inventoried at the end of the first year $7,000; at the end of the second year $32,000; and at the end of ten years $400,000. Fifteen months after starting they employed 75 men. There is little doubt that this rapid success induced quite a number of the better and more ambitious mechanics in Cincinnati to take up similar work. Mr. Lodge was well known among the mechanics of the city and had been president of their union. If one of their number could build up a successful business, why could they not do the same? Some of the best known of the Cincinnati tool-building firms were established during the few years after Mr. Lodge's start.

Wm Lodge

In 1886 Mr. Barker sold his interest to Charles Davis. Lodge and Davis continued in partnership until 1892, when Mr. Lodge severed his connection with the firm and it later became the American Tool Works. They were employing at that time between 300 and 400 men. Mr. Lodge, in March, 1892, organized the Ohio Machine Tool Company, and in August, 1892, became associated with Murray Shipley, forming the present The Lodge & Shipley Machine Tool Company.

Mr. Lodge's first export order was received in 1889. Alfred Herbert, who had just started in Coventry, sent an inquiry in regard to drill presses to Cincinnati, which was forwarded to Mr. Lodge in London. Mr. Lodge went down to see him and asked whether the inquiry was for the purposes of information or for purchase. Mr. Herbert said that if Lodge had a better machine he would buy. Mr. Lodge asked to see his machine and after a little hesitation he was taken out into the shop. The first machine he saw was a planer. He said he could save thirty per cent on the work as it was being done, and would sell them a machine which would do it for £100. He was told that the planer they were looking at cost only £65, and replied that that was all it was worth. He spent several hours in the shop and left the plant not only with an order but with the check in payment thereof. This was the beginning of a large export business.

While the firm was Lodge & Davis, it built lathes, planers and drill presses. Mr. Lodge wanted to manufacture rather than build, and to specialize upon lathes. Mr. Davis, who was a business man, wanted a complete line of tools, as he saw the opportunity of selling other machines with the lathes. This led to the policy of concentrating upon the manufacture of engine lathes, and placing orders for other types of tools with mechanics just starting up, or with workmen from their own plant whom they helped to start in business. For instance, to Smith & Mills, who had been foremen with John Steptoe and had started making set screws and cap screws, they gave an order for 300 shapers. To R. K. LeBlond, who had served his apprenticeship with Brown & Sharpe Manufacturing Co., and had come to Cincinnati to make printers' machinery and supplies, Lodge & Davis gave a large order for slide-rests. To William Owen, one of their workmen, they gave an order for Fox monitors. Owen went into partnership with Philip Montanus and started the Springfield Machine Tool Company, and Lodge & Shipley bought their entire product for eight years. Through Mr. Lodge's influence, Frank Kempsmith came from Warner & Swasey as one of the partners in this firm. He afterwards moved to

Milwaukee and started the Kempsmith Manufacturing Company.

Mr. Lodge had, during his apprenticeship in the shops of Fairbairn & Co., where specialization of manufacture was carried out to a marked degree, completely absorbed the idea of the manufacture of machinery in large lots. He was particularly well known for the fact that he was one of the first, if not the first, to specialize in the manufacture of one type of machine tool only, instead of making a few of many kinds of machine tools.

Some of the firms whose principals have in one way or another been associated with Mr. Lodge are the Fosdick Machine Tool Company, Boye & Emmes Machine Tool Company, Dreses, Mueller and Company and the Cincinnati [illegible] Company.

Mr. Lodge was a member of The American Society of Mechanical Engineers for 27 years, was a member of the Engineers' Club of Cincinnati, the Machinery Club of New York, the Ohio Manufacturers' Association and various other organizations; and was especially active in the National Metal Trades Association, of which he was treasurer for [illegible] years. He was one of the organizers of the National Machine Tool Builders' Association and served as its president for [illegible] years.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER JULY 10, 1917

THE American Society of Mechanical Engineers is an organization for mutual service of over 7800 engineers and associates coöperating with engineers. The membership of the Society comprises Honorary Members, Members, Associates, Associate-Members and Juniors, all elected by ballot of the Council. Application for membership is made on a regular form furnished by the Secretary which provides for a statement of the standing and professional experience of the applicant and requires references from voting members personally acquainted with the applicant. The requirements for admission to the various grades will be furnished upon request.

Below is the list of candidates who have filed applications for membership since the date of the last issue of The Journal. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate-Member or Junior, and those in the third under Junior grade only. Applications for change of grading are also posted.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by July 10, 1917, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about August 15, 1917.

NOTE. The Council desires to [illegible] upon applicants for membership that under the present national conditions the procedure of election of members may be somewhat slower than under normal conditions. The first step in the consideration of an application is taken by the Membership Committee and this committee is composed of [illegible] fewer opportunities to meet together in these strenuous times.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE [illegible]

California

HANSON, FRED P., Shop Superintendent and Engineer
American Gold Dredging Co., [illegible]

KEY, JAMES F., President,
Key Adding Machine Co., Los Angeles

KILGORE, EDWIN R., Division Superintendent Pipe Line Department,
Standard Oil Co., Patterson

LAMPMAN, JAY B., Assistant General Sales Manager,
Worthington Pump & Machinery Corp., Los Angeles

ROLPH, GEORGE M., General Manager,
California & Hawaiian Sugar Refining [illegible], San Francisco

Colorado

SALISBURY, ROYAL D., Consulting Engineer, Denver

Connecticut

ANDERSON, ROBERT E., Production [illegible],
Winchester Repeating Arms Co., New Haven

BLAKESLEE, RUSSELL C., Mechanical Superintendent,
Chase Metal Works, Waterbury

DART, HARRY E., Superintendent Engineering Department,
The Hartford Steam Boiler Inspection & Insurance Co., Hartford

HENDERSON, GEORGE A., [illegible] Machine Shop,
Winchester Repeating Arms [illegible], New Haven

KANN, H. E. ARTHUR, [illegible],
Winchester Repeating Arms [illegible], New Haven

Georgia

KLEIN, EDWARD W., Heating Engineer,
Bishop Babcock Becker C[illegible], Atlanta

Illinois

McELROY, JOSEPH W., [illegible] Engineer,
Westinghouse Elec. & Mfg. Co., Chicago

NOLTE, CHARLES B., Mechanical Engineer,
Robert W. Hunt & Co., Chicago

SAVERY, THOMAS H., JR., Consulting Engineer, Chicago

SHIELDS, HARRY C., Western Sales Engineer,
[illegible] Engineering Co., Chicago

WEBER, FRANK E., Industrial Engineer, Chicago

Indiana

GRIMES, [illegible] L., Engineer and Superintendent,
Johnson & Miller [illegible], Terre Haute

Kentucky

HOUSTON, HERMAN M., Secretary and Treasurer,
The Houston Stanwood & Gamble Co., [illegible]

Louisiana

MOODY, HOWARD N., [illegible] Engineer, New Orleans

Massachusetts

CHAPMAN, ALBERT P., Superintendent Power and Repairs,
Ludlow Mfg. Associates, Ludlow

HEALD, JAMES N., Treasurer and General Manager,
The Heald Machine Co., Worcester

MARTIN, GEORGE R., Assistant General Manager,
American Steam Gauge & Valve Mfg. Co., Boston

Michigan

HEWITT, RICHARD D., Secretary-Manager,
General Fire Extinguisher Co., Detroit

MEDHURST, ARTHUR W., Assistant General Factory Manager and Mechanical Engineer,
Anderson Electric Car Co., Detroit

SQUIRES, [illegible], Consulting Engineer,
Signal Motor Truck Co., Detroit

Minnesota

EMERSON, George H., General Manager,
Great Northern Railway Co., St. Paul

Missouri

BATEMAN, Paul, Assistant Chief Estimator,
American Car & Fdy. Co., St. Louis

LILJEGREN, Gunnar O., Manager Sprinkler Department,
Urbauer Atwood Heating Co., St. Louis

New Hampshire

FLATHER, Ernest J., President and Treasurer,
E. J. Flather Mfg. Co., Nashua

TILTON, Henry B., Superintendent and Works Manager,
Morley Button Mfg. Co., Portsmouth

New Jersey

ACKERMAN, Albert A., Jr., Chief Draftsman,
The Singer Manufacturing Co., Elizabethport

BROWN, Albert F., Engineering Assistant, Mechanical Dept.,
Public Service Elec. Co., Newark

BURDICK, Herbert, Designing Engineer, Chief Draftsman,
DeCamp & Sloan, Inc., Newark

HOWARD, Arthur E., Manager Rate Service Dept.,
T. A. Edison Affiliated Interests, Orange

MUSSO, Alfred, Factory Consulting Engineer,
Edison Battery Co., Orange

PATTERSON, Edgar H., Assistant to Chief Engineer,
New York Shipbuilding Corp., Camden

New York

CHAMBERLAIN, William T., Chief Draftsman,
Standard Aniline Products, Inc., Wappingers Falls

HALL, Charles R., Manager Mechanical Sales Dept.,
Diamond Rubber Co., New York

LAENCHER, Frederick W., Chief Engineer,
W. C. Ritchie & Co., Brooklyn

LOCKWOOD, Marquis H., Mechanical Expert and Patent
Attorney, New York

MANNING, James H., Superintendent Motive Power,
The Delaware & Hudson Co., Watervliet

MULCARE, James J., Assistant Engineer in Charge Drafting
Dept., General Electric Co., Schenectady

QUIRK, Clinton H., Engineer,
Howard & Morse, New York

ROBINSON, Thomas R., Engineer,
W. S. Barstow & Co., Inc., New York

ROWLAND, George R., Supervising Engineer, Lubricating Div.,
The Texas Co., New York

STAFFORD, Hal R., Mechanical Engineer,
Economy Devices Corp., New York

STRATTON, David V., Production Manager,
Pyrene Manufacturing Co., New York

North Carolina

STATES, Louis A., Consulting Engineer, Gastonia

Ohio

CORDON, Byron B., Scale Inspector,
Pennsylvania Lines West, Columbus

SHIPLEY, Murray, Vice-President and Secretary,
The Ledge & Shipley Mch. Tool Co., Cincinnati

SNYDER, Herbert W., Assistant to Vice-President,
Lima Locomotive Works, Inc., Lima

Pennsylvania

BOYD, Frank F., Consulting Engineer,
Ballinger & Perrot, Philadelphia

CHURCH, Arthur L., Assistant to President,
The Baldwin Locomotive Works, Philadelphia

HAARBYE, Storm B., Assistant Engineer,
American Sheet & Tin Plate Co., Pittsburgh

JAMES, Richard L., Constructor,
The United Gas Improvement Co., Philadelphia

KENYON, John T., Consulting Rifle Expert,
Remington Arms Co., Delaware, Eddystone

LAWRENCE, John S., Manufacturing Superintendent, Erie Works,
General Electric Co., Erie

LINNING, Frank, Works Manager,
Tacony Steel Co., Tacony

MAHONEY, Joseph N., Engineer with
Westinghouse Elec. & Manufacturing Co., Pittsburgh

RASCHE, Charles M., Superintendent Toolroom,
Remington Arms Co. of Del., Eddystone

SELKIRK, William M., Chief Engineer,
Pittsburgh Steel Products Co., Monessen

STETSON, John B., Jr., President,
Defiance Manufacturing Co., Philadelphia

Utah

LEDDELL, William A., Engineer,
United States Smelting, Refining & Mining Co., Salt Lake City

Virginia

MAST, Frank H., President & Treasurer,
Atlantic Iron Works, Inc., Norfolk

Vermont

LOVEJOY, Fred P., President,
Lovejoy Tool Co., Inc., Springfield

Wisconsin

CORWIN, Lloyd A., Efficiency Engineer,
Four Wheel Drive Auto Co., Clintonville

Canada

MACDOUGALL, George D., Chief Engineer,
Dominion Iron & Steel Co., Sydney, N. S.

MELDRUM, Malcolm R., General Manager,
The Herbert Morris Crane & Hoist Co., Ltd., Toronto

PAIGE, James F., General Manager,
Port Arthur Shipbuilding Co., Ltd., Port Arthur, Ont.

Hawaii

RAMSAY, William A., Manager,
Catton, Neill & Co., Ltd., Honolulu

FOR CONSIDERATION AS ASSSOCIATE MEMBER OR JUNIOR

California

GUHA, Kamini K., Student, University of California, Berkeley

KASPAR, Joseph J., Structural Engineer,
Llewellyn Iron Works, Torrance

Connecticut

BANKS, Frederick R., Engineer of Equipment (Commercial
Division) Remington Arms,
U. M. C. Co., Bridgeport

Illinois

CHEYNEY, Charles C., Engineer and Manager Chicago Office,
Buffalo Forge Co.,
Carrier Air Conditioning Co., Chicago

MILLER, Ewell B., Department Head,
Western Electric Co., Inc., Hawthorne

Massachusetts

BLAKELEY, Gerald W., Power Specialties Engineer,
H. W. Johns-Manville Co., Boston

BROUILLETTE, Albert V., Engineer,
New England Westinghouse Co., Chicopee Falls

GREENWOOD, Talma T., Patent Solicitor,
With B. J. Noyes, Boston

HART, Leon A., Industrial Engineer,
N. E. Westinghouse Co., Chicopee Falls

STRICKLAND, Frank S., Rate Department,
N. E. Westinghouse Co., Springfield

Missouri

AYCOCK, Robert V., Proprietor,
R. V. Aycock & Co., Kansas City

DOLL, William E., Engineering Salesman,
Henry R. Worthington, St. Louis

New Jersey

DRAKE, Charles L., Sales Engineer,
S. K. F. Ball Bearing Co., Newark

HOPKINS, George J., Mechanical and Industrial Engineer,
The Celluloid Co., Newark

MEHR, Joseph, Fuel Inspector,
Public Service Electric Co., Newark

Nevada

GIGNOUX, Frank C., Master Mechanic,
Seven Troughs Coalition Mining Co., Seven Troughs

MARTIN, Henry, Jr., Assistant Professor Mechanical Engineering,
University of Nevada, Reno

New Mexico

HARLEY, George T., Efficiency Engineer,
Burro Mt. Copper Co., Tyrone

New York

BRAYTON, Harold M., Student Mechanical Engineering,
Mass. Inst. Tech., Syracuse

CLENDON, George W., Mechanical Engineer,
Locomotive Pulverized Fuel Co., New York

DEXTER, Harris E., Resident Managing Engineer,
Sprague Electric Section Ind. Control Dept., General Electric
Co., Schenectady

MINICH, Henry D., Consulting Engineer, Troy

REYNOLDS, George B., Industrial Engineer,
Eastman Kodak Co., Rochester

SAXBY, Lewis E., Mechanical and Electrical Engineer,
Standard Oil Co. of N. J., New York

SCHWARTZ, Ernest, Assistant Chief Draftsman,
McGraw-Hill Publishing Co., Inc., New York

SMITH, Albert C., Jr., Draftsman,
Combustion Engineering Corp., New York

STITZER, Arthur B., Chief Engineer,
Republic Railway & Light Co., New York

Ohio

BOWMAN, ROBERT B., Factory Representative, The White Co., Cleveland

Pennsylvania

CURLY, RAYMOND E., Superintendent Artillery Case Shop and Mechanical Engineer, Frankford Arsenal, Frankford

PRITCHETT, CARL E., Heating and Ventilating Engineer, Westinghouse Elec. & Mfg. Co., E. Pittsburgh

Texas

TOMPKINS, H. K. V., Chief Engineer, Texas Gas & Electric Co., Houston

Wisconsin

WOLLENSAK, H. P., Sales Engineer, Wisconsin Motor Mfg. Co. Milwaukee

Wyoming

SQUIRES, JESSE C., Mechanical Engineer, Wyoming Electric Co., Casper

FOR CONSIDERATION AS JUNIOR

Alabama

BOYD, WALTER R., with Worthington Pump & Machinery Corp., Birmingham

California

MOORHEAD, ARCHIBALD C., Engineering Corp., Richmond Refinery, Standard Oil Co. of Cal., Richmond

Connecticut

PETERSON, JOHN W., Tool and Machine Designer, The Harris Engineering Co., Bridgeport

SHELDON, JAMES R., JR., Apprentice in Mech. Engrg., Waterbury Clock Co., Waterbury

TAYLOR, EDWARD N., With Winchester Repeating Arms Co., New Haven

Cuba

GIANELLONI, VIVIAN J., General Superintendent, Central Florida, Compania Azucarera, Florida, Camaguey

Illinois

COOPER, HOWARD, Lubrication Engineer, The Texas Co., Chicago

PLOCINSKY, ABE J., Student, Armour Institute of Technology, Chicago

REYMOND, MARTIN H., with Western Electric Co., Chicago

VANDEN BOOM, BERRY C., Installation Sales, The Prest-O-Lite Co., Inc., Chicago

Indiana

LONN, JULIUS M., Mechanical Engineer, Great Western Mfg. Co., La Porte

Maine

TUTTLE, GEORGE W., Assistant Mechanical Superintendent, Eastern Mfg. Co., Lincoln

Massachusetts

BOSNIAN, LUTHER H., Assistant to Consulting Engineer, New England Westinghouse Co., Springfield

BROWN, WILLIS C., Engineer-Salesman, The Foxboro Co. Inc., Foxboro

CLAUSSEN, HOWARD P., with Bemis Bro. Bag Co., Boston

COLE, RAYMOND A., Designer, New England Westinghouse Co., Springfield

DROBISCH, RAYMOND W., Student Mechanical Engineering, Massachusetts Institute of Technology, Boston

Missouri

BENJAMIN R., Sales Engineer, McQuay-Norris Mfg. Co., St. Louis

Nebraska

GEORGE, VINCENT C., Private Electric Wiring Business, Seward

New Jersey

FLETCHER, ANDREW JR., with The W. & A. Fletcher Co., Hoboken

SMITH, ALBERT K., Assistant Chief Draftsman, Westinghouse Lamp Co., Bloomfield

WADE, ALFRED D., Efficiency Engineer, Schwarzenbach-Huber Co., West Hoboken

New York

BASSETT, CHARLES K., Secretary, Buffalo Meter Co., Buffalo

BASSETT, ROBERT S., Treasurer, Buffalo Meter Co., Buffalo

CHURCH, F. O., Mechanical Engineer, Hill & Ferguson, Cons. Engrs., New York

DRESSLER, L. RICHARD, Inspector, American Arch Co., New York

HILL, MAXWELL H., Machine Designer and Draftsman, Camera Works, Eastman Kodak Co., Rochester

KRAUSE, WILLIAM A., Laboratorian, Navy Yard, Brooklyn

LIPTAY, JOHN M., Mechanical Engineer, They Kny-Scheerer Corp., New York

MACNABB, CLIFTON E., Sales Engineer, Worthington Pump & Machinery Corp., New York

MEYLER, ROBERT G., Instructor in Industrial Engineering, Cornell University, Ithaca

MURPHY, EDWARD S., Draftsman, Honolulu Iron Works Co., New York

SMITH, RAYMOND P., Student, Otis Elevator Co., Yonkers

WARDROP, GEORGE D., Editor, Aerial Age Weekly, Aerial Age Co. Inc., New York

WARNER, DOUGLAS K., Graduate Student, Sheffield Scientific School, Yale University, Brooklyn

Ohio

JAYNES, LUTHER L., Chief Clerk, Whitaker-Glessner Steel Co., Portsmouth

Pennsylvania

ADDLEMAN, CLARENCE L., Mechanical Draftsman, H. Koppers Co., Pittsburgh

JARRETT, HILLARD W., Instructor, Mechanics & Materials of Construction, Pennsylvania State College, State College

KELLER, JOHN O., Instructor in Industrial Engineering, Pennsylvania State College, State College

MALONEY, CHARLES A., Power Plant Efficiency Engineer, United Gas Improvement Co., Philadelphia

WILLIAMS, GEORGE B., Designer for United Engineering & Foundry Co., Pittsburgh

Rhode Island

NAUMBURG, ROBERT E., Efficiency Engineer, Revere Rubber Co., Providence

Texas

DORRANCE, GEORGE W., Mechanical Engineer, The Texas Co., Port Arthur

Vermont

STUART, H. HOWLAND, Assistant to Factory Superintendent, E. & F. Fairbanks & Co., St. Johnsbury

Wisconsin

JACKLIN, HAROLD M., Instructor in Engineering, University of Wisconsin, Madison

Philippine Islands

FAYMONVILLE, PHILIP R., First Lieutenant, Ordnance Department, U. S. Army, Manila

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

New York

TRABOLD, FRANK W., Works Manager, J. H. Williams & Co., Brooklyn

PROMOTION FROM ASSOCIATE-MEMBER

Massachusetts

MURRAY, ARTHUR F., Mechanical Engineer, N. E. Westinghouse Co., Springfield

Ohio

QUAYLE LEROY A., Chief Mechanical Engineer, Dept. of Public Utilities, Div. of Water, Cleveland

PROMOTION FROM JUNIOR

Connecticut

PLEASONTON, FRANK R., Chief Engineer, The Remington Arms, U. M. C. Co. Inc., Bridgeport

Michigan

HINKLEY, CARL C., Works Manager and Chief Engineer, Chalmers Motor Co., Detroit

New Jersey

GIELE, WALTER S., Mechanical Engineer, Palmyra

New York

CHALMERS, JOHN B., Instructor Steam and Applied Mechanics, Pratt Institute, Brooklyn

LYMAN, ELIHU R., Assistant Works Manager, Dexter Folder Co., Pearl River

MERRILL, GEORGE H., Secretary, Merrill Brothers, Maspeth

Pennsylvania

BAUHAN, ALEXANDER E., Station Superintendent, Pennsylvania Water & Power Co., Holtwood

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NECROLOGY

ORVILLE G. BENNET

Orville G. Bennet was born in New York City on August [illegible] 18[illegible]. He received his early education in the Horace Mann School and was graduated from Cornell University in 1904.

His first position was with Westinghouse, Church, Kerr & Co. He left that firm to become associated with the Ingersoll-Rand Drill Company, where he remained till 1906, when he accepted a position with the American Trading Company, representing that company in Japan until 1909, chiefly in the sale and installation of mining machinery. Not wishing to become permanently identified with the Orient, he resigned in 1910 to accept a position with the Akonite Company, New York City. In 1911 he took over the management of the export business of the General Motors Company, later becoming president and general manager of the company. He resigned this position in 1916, and at the time of his death was organizing a company for the distribution of the output of the Nash Motors Company in the state of Texas.

He became a junior member of the Society in 1907. He died February 28, 1917.

EDWIN J. HADDOCK

Edwin J. Haddock was born in Mount Vernon, N. Y., June 13, 1868. He was educated in the schools of New York City. He obtained his early experience in the shops and drafting rooms in the vicinity of New York, completing this training with seven years spent under the immediate direction of Thomas A. Edison.

He held successively the positions of chief draftsman of the Robins Conveying Belt Company, New York City; chief engineer of the Jeffrey Manufacturing Company, Columbus, O., and chief draftsman of the Tennessee Coal, Iron and Railway Company, Birmingham, Ala. Later, he engaged in private practise in Milwaukee, Wis., building numerous stone-crushing plants in that region. At the time of his death he was chief engineer of the Edgewater Steel Company, Pittsburgh.

He became a member of the Society in 1906. He died April 11, 1917.

CLINTON A. HAMILTON

Clinton A. Hamilton was born on October 5, 1873, at East Orange, N. J. He was a graduate of the high school of East Orange. He served a three-years' apprenticeship in the E. P. Allis Company's shops at Milwaukee, and then went to Pittsburgh to take a position with the National Tube Company. When he severed his connection with this firm he entered into consulting engineering in New York City, under the firm name of McClave, Hamilton & Remmer. Later he became general sales manager for the International Steam Pump Company, with headquarters at Pittsburgh. In 1906 he accepted the position of vice-president and general manager of the Wisconsin Engine Company, Corliss, Wis., and remained with this company for about six years, resigning to accept the position of vice president and general manager of the Lavine Steering Gear Company, Racine, Wis. In 1913 he became president and general manager of the Racine Manufacturing Company, and retained this position until 1916, when he formed a partnership with Mr. James Cram and took over the sales agency of the Allen Motor Car Company. He was connected with this company at the time of his death.

He became a member of the Society in 1908. He died on March 12, 1917.

JOHN SEDGWICK HYDE

John Sedgwick Hyde was born in Bath, Me., March 25, 1867. He was a graduate of the Massachusetts Institute of Technology, class of 1888. He was connected with the Bath Iron Works, Ltd., in the successive capacities of apprentice, draftsman, paymaster, assistant superintending engineer, superintendent, vice-president and general manager and since 1905 as president of that company. He was a director of the Maine Central Railroad.

Mr. Hyde was a member of the New York Engineers' Club, Society of Naval Architects and Marine Engineers, American Society of Naval Engineers, and the Institution of Naval Architects of Great Britain. He became an Associate of the Society in 1892. He died at St. Augustine, Fla., March 17, 1917.

BRUCE C. McALPINE

Bruce C. McAlpine was born on June 2, 1872, at Pierceton, Ind. He received his early education in the high schools of Peoria, Ill., and Charlotte, Mich. From the latter he entered the Michigan Agricultural College, and was graduated from the mechanical-engineering course in 1905.

He entered the employment of George D. Walcott & Son, builders of machine tools at Jackson, Mich., as draftsman, and later became successively chief draftsman and general manager. Owing to changes in the ownership of the Walcott firm, he moved to Detroit, where he was engaged in the design of special tool equipment. In May 1913 he became chief draftsman and mechanical engineer for the Frost Gear & Forge Co., of Jackson, Mich., which position he held at the time of his death.

He became a member of the Society in 1914. He died on December 27, 1916.

WILLIAM F. MATTES

William F. Mattes was born on September 29, 1849, in Scranton, Pa. When seventeen years of age he was made superintendent of a small mining railroad near Mount Hope, N. J., and he continued in the iron-mining industry in New Jersey, and later in Virginia, until 1882, when he was made chief engineer of the Lackawanna Iron & Steel Works, of Scranton. In 1888 he became general manager of the West Superior Iron and Steel Works, West Superior, Wis. He was director of the First National Bank, president of the Manufacturers, Shippers' and Jobbers' Association, and park commissioner, of that city.

In 1893 failing health compelled him to move to Colorado, where he was interested in mining enterprises for several years. Later he returned to Scranton and was made chief engineer of the Lackawanna & Wyoming Valley Railroad Co. while

the Laurel line was in the process of construction. When his brother, Charles C. Mattes, died, he succeeded him as general manager of the Lackawanna Iron & Coal Co.

He was a member of the American Institute of Mining Engineers, The Franklin Institute, and the New York chapter of the Sons of the Revolution. He became a life member of the Society in 1882. He died on February 3, 1917.

EDWARD J. MARTIN

Edward J. Martin was born at West Roxbury, Mass., September 7, 1882. He was educated in the public schools of Boston. He then served an apprenticeship as machinist. He was a graduate of the mechanical engineering course of the International Correspondence Schools, and also of the Emerson Institute of Efficiency. At the time of his death he was secretary and manager of the Connecticut Electric Manufacturing Company. He became an associate-member of the Society in 1915. He died on April 7, 1917.

LEWIS R. POMEROY

Lewis R. Pomeroy, well known as a consulting mechanical engineer, especially expert in matters relating to the construction, maintenance and efficiency of locomotives and the necessary shop equipment, died suddenly at his home in Orange, N. J., May 7.

Mr. Pomeroy was born at Port Byron, N. Y., February, 1857, and was graduated from the Irving Institute, Tarrytown, N. Y. He early entered the railroad field, where his work attracted considerable attention. From 1886 to 1890 he was a special representative of the Carnegie Steel Company, introducing basic boiler steel for locomotives and special forgings for railways. For nine years he was engaged in similar work with the Cambria Steel Company and the Latrobe Steel Company jointly. He then became connected with the Schenectady Locomotive Works as assistant to the general manager, a position he held until 1902.

During the following six years he was a special representative for the General Electric Company in the railway field, this work covering the electrification of steam roads and railway shops and general application of electricity to all railway purposes. Subsequently, for two years, he was assistant to the president of the Safety Car Heating and Lighting Company, leaving to become chief engineer of the railway and industrial division of J. G. White and Company. Late in 1911, he resigned to open an office in New York City as a consulting engineer. In 1914 he became associated with the U. S. Light and Heat Company as manager of the New York office. For the past year or so he had again been engaged in consulting work along lines in which he was qualified by his wide experience.

Mr. Pomeroy was possessed of an enormous fund of information, and was ever ready to give unprejudiced help of a most dependable character. He was serious-minded, yet always cheerful; prompt in action yet painstaking and thorough; delightful in companionship, yet loyal to his convictions.

He joined the Society in 1890 and was Chairman of its Membership Committee at the time of his death. He was also a member of the American Institute of Electrical Engineers, the American Master Mechanics Association, the Railroad Club of New York, the Engineers' Club of New York, and the New York Railroad Club.

WILLIAM C. WILLIAMSON

William C. Williamson spent his early youth in Philadelphia, attending high school there. After leaving school he began his engineering experience by associating himself with a jeweler and watchmaker in repairing watches. This work was not especially to his liking and so he apprenticed himself to the old firm of Reaney, Neafie & Co., at that time one of the foremost engineering firms of the entire Atlantic seaboard.

In 1861 he entered the United States Navy as 3rd assistant-engineer, serving throughout the war. He resigned June 10, 1866, to engage in the engineering business with his two brothers, founding the firm of Williamson Brothers. His engineering talents soon showed in the Williamson type of clutch and frictional-geared cargo hoists. In the early eighties he introduced in a ship building at the yard of the William Cramp and Sons Ship and Engine Building Company, for the Metropolitan Steamship Company of New York, a steam engine to supersede the old type of hand steering wheel for the control of ships. It was an immediate success and entitles him to be classed among the foremost naval engineers of his day.

He was prominent also in financial affairs, being one of the oldest directors of the Kensington National Bank, and director and vice-president of the Industrial Trust, Title and Savings Company of Philadelphia.

He was a member of the Naval Order of the United States, Post No. 2, G. A. R., and the Engineers' Club of Philadelphia. He was a member of the Society of long standing, having been elected to membership in 1882. He died December 2, 1916.

The present inability of farmers to raise more grain is due to the lack of sufficient farm power and the scarcity of farm labor. For farm power farmers are dependent upon either animal power (horses and mules) or tractors. But the animal power will necessarily decrease, owing to the demand of the army for horses and mules. Hence the necessity for the intelligent use of farm tractors on a large scale.

Statistics collected by the Bureau of Farm Management of the Department of Agriculture show that there are now available in the United States approximately 35,000 tractors.

The limiting factors in the production of tractors are today the shortage of materials, machine tools and labor. The Government has been asked by the Tractor Standards Division of the S.A.E. to devise means whereby the tractor manufacturers can be furnished with the materials, machine tools and labor in suitable quantities.

Tentative plans for an organization to be known as the National Committee of Industrial Safety, to act as an auxiliary to the advisory commission of the Council of National Defense, were drawn up at a meeting under the auspices of the American Museum of Safety in New York, Tuesday, April 24. The committee is to have 15 members, selected because of activities in fire protection, structural safety, dust and fume control, etc. Among those already named are: Colonel T. L. Bryant, Arthur H. Young, Lew R. Parmer, C. L. Close, Dan H. Manning, M. A. Dow, Robert B. Kohn, J. L. Mauran, Owen Brainard, Elmer Jensen, and D. Everett Waid. Headquarters will be in the Octagon Building, Washington. (*Daily Iron Trade and Metal Market Report*, vol. 7, no. 82, April 26, 1917, p. 4)

AMONG THE SECTIONS

THE Entertainment Committee of the New York Section made very complete arrangements for the Annual Social Evening which was held in the large dining hall of the Machinery Club, New York City. The speakers of the evening were Edwin J. Prindle, Toastmaster; President Ira N. Hollis, Commander E. P. Jessop, and John J. Swan. All of the speeches related to the part of the engineer in the enormous task confronting the country in the war. These are busy times and a large percentage of the New York membership were evidently unable to attend; nevertheless those present were well rewarded as the occasion was a most enjoyable one. The Entertainment and Acquaintanceship Committees of the New York Section have been doing excellent work in providing opportunity for more of the "human element," and the committees are to be congratulated upon their latest success.

THE FIRST SECTION IN CANADA

The first Section of the Society outside of the domain of the United States was established recently at Toronto, Canada. The Council at its April meeting approved the petition of the members of the Society in the Province of Ontario for permission to hold meetings.

The Executive Committee of the Ontario Section, as it will be known, is: G. V. Ahara, Prof. R. W. Angus, C. R. Burt, L. H. Fletemeyer and C. B. Hamilton.

A CONNECTICUT STATE SECTION

A meeting was held at Bridgeport on May 2, at which were present members from most of the prominent cities of the State of Connecticut. The object was to consider the advisability of forming a State Section, with branches at several centers. The existing New Haven Section was represented by Messrs. Henry B. Sargent, Chairman, Joseph W. Roe, and J. A. Norcross. It was agreed to formulate a plan whereby a Connecticut State Section will be organized, with headquarters probably at New Haven, where at least two meetings will be held annually, as at present, and in addition it is planned to hold each year at least one meeting at each of the following centers: Bridgeport, Hartford, Meriden and Waterbury. A committee was appointed to arrange the necessary details for putting the idea into effect, consisting of Messrs. Henry B. Sargent, Chairman, C. K. Decherd, H. E. Harris, S. F. Jeter and E. S. Sanderson.

A quorum of the Committee on Sections was present at the meeting, D. Robert Yarnall, Chairman, L. C. Marburg and Walter Rautenstrauch. Secretary Rice acted as chairman of the evening, and an address was made by Judge Edward K. Nicholson on ways in which engineers can coöperate in the mobilization of the resources, industrial and agricultural, of the United States.

The meeting approved a motion to petition the Council to take a referendum vote of the members of the Society to determine whether we should support national prohibition during the period of the War as a means toward greater industrial effectiveness and a saving in spoiled material.

BALTIMORE

April 12. At the meeting of the Section held at the Engineers' Club the following officers were elected for the ensuing year: Chairman, W. W. Varney; vice-chairman, A. B. Robertson; secretary, A. G. Christie; and treasurer, C. C. Thomas. William Chatard was elected a member of the Executive Committee.

Alten T. Miller, Vice-President of the Bartlett Hayward Co., of Baltimore, gave a most interesting address on Munitions and Preparedness, and the discussion of the subject which followed was of much interest and proved most instructive to all present.

A. KENNEDY,
Temporary Branch Secretary.

BUFFALO

April 18. A History of Aviation was the subject of the paper delivered before the Engineering Society of Buffalo by Charles M. Manly, Mem.Am.Soc.M.E. Mr. Manley, who has been actively engaged in aeronautics for many years, was associated with Professor Langley when the latter developed his ideas of the physics of the air and the art of flying. His paper treated particularly of the early development of aviation and included the present military problems being met in flying.

The following resolution was adopted at this meeting:

"Resolved, that the Engineering Society of Buffalo express its approval of the principle of universal and obligatory military training and service, and that we urge the Senators and Representatives in Congress of the State of New York, and particularly the Representatives of the Buffalo districts, to support in every way possible this principle, especially as it is embodied in the Administration measures looking to the raising of an army on this basis."

May 2. At the annual meeting John Younger, Mem.Am.Soc.M.E., resigned from the office of president, which he has held for three years, during which time the society has become known as one of the most energetic and useful engineering bodies. The election resulted in the choice of the following officers for the coming year: President, F. A. Lidbury, Mem.Am.Soc.M.E.; first vice-president, D. W. Sowers, Mem.Am.Soc.M.E.: secretary, F. B. Hubbard, Mem.Am.Soc.M.E.; treasurer, W. M. Dollar, Mem.Am.Soc.M.E.; directors, H. B. Alverson, Mem.Am.Soc.M.E., and F. E. Cardullo, Mem.Am.Soc.M.E.

LOUIS J. FOLEY,
Assistant to Secretary.

DETROIT

April 20. A number of the members and several ladies attended the dinner on this date, which was followed by an address by John W. Lieb, Mem.Am.Soc.M.E., on Leonardo da Vinci—Artist, Philosopher and Engineer. Mr. Lieb's address was most interesting, as it was based upon his researches during a residence of ten years in Italy, in the early days of electric railroading.

J. W. PARKER,
Section Secretary.

MERIDEN

May 3. An illustrated lecture on the Steam Turbine was given by J. Breslav, Mem.Am.Soc.M.E., before the Meriden members of the Society. This lecture proved of much interest and general discussion by those present followed.

R. S. BROTHERHOOD,
Secretary.

NEW YORK

May 8. Mr. Siegfried Rosenzweig, Mem.Am.Soc.M.E., addressed the meeting on The Development of the Poppet Valve Steam Engine with Special Reference to its Present Status in the United States.

Under the heading of thermal considerations, the author enumerated the advantages of high steam pressures and high superheats, and gave reasons why under such working conditions the poppet-valve engine is the most suitable type. He showed how

and why the application of high steam pressures and superheats and the development of the poppet-valve engine eliminate the multiple-cylinder arrangement, leading to compound engines and finally to single-cylinder engines, particularly of the uniflow type. The advantages and disadvantages of each type were defined and explained. Comparative steam consumptions of Corliss, poppet-valve and uniflow poppet-valve engines were given, and also the economies of small and medium-size turbines and uniflow engines were compared.

This part of the paper was followed by a consideration of structural features, in which the stationary engine, the locomobile, the marine engine, and the locomotive were described in a general way, and in a number of designs the development of these important types explained. The paper concluded with an explanation of a number of the different and most prominent types of valve gears and detail constructions, the latter with special reference to the best forms of cylinder designs. Both American and European types were shown.

The lecture was fully illustrated by lantern slides and drew forth considerable discussion.

A. D. Blake,
Section Secretary.

PHILADELPHIA

April 24. D. Robert Yarnall, Mem.Am.Soc.M.E., the speaker at this meeting, presented a paper on Recent Developments in V-Notch Weir Measurement.

The paper was fully illustrated with lantern slides and the speaker traced the early history of the V-notch weir, showing the various steps in its evolution up to the present time. Particular emphasis was put on the fact that the V-notch weir, irrespective of the particular make of the instrument, furnishes the most successful method of measuring liquids.

The results of the tests at the University of Pennsylvania, in which a Lea instrument was used, were given. Here the accuracy curve for various rates of flow was practically a straight line. The water used in the test was weighed by very accurate scales and the percentage of error during the entire test was about 0.6 per cent., while the guaranteed accuracy of most instruments of this type is about 1.5 per cent. A discussion followed in which J. W. LeDoux, Mem.Am.Soc.M.E.; T. C. McBride, Mem.Am.Soc.M.E., and L. F. Moody, Mem.Am.Soc.M.E., participated.

May 22. The closing meeting of the season was held on this date, and in order to continue the helpful spirit of coöperation now prevailing in Philadelphia, Mr. Willard Beahan, First Assistant Engineer, Lake Shore and Michigan Southern Railway, addressed this Section on Engineering of Men.

All the Members of the Engineers' Club of Philadelphia and all the engineering organizations affiliated with the club were invited to hear Mr. Beahan, and the response was general.

In order to further promote harmony and to tie the various organizations together more closely, a dinner was given to the chairmen of the several affiliated societies, the president of the Engineers' Club, and the president and secretary of The Franklin Institute.

W. R. Jones,
Secretary.

PROVIDENCE

May 2. The second annual banquet of the Providence Engineering Society, held in Elks Hall, surged with patriotic enthusiasm as the representatives of four of the allied countries addressed the audience.

Mayor Gainer, the first speaker of the evening, welcomed the distinguished guests and declared that the United States was in the war to stick until victory was assured.

Capt. M. de Jarny, a French military officer sent here after many months' service in the trenches to instruct the Harvard Training Camp, acted as the representative of Ambassador Jusserand. He said that the war is an engineers' war and that the United States, the greatest engineering country in the world, is sure to play a great part in it for that reason.

Capt. Nathan Horowitz, U.S.A., declared that the word "engineer" was a synonym for efficiency, and that efficiency must guide every action taken by the citizens here so that all the resources may be used to the best advantage. His brief talk closed with a reassurance that the coast defences of the country were sufficient as our harbors are amply protected by nets. He also said that we were not awake to the reality of war and that the sight of a submarine or Zeppelin might arouse us more fully to a realization of our duty.

M. S. Davidson, of Toronto, prefaced his talk with "Comrades-in-arms," which was greeted with applause. He said that the Allies had been confident of winning with or without the United States, but that he thought the war should be considerably shortened by the entrance of this country into the combat. The speaker said that the greatest good derived from the war was the new conception of life which all of the fighting countries are gaining.

Dr. Ira N. Hollis, Pres.Am.Soc.M.E., spoke on behalf of the United States. Dr. Hollis said: "Many young men have asked me in the last few weeks how they could do their share. Our country must provide a man for every place and we must have an agency of the Government to allot the men to the places where they can best serve. We serve best in this funeral procession on the way to the burial of the divine right of kings, when we fit into the place where we can do the most good."

Prof. Albert Van Hecke, of the University of Louvain, was Belgium's representative. He told of the sufferings that Belgium has undergone since the outbreak of the war and something of the atrocities, and followed with motion pictures of scenes in the refugee camps in Holland. These pictures gave views in the different workshops, homes, schools and playgrounds, and showed how the work has been systematized by Professor Van Hecke.

Albert Thornley,
Corresponding Secretary.

ST. LOUIS

April 11. H. R. Setz, Mem.Am.Soc.M.E., read a most interesting paper on Some Unusual Applications of the Diesel Engine, before the joint meeting of the Section and the Engineers' Club.

The paper dealt with the application of the Diesel engine to traction problems on railroads. The greatly varying relations between train speeds on level and rising or falling tracks, engine hp., point of cut-off and tractive effort were first explained by means of a typical dynamometer test chart from a steam locomotive.

Gasolene engines have for some time been used for traction service and, as far as the technical solution of the problem is concerned, have been an entire success. Mr. Setz explained why Diesel engines, owing to their greater flexibility, lend themselves even more readily to this class of work.

He then gave particulars of three methods by which the Diesel engine can be made use of for traction purposes, as follows:

Direct drive, in principle similar to the present practice with steam locomotives. Since at the slower speeds the Diesel engine would be unable to produce the necessary tractive effort, provisions must be made to increase artificially the mean effective pressure in the engine cylinder beyond that resulting from the regular cycle of operation. This is accomplished, while running, by the admission of extra charges of fuel oil together with high-pressure air, while for starting, the range cut-off of the starting valve must be extended to about 70 per cent of the piston stroke.

Mechanical drive, obtained by speed-change gears similar to present practice in automobile construction. For the purpose of smooth operation it is important that the engine hp. as well as the momentary tractive effort resulting from a change of speed be the same both before and after shifting the gear. Particular attention is to be paid to a suitable form of clutch. As modifications of the mechanical drive should be mentioned the various methods of hydraulic and compressed-air transmissions, which are primarily to increase the torque in starting and at slow speeds.

Electric drive, consisting of a regular Diesel-electric generating unit located independently on the car or locomotive without regard to the driving axles, which latter are driven by a suitable number of motors through gears. Here the torque may be varied either by varying the voltage or the speed of the engine.

Mr. Setz explained by means of diagrams and lantern slides the theoretical considerations underlying the different forms of Diesel engine propulsion.

A lively and extended discussion followed, showing that the subject was both interesting and timely.

L. A. Day,
Section Secretary.

STUDENT BRANCHES

Members of Student Branches are requested to notify the Secretary of any changes in dates as promptly as possible, in order to facilitate delivery of The Journal.

The Society has received from the Student Branches accounts of the measures taken by the student bodies regarding preparedness for national defense. That each university and college is "doing its bit" in this respect is shown by the summarized reports below.

Armour Institute of Technology. Entire student body meeting once a week for drill; military training compulsory. One hundred undergraduates to enlist in Navy. Plans in formation for instruction to be given in internal-combustion engineering for men training for service in United States Coast Defense Patrol.

Bucknell University. Student branch offered services to War Department, with request as to how to be of greatest service.

University of California. Cadet corps numbers 1263; 35 immediately available for commissions and 300 within the year. One of the universities designated by the War Department as training school for aviators; school to start shortly.

Case School of Applied Science. All students taking military drill each day. Work to be increased toward end of term. Application now in for Government to establish senior unit of the Officers' Reserve Corps in this institution. Two instructors received commissions in Officers' Reserve Corps.

University of Cincinnati. Military problems being introduced in all courses in civil, chemical, electrical, and mechanical engineering.

University of Colorado. Engineers corps of 50 men formed. Company of cavalry organized; to be increased to full squadron shortly.

Colorado State Agricultural College. Nearly half student body applying for membership in Officers' Reserve Corps; some have received commissions. Military instruction given daily to undergraduates.

Columbia University. Aerial Coast Patrol Unit No. 4 in formation. Six-week courses in military and naval subjects started, to include trench warfare, map reading, radio telegraphy, mining, trench signal service, infantry drill, military law, practical navigation, electric steering, turret control, gyroscopic compass, submarine signals, etc. Ambulance unit plans in formation. Signal corps in training. Agricultural volunteer system inaugurated, with credit given to students volunteering. Military census being taken.

Cornell University. Cadet corps numbers 2000; training in charge of regular United States officers; equipment up-to-date and complete; corps comprised of regiment of infantry, engineering division, machine gun division, signal corps, ambulance division, and military band; officers of corps are students holding commissions. Six hundred students enlisted in Government service; majority in mosquito fleet at Newport. Cornell ambulance unit for service in France enrolled and equipped and now in service; second unit to leave in a few weeks. Plans for new field battalion of signal corps in formation. Complete military census of undergraduate body taken. One of the universities designated by the War Department as training school for aviators; school to start shortly.

Georgia School of Technology. School offered to Government as military training center for officers. Aviation school in formation. Government expected to take advantage of offer shortly.

University of Illinois. Usual military training being pushed to the limit. Student aviation corps in formation, with many applications for membership. One of the universities designated by War Department as training school for aviators; school to start shortly.

Johns Hopkins University. Reserve Officers' Training Corps organized at beginning of collegiate year; battalion of 250 men drill under officer from War Department. Five men have commissions in the Reserve Corps and thirty have enlisted in the naval reserve and state militia. Credit for balance of year given to all enlisting.

University of Kansas. Courses in military science and engineering organized under direction of Dean of Engineering. Many undergraduates applying for admission to Officers' Reserve Corps and to the Quartermaster's Department. Credit for the balance of school year being given students enlisting or taking industrial positions in the service of the country.

Leland Stanford Junior University. Credit being given students entering intensive military training or active service. About 800 students now in training. Large number of advanced engineering students excused to take up industrial work in connection with federal contracts. Officers' Reserve Corps has many applications for admission. A few students taking up aviation. Two complete ambulance corps now in France.

Lehigh University. Class in military training held four times a week. Chemists have list of men classified for industrial positions.

University of Maine. Two years' military training required of all students; courses rearranged to permit of entire student body taking military training two hours daily. Courses in map making and reading, problems of intrenchment, use of high explosives, and signal corps work established and well attended. Many students enlisting in Coast Patrol. Cadet battalion of 532 men.

Massachusetts Institute of Technology. Trains all constructors for Navy. All seniors graduated in advance and now in service. Military department, existing for fifty years, now being enlarged. Engineering courses being reorganized on war basis to train men for technical departments of the army, engineering division, coast artillery, signal corps, and ordnance. Laboratories placed at disposal of Government. One of the universities designated by War Department as training school for aviators; school to start shortly. Industrial survey of alumni, started last year, now being completed.

University of Michigan. Seven companies of engineers organized; drilling twice a week. Special courses being given in military engineering, camp sanitation, transportation of supplies and munitions, high explosives, etc. Many students leaving to join various military and naval units.

University of Missouri. Special company of fifty cadets now in intensive training; eight immediately available for commissions, and thirty more within the year.

University of Minnesota. Military corps numbers 1250; 50 immediately available for commissions; 300 to attend officers' training camp this summer. Resolutions passed by students pledging themselves ready and willing for active service.

University of Nebraska. Cadet corps numbers 800 men; 46 immediately available for commissions and 100 within the year.

New York University. Red Cross ambulance company of 100 men formed; drill three hours a week under regular army officer. Four companies of Reserve Officers' Training Corps formed, seventy men to a company, receiving three hours' drill a week. Courses in ordnance and gunnery, electrical and steam engineering, signaling, and navigation on board battle ship *New Jersey* discontinued. Course in signaling to be given in university.

Ohio State University. About one thousand students leaving either for Officers' Reserve Corps, industrial positions, or agricultural pursuits; full credit being given these students. Sophomore regiment of cadets have open-order drill on Saturdays, besides regular drill periods. One of the universities designated by War Department as training school for aviators; school to start shortly.

University of Oklahoma. Compulsory military drill established throughout university. Engineering school forming signal corps for two upper classes. Sixty-four students to enter officers' training camp at Fort Logan H. Root, Arkansas. Intercollegiate Intelligence Bureau making complete investigation of alumni and undergraduates as to fitness for Government service.

Oregon Agricultural College. About fifty per cent of the seniors and twenty per cent of the junior engineering students qualified for Reserve Officers' Training camp at San Francisco. Full university credit being given these students. Many undergraduates leaving to take up work on farms.

Pennsylvania State College. Cadet corps numbers 1500; 300 men available for commissions and 300 more within the year. Courses being given in aeronautics, navigation, ordnance, and quartermaster work. Special instruction in ambulance and first-aid medical field service.

University of Pittsburgh. Survey of all students and alumni prepared and forwarded to National Intelligence Bureau. University wireless plant now at the service of the Government. Base hospital formed in school of medicine. Lectures given on camp sanitation. Regiment of six companies has 700 students enrolled; daily drill. Agricultural bureau of the university enlisting students for farm work. Full credit being given to those enlisting and to those taking up agricultural or industrial work.

Polytechnic Institute of Brooklyn. Training corps of 160 established; drills three hours a week at 13th Regiment armory. About twenty students in Naval Reserve and about 12 per cent. of the student body in active service.

Purdue University. Cadet corps numbers 1000; 300 to attend officers' training camp and will be available for commissions; 300 more within the year.

Rensselaer Polytechnic Institute. Course in military engineering established. Military instruction to be instituted immediately. Over one hundred undergraduates leaving for Officers' Reserve Corps, Naval Engineering Corps, regular army, or state militia.

Stevens Institute of Technology. All students being drilled five times a week. Commencement advanced to permit of students entering camps.

Syracuse University. Eight hundred students drilling twice a week; 150 graduate students to enter Officers' Reserve Corps. Ambulance corps being formed. Credit being given students enlisting or entering agricultural or industrial work.

Virginia Polytechnic Institute. Course of lectures by Red Cross representative attended by student body. Four hours of military drill daily. About one hundred students certified for admission to Fort Myer officers' training camp. Cadet corps a unit of Reserve Officers' Training Corps.

Washington University. Plans are now being made to form Reserve Officers' Training Corps, modeled after Yale's, to be under authority of War Department. About one hundred men already in national service and about one hundred more to be enrolled in reserve officers' training camps. Many students to go as ambulance drivers to France.

University of Washington. Cadet corps numbers 800; 100 available for commissions within the year; 85 to attend officers' training camp at San Francisco. Complete census of undergraduates and alumni taken.

University of Wisconsin. Courses offered in intensive military training with full credit allowed. Cadet corps numbers 1200; 140 available immediately for commissions and 600 within the year.

Worcester Polytechnic Institute. Military training of students under experienced drill officer. Number of seniors to take forthcoming examinations for commissions in regular army; such students excused from all regular institute work. Work of engineer officers outlined in address by Captain Williford, of Coast Artillery.

Yale University. About 1500 men engaged in military work; 300 immediately available for commissions and 600 within the year. Regular army officers in command of the men. Aerial coast patrol unit formed and in training. Naval training unit enrolled. Hospital unit organized and ready for service abroad. Signal corps unit in active training. Many students already in active service abroad. Laboratories offered to Government. Intercollegiate Intelligence Bureau work being forwarded.

Preparedness in its different phases is not confined to any group of universities or colleges, but throughout the country there is a general movement among college men to make themselves ready for the call.

Brown University. Military unit of 250 in training; 150 men organized for agricultural work. University equipped several ambulances for use in France. Many undergraduates to go to Plattsburg.

Colgate University. Military drill being instituted for all students under Plattsburg men. Full credit being given to all students enlisting or taking up agricultural or industrial work. Laboratories and other facilities of the university offered to Government. Special military courses being given.

Dartmouth College. Five hundred withdrawn to enter Naval Reserve, Reserve Officers' Training Corps, and Aviation Corps. Two complete ambulance units equipped and on the way to France. One thousand drilling daily. Military census being taken. Vacant land being intensively cultivated.

Delaware College. Ambulance corps organized and equipped. Military census of undergraduates and alumni taken. Many students leaving to enlist in active service.

Fordham University. Military training compulsory. Over 1000 students drilling daily, about 100 applying for admission to Plattsburg. Ambulance Corps No. 6 in formation.

George Washington University. First Company, Coast Artillery, District of Columbia Guard, formed in 1915, in active District service. Many students to enter Fort Myer Officers' Reserve camp. Military census taken.

Harvard University. Officers' Training Corps numbers 1200 men, under regular army command. Five French army officers assisting in training. Ambulance unit now in service in France.

University of Indiana. Training corps numbers 312, 70 per cent. of this number to be available within the year for commissions.

Massachusetts Agricultural College. Cadet corps numbers 126, 47 are available for commissions and have enrolled in the Government officers' training camps.

Michigan Agricultural College. Cadet corps numbers 875; 150 men are immediately available for commissions; 250 within the year.

New Hampshire College. Cadet corps numbers 380; 12 immediately available for commissions and 75 more within the year.

New Mexico School of Agriculture and Mechanic Arts. Intercollegiate Intelligence Bureau taking census of alumni and students. Agricultural school in full charge of agricultural resources of the state for greater crop returns. Practically all of engineering students applying for admission to Officers' Reserve Corps.

College of the City of New York. Complete equipment of chemistry building and services of faculty offered to Government. Resolutions adopted expressing students' willingness for national service. Ambulance unit plans in formation.

North Carolina College of Agriculture and Mechanic Arts. Cadet corps numbers 400; 60 available for commissions, 60 more within the year.

Norwich University. Cadet corps numbers 200. Ten seniors designated for regular army commissions and four as second lieutenants in the Marine Corps.

University of Notre Dame. Cadet battalion in training; 90 immediately available for commissions and at least one-fourth of the whole battalion within the year.

Pennsylvania College. Cadet corps numbers 314; 35 immediately available for commissions and 120 within the year. Many students to attend officers' training camps this summer.

University of Pennsylvania. Twenty-two hundred students drilling daily under regular United States officers. University Base Hospital No. 20 ready to sail for France. Over two hundred students enrolled in army of commissary for work on farms. Military census just completed.

Princeton University. Military drill established. Aviation school started, with more than two hundred applying for admission. About two hundred to enter officers' reserve training camps. Four ambulance units of twenty-five men each to sail for France the end of May for field service with the American Ambulance Corps. Full credit allowed those enlisting.

Rhode Island State College. Cadet corps numbers 252; 15 immediately available for commissions and 50 more within the year.

Rose Polytechnic Institute. Military training started. Plans being worked out in connection with National Defense Council and National Research Council. Laboratories well equipped for preparedness work.

Rutgers College. Reserve Officers' Training Corps numbers 300; 37 immediately available for commissions. Students being released for farm work. Plans in formation for students not in direct military service to enter munitions making.

Trinity College. Unit of Officers' Reserve Corps established. Half of undergraduate body drilling ten hours a week. Courses established in military science. Twenty-five men enrolled in Connecticut National Guard and others in ambulance and machine-gun divisions.

Tufts College. Military census taken of students and graduates. About fifty enrolled in Naval and Coast Defense Reserves. Division of ambulance field service now being organized. Twenty students accepted for Officers' Reserve Corps. Credit being given to those enlisting or taking up agricultural or industrial work.

Tulane University of Louisiana. All facilities of laboratories offered to Government. Questionnaire sent to 3300 alumni to determine number willing to enlist. Many graduates of Medical Department enlisted in service. Large number of engineering alumni in officers' training camps.

Union College. Two hundred and twenty-five students drilling four hours a week; non-commissioned officers' class for seventy-five. Courses of lectures, with field work, given on military engineering, code and flag signaling, and military topography. Military census taken.

University of Vermont. Student cadet corps of 250 men, 80 available for commissions within the year. University sent a complete infantry company and medical detachment to Mexican border last summer.

Williams College. Training corps consisting of 120 men, 200 available for Federal service within the year, 20 seniors to go to Plattsburg.

ARMOUR INSTITUTE OF TECHNOLOGY

April [illegible]. Robert Randolph was the speaker at the joint meeting of all the engineering societies, speaking on the Potential Resources of the Drainage Canal in Time of War. After the lecture which was illustrated with lantern slides, Mr. Randolph answered many questions concerning military matters and his explanations were most enlightening.

May 7. A business meeting was held at which the following officers were elected: W. H. Bretting, president; K. A. Taylor, vice-president; V. A. Kerr, secretary; N. L. Marvin, treasurer. The newly elected officers gave short talks following their appointment.

Abe J. Plocinsky,
Branch Secretary.

BUCKNELL UNIVERSITY

May 7. C. C. Kepple gave an interesting and instructive talk on the Field and Future of the Low-Pressure Steam Turbine. The most important point in the discussion was the showing of the increased efficiency of a plant due to the installation of a low-pressure turbine. Prof. F. E. Burpee, Mem.Am.Soc.M.E., gave a short discussion on the same subject.

C. M. Kriner,
Branch Secretary.

UNIVERSITY OF COLORADO

April 26. Organization was the subject of an address before the Branch by Prof. John A. Hunter, Mem.Am.Soc.M.E. Later the annual election of officers took place, resulting as follows: President, H. T. Sears; vice-president, R. B. Burlingame; secretary, H. O. Croft. The election was followed by a big get-together

H. O. Croft,
Branch Secretary.

UNIVERSITY OF ILLINOIS

April 19. In competition for prizes offered the Junior and Sophomore classes by Pi Tau Sigma, Mr. Shonkwiler delivered a short talk on Ice Plants and Refrigeration, and was followed by Mr. Morse, who spoke on Speed-boats and Hydroplanes. Both talks were interesting and well illustrated with lantern slides.

H. C. Dieserud,
Branch Secretary.

University of Cincinnati Student Branch Am.Soc.M.E.

KANSAS STATE AGRICULTURAL COLLEGE

May 14. Engineers' week was celebrated by the students starting with open house and a band concert, moving pictures showing many manufacturing processes and engineering works.

At the regular Branch meeting Joseph Harrington, Mem.Am.Soc.M.E., gave an interesting talk on boiler settings and furnace combustion.

A parade was held with many interesting and attractive floats, one of which was a small gas tractor, built complete in the college shops and consisting of a 1½-hp. gas engine mounted on specially built trucks, which gave a small but powerful tractor. There were many novel features among the floats, such as one which carried the power plant which furnished power and light for the other floats, another with a small mill in operation, one showing an electrical "wash day" as compared with the old-style kitchen, and many others of equal interest. The closing event of the week was the annual engineers' ball.

William N. Caton,
Branch Secretary.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

May 3. The close of a very successful year was celebrated by the Annual Banquet, at which the principal speakers were Ira N. Hollis, Pres., Am.Soc.M.E., Rowland W. Boyden, and Prof. E. F. Miller, Mem.Am.Soc.M.E.

Professor Miller sounded a warning to the men going out from the Institute into the Government's service in the capacity of munition inspectors, as they are open to many temptations in the way of graft.

Mr. Boyden said that it was now time for us to consider facts sanely and with calm judgment, as we receive proofs every day of the stupendousness of the task confronting us. Those in high authority in the Army and Navy must now have broad vision and administrative and executive powers in order to make an impression on the enemy, and we can congratulate ourselves on the number of men we have who possess these powers. The so-called "captains of industry" are just the men of this type who will produce efficiency, and Mr. Boyden cited several examples of both young and older men who are proving their patriotic spirit and devotion to their work.

Dr. Hollis advised the men to read history to see what the

end of the war is destined to be. He considered the definition of civilization as given by Louis Pasteur the best—"That civilization in which the individual is permitted to develop himself to the maximum capacity for the benefit of mankind." As the blood was to many of us the symbol of the washing away of the sins of the world, now bloodshed may again be worthy to fulfill the command, "Love thy neighbor as thyself." The development of the engineer, Dr. Hollis said, has gone hand in hand with democracy, and there is a tendency of science to weld the nations together. The mechanical engineer has a peculiar right to claim that his share in this war is preëminent, and each individual should prepare himself for whatever he is best fitted.

Announcement was made of the result of the election of officers for the coming year, as follows: Chairman, A. Saunders, vice-chairman, A. L. Hamilton, treasurer, H. W. Fitch, secretary, S. H. Caldwell.

S. H. CALDWELL,
Branch Secretary.

OHIO STATE UNIVERSITY

April 25. Mr. Fikret, instructor in the mechanical-engineering department, gave a well-illustrated lecture on the construction and equipment of the Essex Power Station of the Public Service Electric Company of New Jersey, with which company he was formerly connected.

F. E. SYMSER,
Branch Secretary.

OREGON STATE AGRICULTURAL COLLEGE

April 19. A general business meeting was held and officers for next year nominated.

May 10. After the regular routine of business the following officers were elected for next year: President, A. O. Leech; vice-president, F. P. Myers; secretary, H. W. Fish; treasurer, H. B. Morris.

ARCHER O. LEECH,
Branch Secretary.

OKLAHOMA UNIVERSITY

May 8. E. W. Pembleton addressed a joint meeting of the electrical and mechanical branches on Gasolene Extraction from Gas, and was followed by Prof. L. W. W. Morrow, who spoke on illumination.

The latter paper was illustrated by lantern slides and discussed the mechanical operation of the eye, the limited number of light waves which can be seen, and the causes and results of eye strain. The methods of avoiding them by proper illumination were also explained.

TOM L. SOREY,
Branch Secretary.

POLYTECHNIC INSTITUTE OF BROOKLYN

May 5. Samuel P. Blakeman, Mem.Am.Soc.M.E., gave a most interesting talk on S.K.F. Ball Bearings.

Mr. Blakeman described in detail the manufacture and various uses of the ball bearings and illustrated his points with many interesting lantern slides.

The following officers were elected for the coming year: President, Frederick H. Bromm; vice-president, Charles L. Schweizer; treasurer, Joseph L. Kopf; secretary, Nathan N. Wolpert.

GEORGE CHERR,
Corresponding Secretary.

SYRACUSE UNIVERSITY

May 7. After a few general remarks addressed by the President to the new members of the Branch concerning its principles and aims, short talks were given by Messrs. M. P. Whitney, M. P. Ferguson, Smith, and Lanigan. W. I. Rodgers, Jr., followed with a report of the Joint Student Branch Conference in New York.

The officers for next year were elected as follows: President, Maurice P. Whitney; vice-president, Walter I. Rodgers, Jr.; secretary, T. Dean Howland; treasurer, Malcolm P. Ferguson.

T. DEAN HOWLAND,
Branch Secretary.

VIRGINIA POLYTECHNIC INSTITUTE

May 1. City Management was the subject of a most interesting and informing paper presented by R. S. Royer, City Manager of Fredericksburg, Va. This is a new field of work for engineers and the paper was received with much interest by the members of the branch.

G. F. MINOR,
Branch Secretary.

UNIVERSITY OF WISCONSIN

May 3. Prof. W. J. Mead of the Geology Department gave an interesting illustrated lecture on Landslides at this meeting.

JOHN M. WOOD
Branch Secretary.

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping anyone desiring engineering services. The Society acts only as a clearing house in these matters.

POSITIONS AVAILABLE

In forwarding applications, stamps should be enclosed for transmittal to advertisers; applications from non-members should be accompanied by a letter of reference or introduction from a member, such reference letter to be filed with the Society. Copy for notices must be in hand by the 15th of the month.

INSTRUCTORS for school of mechanical trades in Iowa. Salaries $1,000 to $1,200. Promotion dependent to large extent upon commercial work which can be turned out during year. Men wanted now are as follows:

(*a*) Energetic young man with some business ability to take charge of automobile department doing large repair business; must know subject thoroughly and be able to build up department educationally and commercially. Competent to teach automobile lines, including electric-cranking, lighting and ignition course, to organize material and work in such way that maximum number of students can be handled with minimum teaching force and expense.

(*b*) Man to handle foundry and machine shop and possibly forge. 676.

TECHNICAL ENGINEER, with experience in steam engineering, to act as assistant operating engineer in large industrial plant located near Chicago. State age, experience and salary expected. 938.

YOUNG TECHNICAL GRADUATE with one or two years' experience in steam engineering, for testing work; location New Jersey. State age, experience and salary expected. 939.

MASTER MECHANIC for steel mill; experienced in this line of work and able to handle 60 to 75 men. Age 28 to 40, and a hustler. Salary about $2400. Location Pennsylvania. 1000.

DRAFTSMEN AND DESIGNERS. Experienced men with knowledge of valves and fittings; good future with large concern. State experience in full, salary expected and references. 1002.

ESTIMATOR, general jobbing and manufacturing shop; man ex-

... standard work. State ... salary desired and when available. Location New Jersey. 1006.

GENERAL CORRESPONDENT to be located in New York office of concern doing business with South American countries. Must speak Spanish. Prefer South American or one who has resided in South America and is familiar with conditions and language from personal experience. Salary depends on man. 1007.

FARM TRACTOR MANUFACTURER, well established, wishes to get in touch with large manufacturing property whose foundries and machine shops are capable of manufacturing at least 10,000 tractors per year including internal combustion motors of 30 hp. 1016.

SUPERINTENDENT AND FOREMAN of power plant. Capable of taking complete charge of large smelter plant consisting of steam turbines, large blowing engines and rotary blowers, Diesel engines, waste heat and oil fired boilers, pumping plant, high and low tension electrical equipment, etc. Must be familiar with combustion and operating problems, and have organizing and executive ability. Salary about $2500. Location Arizona. 1025.

DRAFTSMEN on miscellaneous mine and smelter equipment. Practical men with ten to fifteen years' mechanical and structural experience in shops, industrial plants and contract work, to act as squad leaders. Salary $190 per month, transportation refunded; 44 working hours per week; living expenses about $35 a month. Duration of employment not less than 5 months. Single men preferred. Location Copper Cliff, Ont., Canada. 1028.

GENERAL SUPERINTENDENT for plant with over 1200 employees near New York. Highly developed technique involving wide field. Applicant must have keen sense of justice and obvious ability to be successful executive in democratic organization. Thorough appreciation of importance of making deductions from facts alone; technical training. Men chosen for the position will be given opportunity to learn technique and establish himself in the confidence and esteem of the personnel. He will probably not be given full responsibility within a year. Plant is part of very large organization and affords ample opportunity for advancement. 1030.

ADVERTISING MAN. Boston advertising agency. Must be technically trained with advertising experience, preferably as advertising manager, and capable of taking full charge of accounts in engineering field. 1032.

DRAFTSMAN to make measurements and drawings of machine tools. Work will require considerable time. Good promise for the future. Young man of technical education and some practical experience, especially in machine tool work. Location Buffalo, N. Y. 1033.

PRODUCTION MANAGER. Age 35 to 45; married man preferred. Clean-cut, aggressive, of generous build preferred, executive ability. Technical graduate preferred, not absolutely required. Must have had actual shop experience in all departments, such as machine shop, drawing-room, tool designing, die making, etc. Thorough knowledge of design and operation of tools for press work absolutely necessary and familiarity with modern efficiency methods, including time studies, costs, planning, etc. Experience in electrical work desirable. Location vicinity New York City. Salary $3000 to $4000 or more according to qualifications. 1034.

FACTORY MANAGER, experienced in rubber industry, familiar with compounding and the different compounds. Salary $3000 to $4000. Location New Jersey. 1036.

MEN experienced in mill-room and press-room work of rubber industry. Day mill-room foreman. 1037. Night mill-room foreman. 1038. Foreman for press department. 1039.

MECHANICAL ENGINEER of some experience wanted for manufacturers of vegetable oils—linseed, castor, cocoanut, etc., crushing plants producing the raw material and refineries; young man out of college for five or six years, and engaged in manuacturing plant work. Knowledge of chemistry desirable, preferably both organic and inorganic. Absolutely trustworthy. Salary about $1800. Location New York State. 1040.

MASTER MECHANIC in long established manufacturing concern located near New York to take entire charge of construction, maintenance and repair departments, consisting of approximately 350 men. Must have experience and ability in organization, direction and efficiency methods. Excellent opportunity. 1041.

STEAM BOILER DESIGNER, experienced in water tube work. Location Erie, Pa. 1042.

REPRESENTATIVE AND SALES ENGINEER, especially in sugar house, and mill supplies; man from 25 to 35 years of age for manufacturers agents, machinery and supplies. Would be required to spend about three months in Cuba. Knowledge of Spanish essential. 1043.

MECHANICAL ENGINEER for about six months' position having several years' experience in the efficient use of steam in industrial plants, to systematize, distribute, run tests and economize on steam used for power, cooking and evaporation in various departments of large chemical plant. Hours 7—5.30. Salary $175. Location Brooklyn, N. Y. 1044.

SEVERAL INSTRUCTORS in mechanical engineering are needed by one of the large state universities in middle West, men having specialized training and experience in machine design, gas power engineering, and general laboratory work. Give complete statement of training, experience, minimum salary expected, and recent photograph. 1045.

INSTRUCTOR IN DRAWING, in large university in middle West. Technical graduate, preferably with drafting room experience. 1046.

YOUNG ORGANIZING ENGINEERS, for intensive management work, general manager's office, in one of the large units of the rubber industry. Opportunity decidedly promising. State initial salary expected, age, experience, qualifications, etc. 1047.

OFFICE EXECUTIVE for steel mill near Pittsburgh, competent to run office and direct men. Salary $125 monthly. Apply by letter. 1048.

MACHINE DESIGNER for automatic machinery for large rubber concern in northern Ohio. Prefer man with experience on machine tools. Pleasant surroundings, permanent position, opportunity for advancement. State age, education, experience, present and expected salary. 1049.

RESIDENT ENGINEER to superintend installation of foundations, buildings, gas machinery and piping. State experience and salary. 1054.

COMPANY manufacturing well-known food products desires mechanical engineer to study and improve methods of manufacture. Should have practical factory experience and be able to handle men. Good opportunity for energetic man. Location Long Island City. 1058.

TECHNICAL GRADUATE approximately 30 to 38 years of age with experience of sufficient breadth to be posted on problems of manufacture in more than one line. Man steadied by experience, yet ambitious to push ahead and interested in the various problems of manufacture and construction. Location Massachusetts. 1059.

ASSISTANT in mechanical laboratory of technical school in Greater New York. Recent mechanical engineering graduate with one or more years of practical work since graduation. Single man about 25 years of age preferred. Position offers exceptional opportunity for advancement. State age, education, experience, present employment and references. Enclose photograph with application. Salary $1200. 1060.

DESIGNER and lay-out man. Technical graduate with at least four or five years' experience in designing preferably on tools and fixtures, labor-saving and semi-automatic machinery. Location Michigan. 1061.

YOUNG MECHANICAL ENGINEER in cement plant, capable of designing machinery layouts, following up same in field and working into position of assistant superintendent. Give age, references and salary expected. Location Kansas. 1062.

SUPERINTENDENT for shipyard. Man experienced in the construction of wooden boats and barges. Eastern location. 1064.

FOREMAN in tool room of large factory making steel stampings. Salary to start $2000 to $2500. Location central New York. 1070.

YOUNG ENGINEERS desiring positions in which they might gain experience and advancement according to merit, in drafting room, in development of new and useful ideas and the improvement of old ones pertaining to oil well drilling tools. Salary $125 per month to start. Advancement according to capacity. Location Texas. 1071.

DRAFTSMAN familiar with piping layout of steam power plants, also assistant to chief draftsman capable of designing industrial buildings. Location Connecticut. 1074.

ELECTRICAL TESTER wanted immediately by Chicago blower manufacturer; will work as draftsman 20 per cent of time. Permanent with opportunity for promotion to salesman, designer or foreman. Salary $15.00 for first twenty weeks. Experience unnecessary. Describe education and physical condition. 1075.

GENERAL SUPERINTENDENT of shop employing about 500 men. Age between 35 and 42; technical education in mechanical engineering. Some knowledge of electrical and power plant engineering. Experience in machine shop work, ranging from small fine interchangeable work, tool and jig design and manufacture, intricate machinery, to finish machining work weighing 30 tons calling for the use of 100" lathes and kindred machines. Well educated, of good presence, self-confident, self-reliant, and energetic. New York State. Apply by letter. 1076.

MEN AVAILABLE

Only members of the Society are listed in the published notices in this section. Copy for notices should be in hand by the 15th of the month, and the form of the notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

TECHNICAL GRADUATE, E.E. and M.E., some power plant experience; for last six years engaged as instructor in mechanical engineering in two leading technical schools. Desires position which offers opportunity for advancement in power plant or research work. Will be free after June 15th. F-199.

INDUSTRIAL ENGINEER AND DRAFTSMAN. Single, age 29. Five years experience on modern industrial accounting, planning and scheduling production, stores, determining standard tasks, standardizing equipment; designing draftsman industrial plants, special machinery and transmission work. At present employed. Good reason for desiring change. Interview New York City. F-200.

SHOP EXECUTIVE. Practical superintendent and technical graduate. Desires to locate in New York State or New England. Salary $3,000. F-201.

ASSISTANT TO EXECUTIVE. Graduate mechanical engineer, with eight years experience and some business training, can plan and follow up productive operations, wishes to engage with a growing manufacturing concern. F-202.

CONSTRUCTION ENGINEER. Stevens graduate, age 28, wishes connection with industrial company in construction or maintenance work. Has had seven years experience with large construction company for which he is now acting as purchasing engineer. Familiar with costs, specifications, and commercial as well as technical and practical features of building construction. F-203.

HEATING AND VENTILATING ENGINEER. Technical graduate. Seven years experience in design, installation and writing specifications for heating and ventilating and power plant equipment for group of buildings, industrial and public. Age 29, married. Minimum salary $2,000 a year. At present employed. Location immaterial. F-204.

MECHANICAL ENGINEER. Age 25. Technical graduate; power plant consulting, teaching, and some shop experience. Desires position with manufacturing concern where there is opportunity for advancement. At present employed. F-205.

TECHNICAL GRADUATE. Three years practical experience in boiler, gas and power plant work. Available latter part of June. F-206.

WORKS MANAGER. Graduate M.I.T., age 39. Thoroughly experienced in the manufacture and design of electrical devices and fittings, special and automatic machinery, armored cable, flexible metallic tubing and conduits, electro-galvanizing, sherardizing, etc. Specialized in the manufacture of interchangeable parts, applied for fifty patents, and had experience in patent litigation. Thoroughly conversant with modern shop organization, efficiency methods, production and handling men. At liberty June 1st. F-207.

MECHANICAL ENGINEER. Fifteen years experience in combustion and maintenance engineering. Would like to connect with large concern who wishes to improve conditions. F-208.

PRODUCTION ENGINEER OR SUPERINTENDENT. Successful executive. Technical graduate: 20 years experience in positions from foreman to manager. Experienced in revising plant management and in the introduction of modern systems. F-209.

MECHANICAL AND ELECTRICAL ENGINEER. Experienced in railway management. Twenty-four years practical experience. Can give good service in office management and administrative service, and assistance in organizing, engineering, maintenance or construction work. Knowledge and experience with materials of construction. F-210.

MECHANICAL ENGINEER. Age 47. Thorough and wide experience of 25 years in design and manufacture of general machinery, steam shovels, tank work, boilers, etc., including departments of correspondence, estimating, drawing room and shop construction. Desires agency or representation in City of Cleveland for outside representative and responsible firm. F-211.

ASSISTANT SUPERINTENDENT OR ENGINEERING EXECUTIVE. American, age 34. Eight years general engineering experience covering complete design, construction and maintenance of public utility properties. Energetic and ambitious. Has reached limit of advancement with present employers. Desires to connect with industrial concern within 300 miles of Chicago. Available upon three weeks notice. F-212.

SUMMER POSITION wanted by Junior Member with practical and teaching experience in drafting room, shop and laboratories. F-213.

EXECUTIVE OR SALES ENGINEER. Technical graduate. Past 15 years responsible charge of engineering work, construction, operation and management, together with several years experience as sales engineer. Desires position more or less executive. Salary to be commensurate with position. F-214.

MECHANICAL ENGINEER. Age 27. Columbia graduate. Five years experience in design, construction, and inspection with prominent concerns. Desires position in executive capacity, or as assistant with good chance of advancement. Employed at present, but will consider any fair offer. F-215.

WORKS MANAGER OR CHIEF ENGINEER. Graduate Stevens Inst. of Tech. Especially experienced along mechanical and operating lines; charge of design and tests of cars for city railway company, and operation of large steel mill for number of years. Assistant superintendent and chief engineer with well known firm of power transmission machinists and engineers. Experienced in production work in several types of industries for firm of consulting engineers. Salary $3,000-$4,000 depending upon character of employment. F-216.

ASSISTANT TO SUPERINTENDENT OR WORKS MANAGER. Technical graduate, 27. Four years experience as graduate student apprentice, time study man, rate setter and foreman of methods, with large manufacturing company. Available July 1st. Salary $1,800-$2,000. F-217.

MAINTENANCE-MECHANICAL ENGINEER. Graduate M.E. Columbia University. Design, inspection, shop maintenance and power house experience. Employed at present. Salary $30. F-218.

YOUNG ENGINEER. Age 26. Five years general machine shop experience, tool designing, and production work, graduating in mechanical engineering this June. Desires to locate with reputable concern in Southeast in production, efficiency work, or metallurgy. F-219.

ENGINEER, with experience in testing, operating, erecting, and repairing power house and boiler house equipment. Also experienced in various shop work. Technical graduate in steam and electrical engineering. At present employed but desires position with concern where there is chance of advancement. Location preferred in Western states. F-220.

MECHANICAL ENGINEER. Experienced in steam power plants, water works, compressing engines, rope drives, screw and pan conveyors, elevators and crushing machinery, and general mill machinery. Desires position with industrial manufacturing plant, in capacity of superintendent or master mechanic. Competent organizer and capable of handling men. Salary to be commensurate to position offered. F-221.

SALES ENGINEER. Practical machinist, technical graduate, experienced in drafting room, plant operation and selling. Age 31, married. Now holding position requiring salesmanship and good engineering ability. Desires change and would be available in 30 days to one looking for aggressive, capable man of integrity to push a line with merit, preferably on salary and commission basis. Willing to entertain straight salary or straight commission. F-222.

EXECUTIVE, ASSISTANT TO EXECUTIVE OR GENERAL MANAGER. Over 15 years experience in positions covering chief executive, office and works manager, consulting, construction, and efficiency engineering. Recent work has been in connection with manufacture of munitions. At present employed. F-223.

STUDENT MEMBER. Bucknell University. Graduate '17 in mechanical engineering course. Two years shopwork experience. F-224.

MECHANICAL ENGINEER. American, age 31, married. University graduate. Six years experience designing medium and light machinery. At present employed. Best references. Desires permanent and responsible position as designer or in any capacity in which experience will be available. F-225.

[illegible] ENGINEER OR PROFESSOR [illegible] M.E. [illegible] teaching [illegible] [illegible] engine laboratory [illegible] during [illegible] practical experience [illegible] operating and [illegible] plan work and [illegible] At present employed. F-226.

[illegible] PLANT ENGINEER. Technical education [illegible] practical experience. Desires position as [illegible] construction and maintenance of factory buildings and [illegible] with growing manufacturing concern where opportunity for [illegible] Experience as designer of modern factory build[illegible] engineer on erection. At present employed with [illegible] Salary expected not less than $2000 [illegible]

WORKS MANAGER OR ASSISTANT TO EXECUTIVE. Mechanical [illegible] technical graduate. Fourteen years varied experi[illegible] construction and installation work, including ordnance design [illegible] apparatus, hydraulic machinery and structural steel. [illegible] fundamentals of steam and electrical engineering [illegible] practical with executive ability, not afraid of work or [illegible] Location preferably East or South. F-228.

STUDENT MEMBER graduating in June from the mechanical engineering course of well known university, desires position in any mechanical engineering line in New York, New Jersey or Connecticut. F-229.

PRODUCTION SUPERINTENDENT. Twenty years experience in manufacture of interchangeable parts and designing of tools and fixtures for rapid production. Experience in engine and automobile parts manufacturing. At present located with large factory in Middle West. F-230.

RAILWAY ENGINEER. Age 37. Technical education. Seventeen years experience as railway machinist, draftsman, chief draftsman and mechanical engineer. Desires position with railway company, supply house or industrial plant, with greater responsibility and opportunity. At present employed. Location immaterial. Salary $2,400. F-231.

FUEL TESTING ENGINEER. Desires position as combustion engineer for large user of coal. At present employed. Technical graduate, age 34. Seven and a half years experience in scientific testing of coal in industrial plants, for large coal company in Middle West. F-232.

SALES ENGINEER. Desires position as sales manager for coal-operating company. Graduate, experienced in scientific testing and selling of coal. At present employed. F-233.

WORKS MANAGER OR SUPERINTENDENT. American, age 45. Practical and technical. Thoroughly familiar with all branches of the manufacturing business from drawing board to sales, on steam, gasoline and oil engines—standard, marine and tractor—mining machinery, electric motors and generators A.C. and D.C. Vacuum machinery and since the war on 18 Pr. shrapnel 18 Pr. H.E. 6-in. and 8-in. Howitzer. Specialized on efficiency methods, piece, premium and bonus systems, using unskilled labor as specialty men on accurate interchangeable parts, building and power plant construction. At present employed. Best of references. F-234.

DRAFTSMAN, MECHANICAL. Age 24. Experienced in the design and erection of steam power plants, wishes permanent position with power company, with chance of advancement. Not less than $115 per month to start. At present employed. F-235.

MECHANICAL ENGINEER. Sixteen years varied experience in testing, design, foundry, chemistry, metallurgy, special devices. Special aptitude for investigation work. Desires permanent connection with reputable concern leading to technical executive position. F-236.

RESEARCH OR EXECUTIVE POSITION. Technical graduate. Eight years industrial plant experience, largely in chemical and steel industries. Demonstrated ability in work requiring originality, inventive ability and thorough understanding of technical principles. Effected important improvements factory and power plant designs and operations. Capable in handling of men and development of subordinates. Position should offer not less than $3,300 and opportunity. F-237.

EXPERT ENGINEER-SALESMAN. Graduate of leading technical school. Age 35. Desires connection as salesman or sales manager with [illegible] manufacturing pumping machinery, air compressors, or internal combustion engines. Fourteen years sales experience in this line. Thorough, capable and aggressive and can secure results. Best of references from past and present employers as to integrity, honesty and ability. Minimum salary considered $2,500 per annum. New York City or vicinity; available on reasonable notice. F-238.

SUPERINTENDENT. Age 36. Practical tool maker with 18 years experience in light and medium interchangeable manufacture and has held all positions up to and including superintendent. Desires change. F-239.

MANAGER, MECHANICAL AND MARINE ENGINEER; designer; college graduate, age 36, married, American citizen, speaks English, French, Italian, Spanish, some knowledge of German. Three years practical experience as marine engineer. Six years district manager of electric illuminating and manufacturing company. Six years experience in mechanical design of electrical machines with two leading American manufacturing concerns; expert calculating engineer. At present employed; five years in present position; open for engagement in U. S. or abroad. New York City preferred. F-240.

CEMENT MANUFACTURING DESIGNING ENGINEER. Cornell graduate with 20 years' experience designing, constructing and operating cement manufacturing plants both wet and dry processes; broad engineering and executive experience, wishes to make permanent connection where results count. F-241.

INDUSTRIAL ENGINEER, CHEMICAL PLANT EXPERIENCE. Nine years' experience in design, construction, operation and maintenance of industrial plant machinery and power plants. Wide experience in purchasing materials, handling all classes of labor and chemical plant design and maintenance. F-242.

WORKS MANAGER. Mechanical engineering graduate, 37 years of age, having had several years' successful experience as factory manager, desires to make change. Prefers New England location with growing concern in which an interest may be secured. F-243.

EXECUTIVE POSITION wanted by American, technical graduate. Twelve years' experience in steel plant and general engineering work. At present employed. Will arrange for New York interview. F-244.

The question may naturally be asked by the busy manufacturer: "Of what special economic value is all this careful adherence to system and detail in the training of boys for factory work, and what are the results obtained for the outlay of money required to maintain the training department and school, with the necessary corps of foremen, assistant foremen, instructors for the class rooms, clerk, stenographer, etc.?" The answer is this: Every manufacturer knows there are times when it is practically impossible to secure enough good journeymen to fill the departments of his factory with competent, skilled help. He is often compelled to take into his shops unskilled labor and break them in on one or two operations in order to turn out the required amount of product. Furthermore, there is a demand at all times in the larger establishments of the country for skilled labor, and this is where the economic value of training boys and young men is plainly demonstrable.

Out of a force of 400 to 500 apprentices, approximately 120 will graduate each year from the four-year course and hold certificates as journeymen. From 60 to 80 per cent. of this number will remain in the factory for a longer period than one year, and it is safe to assume that a reasonable percentage will remain for an indefinite period.

What is the result? There is a constant influx into the factory of young men possessing not only a knowledge of one of the several trades necessary, but trained in the various shop practices and routine of the factory in which they have been schooled. If these young men remain for a term of years, the employer gains the advantage of their services during the most active period of life, when the energies of mind and body are at their best. Furthermore, the chances of their continuing loyal and faithful to their employer's interest during their term of employment are, on the average, much greater than would be the case with newly engaged employees coming from other and distant localities and having little or no interest either in the city or the factory in which they are employed.—*American Machinist.*

ENGINEERING SURVEY

A Review of Engineering Progress and Attainment in Mechanical Engineering and Related Fields, Including a Digest of Current Technical Periodicals and a Selected List of Engineering Articles

Notes from the Engineering Colleges

Equipment of Laboratories—Investigations in Progress—Changes in Curricula

As a result of inquiries by The Journal, data have been secured from many of the schools and colleges which give courses of instruction in engineering, upon certain features of the professional work which they are undertaking. In particular, information was sought upon (1) characteristics of the laboratory equipment and the kinds of investigations in which the different institutions specialize; (2) tests or researches which have recently been under way or which are in prospect; (3) important changes in curriculum.

The replies have been summarized and the first installment of the information received is given below. In this connection, attention is called to the summary of what is being done by student bodies of the various colleges in military preparedness and service to the country, as recorded in the Student Sections' Department of this number of The Journal.

Johns Hopkins University

RESEARCH WORK

Separation of Tar from Coal Gas: It is hoped to develop a type of separator which will be simpler than those now in use and show an improvement over present methods of recovering the very valuable residues from the gas-manufacturing processes.

Cooling Water for Power-Plant Purposes: A new type of spray head or spray nozzle has been developed for finely dividing large quantities of warm water (Fig. 1). This can satisfactorily handle about 250 g.p.m. as compared with 40 or 50 g.p.m. in the case of other types. The capacity of the new nozzle and the fineness of division of the water are controllable from the side of the spray pond, and the nozzle can be flushed or freed from sediment or solid matter by operating the adjusting means. Probably the most effective known means for cooling water in large quantities is found in the forced-draft cooling tower, which is particularly effective because the cooling effect is controlled according to requirements. The newly developed spray head provides for complete control in a manner comparable to that of the forced-draft tower. The expense of installation and operation of a pond is very much smaller than that of a forced-draft tower. The investigation of the whole question of cooling water is still in progress.

Pumping Water with the Discharge from a Gas-Engine Cylinder: A device has been developed by means of which water can be elevated by attaching a spring-loaded relief valve to the cylinder of an internal-combustion engine and connecting it with the combustion chamber. Immediately after each explosion this valve discharges a certain portion of the hot gases through a nozzle similar to that of an ejector, and by the expansion of these hot gases through the nozzle, water is drawn from a suitable supply reservoir and is discharged through a pipe leading away from the relief valve. By this means large quantities of water have been elevated to a height of about 75 ft. Enough of the hot gas of explosion is left in the cylinder at each working stroke to cause the engine to continue to operate, in addition to pumping water. Upon closing the relief valve, the engine can carry the full load for which it is designed. This pump may have application in various regions where irrigation and reclaiming works are under way.

Concentration of Metal-Bearing Ores by Flotation: It is supposed that flotation is caused by the fact that certain oils will wet metal, while they will not wet or adhere to non-metal-bearing rock dust. Ordinarily compressed air is blown into the mixture of ore and water and oil. It has been found necessary in many cases to heat the air or the water, and further, to supply some carbon dioxide with the air. The discharge from a gas-engine cylinder is not only hot, but it contains something like 10 per cent of carbon dioxide, and the gas-engine discharge makes an excellent agitating medium, because of the high velocity with which it is discharged from the cylinder. These facts have led to the development of an agitator for use in the flotation process. The means are similar to those above described for pumping water. In both cases it is not the ordinary exhaust from the engine which is used, but high-pressure gases which would otherwise remain in the cylinder during the working stroke of the engine. Tests made show that a very satisfactory concentration is obtainable, and tentative arrangements have been made for trying the method at a mine.

Fig. 1 New Type of Spray Nozzle

Cleaning of Used Lubricating Oils: A new type of agitator for liquids has been developed, suitable for producing very minute subdivisions of liquids containing finely divided solids. It has been applied to clean used lubricating oils, particularly those of automobiles, trucks and the like. By the use of the agitator the finely divided carbon or other solid matter can be very easily and cheaply separated and the oil rendered suitable again for its original purpose.

Smoke-Stack Design: The smoke stack of the university power plant was designed with a view to investigating impor-

ant problems, and means were provided for taking accurate and extensive measurements of pressures, velocities, temperatures, etc., during the operation of the plant. Various problems are being investigated.

Measurement of the Air Required for Combustion in Furnaces: Means have been provided for measuring all of the air supplied to the Taylor stokers under two of the boilers in the power station. The determination of the size of blowers and the engines for operating them depends directly upon a knowledge of the amount of air required. This matter affects not only the operation of boiler furnaces, but also furnaces used in connection with the iron and steel industry in metallurgical processes. Some tests have already been concluded.

Losses in an Ammonia Refrigeration System: A very complete ammonia compression system for artificial refrigeration is available in the mechanical laboratory, and an investigation is under way for the determination of the losses of energy and the locations at which they take place. Means have been provided for accurately measuring the quantity of brine circulated in the refrigerating pipes; and this means of measurement is being utilized for another investigation, namely, the determination of the coefficient of discharge of a hydraulic weir when brine of varying temperatures and densities is passing the weir.

Cracking of Petroleum Vapors: The 125-hp. Diesel engine in the laboratory has been used for compressing petroleum vapors to a high pressure in a very brief period of time, with the object of producing separation of the vapors into such products as gasoline, etc. An investigation of this problem has been carried on, and it is expected that the results will be published at an early date.

Recovery of By-Products from the Distillation of Carbon in the Manufacture of Coke and Gas: In response to the demand among the industries for specific information for the production of artificial dyes, drugs, explosives, etc., a laboratory is being equipped for work in this important field. A fund of about $6,000 has been subscribed by the principal gas and coke companies of this country, and the equipment is now in process of erection. The instruction and operation of the plant will be conducted jointly by the Department of Mechanical Engineering and the Department of Chemistry.

Lehigh University

Equipment: Engineering testing laboratory, also physical, electrical, chemical, metallurgical and mining laboratories. The engineering laboratory has a boiler equipment of two water-tube boilers rated at about 100 hp. each. In the heat and light plant there are three 250 hp. Stirling boilers. The engine room of the laboratory contains a vertical triple-expansion engine of 75 hp., a 60 hp. compound two stage Ingersoll air compressor, a complete set of Westinghouse air-brake apparatus, two large condensers, a large belt dynamometer, a Cochrane feed-water heater of 250 hp. capacity. The engine room of the power house contains units of 50 and 100 kw. rating. Simple horizontal Ball engines are direct connected to General Electric alternating current generators.

The laboratory for testing materials contains a general testing section for iron and steel, a cement and concrete section, and a hydraulic section. An electric traveling crane of 10 ton capacity commands the entire central portion of the building in which the testing of large specimens is carried on. The general testing section is equipped with an 800,000 lb. Riehle vertical screw testing machine; an Olsen universal testing machine of 300,000-lb. capacity; smaller machines for ordinary tension, compression, transverse and torsion tests.

The mining laboratory consists of a gyratory crusher, rolls, screens, jigs, Huntington mill, classifiers, concentrators, gravity stamps, amalgamating plates, grinding pan, and cyanide plant, with the necessary apparatus. The laboratory for testing samples contains a small jaw crusher, a small gyratory crusher, rolls, sample grinder, a magnetic separator, and a small air compressor. A special department is equipped for flotation methods.

Experimental Work: Determination of the coefficient of expansion of silica brick; physical tests on properties of concrete columns.

Columbia University

Equipment: Only about 10 per cent of the research work in the mechanical-engineering department is done at the university, so that the laboratory equipment is used mainly for teaching.

Experimental Work: Tests for obtaining data alone are only casually undertaken and then only under special circumstances. The regular laboratory work for students is conducted on lines which are distinctly research in character. Ninety per cent of the research work is done in the field and consists not so much in research but in what is called development work—taking an invention, putting it into practical form to see whether it will work and modifying it until it does work. This work is all done for interested parties.

Development Work: The skill and experience of the research staff is reserved for development work in which there is a distinct commercial or scientific end clearly in sight before the start. People who do the work are the instructing staff and the employees of the firms interested in results. The work is paid for by the firms. Students are rarely used and when they are used, they are only permitted to make readings or make calculations on results. All kinds of researches are undertaken except on material of construction and on pure mechanism. The former are taken care of in the civil engineering and metallurgical and mechanical engineering departments of the university. The latter are also taken care of elsewhere. Some design work in pure mechanism in developing new machines is undertaken, however, this design going hand in hand with the shop work. The nature of the subject-matter of the researches undertaken is almost entirely thermal or chemical. The work is concentrated on processes of a thermal or chemical nature and equipment for properly carrying them out. The work ranges from small isolated problems to problems of large plant installations. Following is an outline of the organization as proposed:

Industrial Development Laboratories: These are to be created for the purpose of promoting the welfare of American manufacturing institutions through

a Furnishing equipment and the services of the best scientific thought in creating, perfecting and introducing improved methods of economic production of commodities and industrial services

b Training engineers in the science of industrial development to the establishment of more economic operating conditions in manufacture.

This service might be rendered through the following means:

a Transposition of new and important principles into industrial and operating units and their perfection into com-

mercial possibilities; for example, the discoveries made by the chemist in his laboratoray might be worked out on a manufacturing scale and plans and specifications may be made available to the manufacturer in developing new lines of industry or in perfecting old ones

b Analysis and development of old processes and their modification and improvement to meet modern economic requirements

c Improvement of physical equipment of plants and methods of business management thereof

d Plant appraisals and reports for financial, legal and ownership interests

e Public service; for example, through these laboratories may be had the best information on the engineering problems arising in municipal and state governments; municipal

Chemical Industries: Electrochemical laboratory, furnace laboratory, distillation laboratory, wet-reaction laboratory, destructive distillation laboratory

Mining Industries: Mining laboratory

Metallurgical Industries: Metallurgical-processes laboratory, ferrous and non-ferrous; metallurgical analysis laboratory

Electrical Industries: Electrical-development laboratories

Manufacturing and Transportation Industries: Aeronautical laboratory, marine laboratory, transportation building, machine-design building, hydraulic laboratories, refrigeration and compressed-air building, steam-engineering building, steam-boiler and furnace building, gas-power building, heat-transfer laboratory, mechanical-standard building and development shops

Administration: Administration building, power, heating and lighting plant.

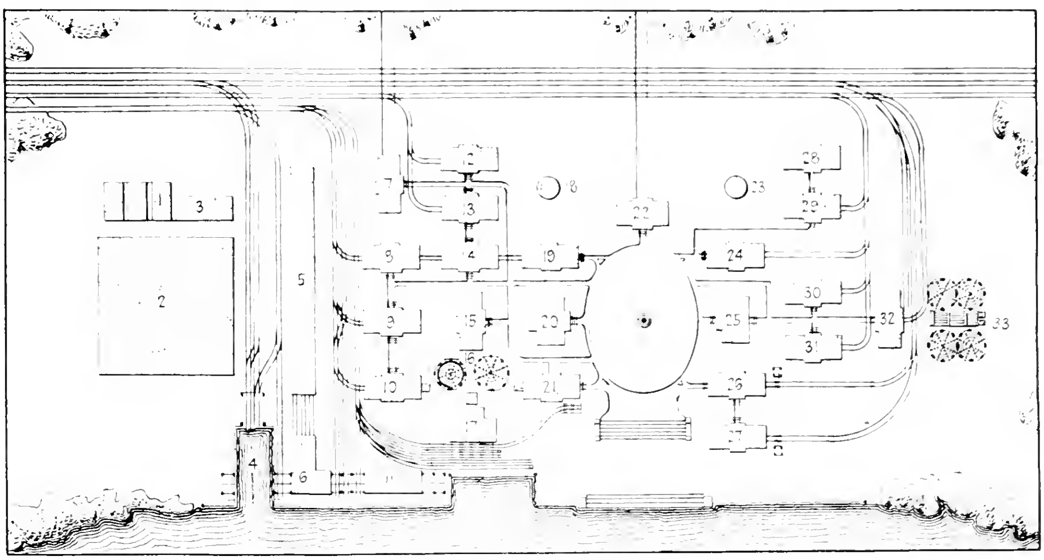

FIG. 2 PROPOSED INDUSTRIAL DEVELOPMENT LABORATORIES FOR COLUMBIA UNIVERSITY

1 Hangars
2 Aviation Field
3 Aeronautical Laboratories
4 Slip
5 Model Tank
6 Marine Laboratory
7 Transportation Building
8 Shop
9 Steam Engineering
10 Steam Boiler and Furnace
11 Hydraulic Laboratory
12 Shop
13 Shop
14 Machine Design
15 Refrigeration and Compressed Air
16 Gas Tanks
17 Power House
18 Water Tank
19 Heat Transfer
20 Mechanical Standards
21 Gas Power
22 Administration
23 Water Tank
24 Mining
25 Chemical Laboratory
26 Electrical Laboratory
27 Electrical Laboratory
28 Metallurgy
29 Metallurgy
30 Chemical Laboratory
31 Chemical Laboratory
32 Chemical Laboratory
33 Gas Tanks

engineers and engineering commissioners will be able to avail themselves of the best assistance in the erection and maintenance of public works, municipal light and gas properties, drainage, sewers, garbage disposal, street cleaning, paving and many other engineering activities of a municipality.

f Laboratory research on problems of allied interests; as, for example, ascertaining the cause of the failure of rails, the failure of concrete structures, the corrosion of steel structures, the rational conservation of natural resources, such as more economic methods of mining, more economic power generation, more economic methods of distributing commodities and such problems

g Service to the national government in connection with the Army and Navy equipment, etc.

The plant proposed for this purpose includes the following buildings:

The approximate cost is given at roughly two million dollars, to which must be added a like sum for the purchase of the necessary land. A proposed layout is given in Fig. 2.

Publications: Most of the material of the researches is not published because it is obtained for private parties. However, sometimes some of the results are in the form of principles of general interest which could properly be published, and the department promises in future to ask permission of its clients to publish material through the Society.

Curriculum: Theses are no longer required, and the time thus gained is devoted to direct work. This year is the last of the four-year courses of the old style. There is still one class left to be graduated this year. Next year is the beginning of the complete operation of the three-year engineering courses prece'ed by three years in college. This will put engineering in Columbia on the same basis as law and medicine. So far Columbia is the only institution in America which has established the three-year courses in engineering.

Massachusetts Institute of Technology

Equipment: The new mechanical laboratories cover an area of about 70,000 sq. ft. Before planning the laboratories a study was made of the equipments of other engineering schools both in this country and abroad. Leading steam, hydraulic, and refrigerating engineers were asked to criticise the preliminary plans and assistance of great value was obtained through this means. The equipment of the laboratories was selected with the following objects in view: first, to give a student practice in such experimental work as an engineer in the pursuit of his profession is called upon to perform; and second, to provide ample facilities for original investigation and research in engineering subjects. The laboratory is divided into six branches, material testing, steam and compressed air, hydraulics, power measurement, refrigeration and gas engine, and an expert in the particular line of experimental work is in charge of each branch.

Experimental Work: Design and construction of a machine for testing the crimp in tire fabric; tests of the relative wear of knit goods and design of machine for this purpose; economic investigation of central station conditions in several towns to determine whether or not the respective loads can be more economically operated from a common source; study of the effect of pressure on the temperautre at which spontaneous combustion of liquid fuel (gasoline, kerosene and some heavy oil) takes place; investigation of the heating of an automobile tire; study of the relative strength of rolled and cut screw threads in soft steel bolts; study of the theoretical possibilities of the different refrigerants and of various domestic refrigerating machines on the market, to determine those most desirable for domestic use; investigations of the effects of high-pressure steam on power plant operation; investigation of the strength of rivets due to duration of heating; determination of the respective lengths of copper, iron and brass pipes to give best economy in water heaters; investigation of the physical properties and performance of the Baush Universal joints; investigation concerning the effect of rest, after over-straining, on the elastic limit of steel; design of a hygrometer; investigation of the strength of phosphor bronze under varying thermal conditions; investigation of the strength of steel in the blue heat region; effect of reabsorbed moisture on fir and pine timber; study of wood preservatives; investigation of the effect of different sizes and aggregates in bituminous pavements; investigation of skew and plain arches of the same general dimensions; investigation of oyster shell concrete; effect on concrete of the time of mixing; study of the effect of various waterproofing compounds on concrete; effect of steam on concrete; strength of various types of rope; study of substances to prevent cement from setting; strength of magnesium alloys; strength of composite cables; strength of glue.

Leland Stanford Junior University

Equipment: The laboratory includes a good selection of apparatus for experimental work in fuel analysis, power plant work, automobile testing, friction and lubrication, refrigeration, hydraulics, hydraulic machinery, and aerodynamics. The laboratory for aeronautics has been developed along original lines in many respects. While it comprises the usual tunnel for testing models in an air-current, the main purpose at present is to carry out tests of various propellers. In this connection several novel instruments, permitting to carry out measurements of very high precision, have been developed. An interesting feature of some of these instruments is the application of the telephone receiver for location of the exact points in space or time which it is desired to determine for the purpose of measurement. The use of the telephone receiver in such connection, by no means usual in mechanical measurements, permits a considerable simplification of the measurement itself without sacrificing of the precision and to a certain extent eliminates the personal equation of the experimenter.

Experimental Work: Tests on oil heaters and coolers; investigation relating to thickness of oil film in journal; investigation on flow of oil in pipes in cooperation with the U. S. Bureau of Mines; investigation of air propellers for National Advisory Committee for Aeronautics; research on strength and durability of gear teeth under grant from Engineering Foundation.

Curriculum: The courses of instruction have been recast to fit in with the four-quarter system which the University has adopted, to become effective in the next academic year.

Case School of Applied Science

Experimental Work: During the past year the mechanical engineering department has made a special study of the fuel problem in Cleveland, and has been devoting its energy to the saving of coal in several of the small and moderate-sized independent power stations in and around Cleveland. The fuel problem has been a very acute one in Cleveland during the past year, as indeed it has been all over the country. Since the department is very well equipped to handle such problems, it can do the most good in devoting its energy in this direction.

Curriculum: Additions have been made as follows: a special course on the manufacture of high explosives and shrapnel, shells and time fuses; a course in field surveying adapted to military needs; modifications of the courses in physics and electrical engineering, directing the attention of the students to the application of electricity in warfare.

University of Washington (Seattle)

Equipment: Usual apparatus for student experiments on steam and gas engines, air compressors, and structure of materials; provision for research work on a 27-hp. gas producer, involving the use of mill refuse and bark; on a 2-ton refrigerating compressor plant; on lubricating oils; and on fuels. A dynamic balance for measuring wind pressures is being installed in the wind tunnel and it is expected to carry on an extensive series of tests on aerodynamical engineering problems.

The growth of ship building in this vicinity has been so great that the department expects to add a number of naval architecture subjects for the coming school year, and a new man to carry on some of this work and to handle the aerodynamic laboratory will be appointed during the coming summer.

Curriculum: Changes are proposed involving reduction in hours for mathematics, so as to have calculus for a year only, unifying the engineering courses for the first year at least, and the addition of a course involving engineering problems for the freshmen. This course is to be so arranged as to attempt a training in method and concentration, as well as to give insight into the nature of the work to be found in each of the engineering departments.

News of Other Societies

National Association of Cotton Manufacturers' Convention

THE convention met at the Copley Plaza Hotel in Boston, April 25 and 26, and was one of the most notable in the history of the organization as regarded attendance and interest of the program. It was also more diversified than usual, as it included in its numbers many representatives of other textile associations, from the South, West, and Canada.

The most important feature of the convention involved the report of the Committee on Enlarging the Scope of the Association. The general idea of broadening the activities of the association met the hearty approval of practically the whole membership. An essential feature of this broadening is the creation of a new class of membership—to be known as Sustaining Members, who shall contribute to the funds of the association on a payroll basis, no annual assessment being less than $50, nor more than $500. These sustaining members will enjoy the full privileges of active members and will also be entitled to such direct service as the National Council may be able to render.

The program differed materially in general character from those usual in former years. No printed papers were distributed, and, with the exception of the session on Wednesday afternoon, the topics under consideration were arranged in groups under the direction of different chairmen, who opened the discussion of subjects on which various members had come prepared to speak. This plan proved of greater interest and led to wider participation in the debate.

A number of technical papers were presented. John A. Stevens, Mem.Am.Soc.M.E., discussed the evolution of the steam turbine in the textile industry. He pointed out how from surprisingly small beginnings in 1883 the steam turbine has grown to such proportions that it has invaded practically every field formerly occupied by the steam engine, which is due to its many advantages as compared with the reciprocating engine, which advantages he carefully enumerated. It is an undisputed fact that the turbine in sizes over 1000 kw. has superseded the steam engine, and even in sizes 200 to 1000 kw. the advantage is still in favor of the turbine, particularly in sizes of over 500 kw. He covered the subjects of low-pressure turbines, mixed-pressure and bleeder types, and the use of reducing gear, and gave illustrated descriptions of representative mill installations. It is expected that a more complete abstract of the technical features of the paper will be given in an early issue of THE JOURNAL.

Representatives of the Federal and Canadian Bureaus of Forestry and of the Southern Pine Growers' Association gave several papers on mill roofs and decay of timbers.

Arthur N. Sheldon, Mem.Am.Soc.M.E., discussed the conductivity of mill roofs and methods for preventing condensation. He brought out that a certain thickness of roof is necessary for a given humidity, the thickness increasing as the humidity increases. The paper is based on experiments with concrete and plank roofs with various kinds of insulation. In the course of the paper the speaker pointed out that if the temperature of the underside of the roof coincides with the dewpoint for the particular humidity and temperature in use, there will be condensation. If the temperature of the underside of the roof is above the dewpoint, there will be no condensation on the underside of the roof, but condensation will take place somewhere in the interior of the plank, depending upon the heat gradient between the inside and outside temperatures of the roof plank. Hence, while it is easy to design a roof which would have no condensation on the underside, it is practically impossible (unless at considerable expense) to design a plank roof with no condensation on the upper surfaces, or somewhere in the interior of the plank. The speaker proceeded to give a comparison of a concrete roof properly insulated and a wood roof of proper thickness and insulation to prevent condensation. A diagram was shown indicating that a thickness of the roof plank of a little over 3 in. would be required, while a 4-in. concrete roof plus 1 in. of cork board would give approximately the same insulation. The prevention of condensation on the underside of the roof planks does not, however, eliminate the possibilities for decay, because there is always condensation between the roof covering and the roof boards during cold weather. It would therefore seem absolutely necessary to treat the wood timber to prevent decay.

Methods for identifying fungus growths were discussed by H. N. Lee, of the Forest Products Laboratory, McGill University, Montreal. The speaker outlined a course of investigation from which he hopes to be able to determine just what fungus is doing the damage to any wood, even if the fungus has not produced any characteristic fruiting body by which it would be immediately identified. He even hopes to be able to tell it from the effect on the wood itself when the fine threads of the fungus do not show. When this is done, any one having trouble from wood decay will have only to send to the laboratory a sample of the wood and the laboratory should be able to tell what fungus is at work; then as soon as this matter is worked out, it can be determined what change of humidity conditions is necessary to stop the development of the fungus, and with it the rotting of the wood.

At the banquet on Wednesday evening, April 25, Henry E. Crampton delivered an address on the Council of National Defense and the Cotton Industry. The speaker stated that there is a comprehensive plan being followed by the advisory commission of the Council, and a great deal more is being done than gets into the newspapers.

The papers of the Thursday session, April 26, were devoted to commercial matters and questions of health insurance, factory safety and sanitation.

A very complete and careful account of the proceedings of the convention will be found in the *Textile World Journal* for April 28, 1917, from which the facts of the present account were mainly taken.

National Electric Light Association Convention

INSTEAD of meeting at Atlantic City, as originally arranged, the National Electric Light Association changed its plans because of the war and held this year's convention in the Engineering Societies Building, New York, May 9 and 10. As characterized by the *Electrical World* of May 12, from which the main facts of the following account are taken, it was essentially a war convention. From the opening words of the president, Herbert A. Wagner, to the final adjournment, half a day earlier than anticipated, the serious responsibility resting upon the industry to make the best use of its facilities for the country was the dominant note of the business transacted.

The proceedings of this convention in their outward manifestations were vastly different from the usual sober and humdrum course of meetings of engineering bodies. Follow-

ing the appointment of the committee on the President's address a bugle was sounded, a squad of khaki-clad men marched in and the flag was raised, while the convention joined in the patriotic strains of "America."

The question uppermost in the minds of those in attendance, as to "How can we best serve?" was answered in the Public Policy Committee Report by saying that both as companies and as an industry the members of the N.E.L.A. can most effectively serve the nation by a continued maintenance of reliable service on the part of the public-service utilities, by conserving the health and safety of the public, and also by furnishing information and assistance to the Government through its organizations and technically trained men.

John W. Lieb, Mem.Am.Soc.M.E., who was elected war president of the association, spoke informally and presented interesting information on experiences in England, where the arguments of the companies supplying electricity secured temporary exemptions from call to the colors for their most important men, which gave them time to rebuild their organizations. He also called attention to the great difficulty of making the proper adjustments for the care of dependents of employees who go to the front without at the same time bankrupting the companies, and stated that it is still a moot question as to what may be exactly the best policy to be pursued.

The same problem was discussed by J. E. Aldred, who has large business interests in Montreal, Canada. While the original intention was to pay the men who went to the front the difference between their regular wage and what the Government gave them in the service, the plan was abandoned afterwards, to some extent, in favor of what is known as the Patriotic Fund. This, however, was not because the burden imposed on the companies by the former plan was excessive. In fact, the proposition not only stimulated enlistment, but also helped maintain the efficiency of the force left at home, so that in the case of the Montreal Light, Heat & Power Co. 30 per cent more business was done than in any previous year of its history. The change to what is known as the Patriotic Fund resulted from pressure from the agricultural sections.

L. A. Ferguson, Commonwealth Edison Co., Chicago, described a plan adopted by that company, but tentative to the extent that it is definite only until August 1. This is based on the theory that the company shall not pay anything to the man himself who goes to the front, but that it shall provide for the dependents he leaves at home.

Of the papers presented in the technical sections, the one of greatest interest to mechanical engineers is the report of the Prime Mover Committee, of which J. M. Graves, Mem. Am.Soc.M.E., is chairman. The report discusses turbines, condensers, station auxiliaries, stokers, refractory materials, coal handling and storage, weathering and spontaneous combustion of coal, etc. Feasibility and practicability of higher steam pressures, condenser cleaning, economical steam velocities and pressure drops, station instruments, analysis of power requirements of station auxiliaries, and treatment of boiler feedwater are also discussed, and comments made regarding Diesel engines, progress of waterpower development, operation and maintenance of hydroelectric stations, ice-handling methods and waterwheel testing.

The report states that there has been a great increase in the number of orders for large prime movers, the development of large condensers, boilers, stokers, and auxiliaries keeping pace with the development of the turbine. The largest turbine so far developed is rated at 70,000 kw., and the largest condenser on order has 100,000 sq. ft. of tube surface.

The tendency in regard to circulating pumps is in the direction of more water per pound of steam. With steam-turbine drive the general trend is toward high turbine speeds. Development work during the past year has been along the lines of adapting the underfeed stoker to high-ash Middle Western coal and to lignite, both of which are now being handled with entire satisfaction.

Owing to the increased rating of boilers the firebrick surfaces have been proportionately increased and higher temperatures have produced greater expansion and contraction in them, so there are more frequent failures both in arch and side walls. Various methods have been tried to strengthen the flat walls, but with little success. Buttresses built inside of the combustion chamber were burned off in a very short time. Sheet-iron linings were also tried, but were melted down as soon as the firebrick inside had been burned away or partly destroyed by slag.

Several pages of the report are devoted to an extensive discussion by J. A. Walls on the question of protection against different forms of ice, including frazil and anchor ice. It is pointed out that if the first formation of frazil ice is not quickly observed, the ice will accumulate so fast as to make a shutdown inevitable. One means of detecting the onset of frazil or ground ice is to immerse a chain in the flowing water of the forebay and examine it every half hour or oftener. Frazil or anchor ice cannot form until the temperature of the water drops to freezing; hence a graphic thermometer will, in many cases, serve as a warning against any danger which may threaten from this cause.

National Fire Protection Association

AT the annual meeting of the National Fire Protection Association, held at Washington, D. C., May 8-10, the main subject for discussion was the new and unusual fire hazards and danger to life and property created by the state of war, and which demand the utmost vigilance on the part of the state, municipalities, and private individuals. Definite recommendations were made which included the following: The adoption by municipalities of the standard building code of the Board of Fire Underwriters, and by the state, of minimum building requirements for its public institutions; the enactment in each state of a fire marshal law; inspection of buildings by city fire marshals; levying the cost of extinguishing preventable fires upon citizens disregarding fire-prevention orders; more extended use of the automatic sprinkler; study of the technical survey of cities made by the Board of Fire Underwriters in regard to fire risks and efficiency of fire fighting apparatus, and the education of the children and the public generally in careful habits regarding the use of fire.

Among the reports discussed were the following of particular interest to mechanical engineers:

Uses of Wood in Building Construction. Containing a new standard for mill construction, with data on the decay of wood and its prevention; and the strength of timber and how to calculate it.

Roof Openings (skylights) and Cornices.

Standards for Pipe and Pipe Fittings. Containing specifications and tabulated dimensions of sprinkler pipe fittings, including long-turn fittings.

Explosives and Combustibles. Dealing mainly with fuel oil, acetylene gas for welding and lighting, and gasoline, with sug-

gestions regarding the safety of acetylene apparatus and the safe use of motion-picture film.

Safety to Life. Dealing, first, with the number of occupants permissible in a building, basing the number on the stair capacity with a view to safe exit in case of fire; and second, classification of the occupants of buildings by inflammability of materials manufactured, stored or used. The first part of the report is comprised mainly of a tabulated form showing the capacity per unit of stair width, and the second part of an elaborate list indicating the materials manufactured or handled and the risk involved according to whether the property would be considered as of "low inflammability," "moderate inflammability," or "high inflammability."

Ammunition Manufacture and Safeguarding of Industrial Plants. This timely paper treats mainly of the situation existing in the manufacture of artillery ammunition and of small-arms ammunition.

A brief description is given of the types of shells and cartridges used and of the processes of manufacture. Suggestions are made for safety in manufacture, and the important feature of guarding ammunition plants which are subject to attack by agents of an enemy is considered, with definite recommendations calling for such provisions as the following: adequate fencing in of property; armed guards; adequate lighting of yard and fences; wiring fences with charged electric wire connected with tell-tale device which will give a signal in case of a short-circuit; bars or screens at windows; patrol organization, etc. The report goes into these matters very fully and in detail.

Fire-Resistance Construction. The important feature of this report is the discussion of what has been designated as "full," "partial" and "temporary" protection in order to indicate the fire-resistance qualities of various materials and types of construction.

Conferences have been held by representatives of various associations, including The American Society of Mechanical Engineers. The representatives of the Society were Ira H. Woolson, Chairman of the committee which prepared this report, and W. C. Mowry, appointed by John R. Freeman, Chairman of the Sub-Committee on Fire Protection of The American Society of Mechanical Engineers.

At these conferences it was decided that the terms "full," "partial" and "temporary" should be superseded by terms indicating time, such as 4-hr. protection, 2-hr. protection, 1-hr. protection, etc. A time-temperature curve, shown in the accompanying diagram, was adopted to indicate standards of fire resistance. A scientifically-determined time-temperature curve is regarded of so great importance that it has been proposed to make the subject one for discussion at the next annual meeting of The American Society of Mechanical Engineers.

Protection of Openings in Walls and Partitions. In this report a feature of importance relates to the control of automatically-closing fire doors in buildings. A definite recommendation is made for the use of apparatus the operation of which depends on the rate of temperature rise, to replace fixed-temperature devices such as now used. By such improved apparatus the door will be closed in case of rapid rise of temperature before a fire will have an opportunity to sweep through the doorway and endanger the contents of the adjoining room, as so often happens with the fixed temperature device, which does not operate until a certain predetermined temperature has been reached. The mechanism of the device which has been recommended is of considerable interest. When a rise of temperature occurs equal to 15 deg. or more within one minute, the air in an inclosed chamber expands a diaphragm plunger and sets into operation a series of releasing levers. Under ordinary conditions the air in the chamber is maintained at atmospheric pressure through the medium of a vent, which is calibrated to permit rise in temperature of

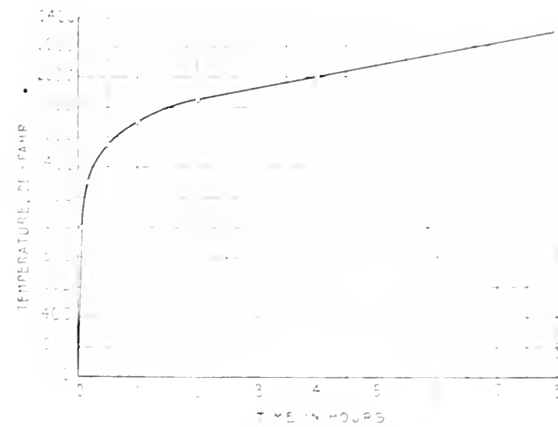

Fig. 3 Tentative Standard Time-Temperature Curve for Fire Tests of Building Construction

(1000 deg. at 5 min.; 1550 deg. at 30 min., etc.)

less than 15 deg. per minute without producing pressure enough to operate the diaphragm.

The secretary of the National Fire Protection Association is Franklin H. Wentworth, 87 Milk St., Boston.

American Chemical Society

The 54th meeting of the American Chemical Society was held in Kansas City, Mo., April 10 to 14.

Like all meetings at this critical period in the life of the nation, that of the chemists was held under the red star of war. The following resolution was unanimously passed by the assembled members: "Resolved, that we reaffirm the tender to the President of the United States of the services of the members of our Society in all the fields in which we are qualified to act. The progress of the war thus far principally teaches us that modern warfare makes extraordinary demands upon science, food supply and finance. For the protection and success of our men under arms we recommend the use, in their respective fields, of all trained chemists, physicists and medical men, including advanced students of these subjects, to this end, in collaboration with the United States Bureau of Mines, we are preparing a census of chemists. With no desire to avoid field service for men of training in the professions named, we urge that those of special ability be held to the work they can best perform. Thus we may avoid unnecessary loss from lack of control of the tools and requirements of war."

In the afternoon a public session on petroleum and natural gas was held, at which several papers were presented. Of particular interest to mechanical engineers are those of H. C. Allen and E. E. Lyder, on Variations in the Compositions of Gas of the Mid-Continent Field, and E. P. Fisher, on Some Experiences in the Use of Oxy-Acetylene Welding in Long Distance Natural Gas Transportation.

The temperature of a boiler tube is within 10 to 20 deg. cent. the same as that of the boiler water, and the temperature of the tube is affected very little by the temperature of the hot gases, but follows the temperature of the boiler water.

A Reference to the Spring Meeting of 1916

At the meeting of the House of Representatives on May 7 last, a quotation was taken from the New York *Times* of May 8. Representative John Q. Tilson of Connecticut, a Republican member of the Military Affairs Committee, discussed the manufacture of United States rifles, and disclosed the fact that only a very limited quantity of such rifles can be manufactured for the United States Government within a reasonable time because of the difficulty of procuring gages.

"Do you think that is good information to make public?" asked Representative Robbins of Pennsylvania.

"Everybody knows it except ourselves," replied Tilson. "All our enemies know it."

It is interesting to recall in this connection that the facts stated by Representative Tilson on May 7 were convincingly brought forward more than a year ago by members of The American Society of Mechanical Engineers at the Spring Meeting of 1916, New Orleans, in the discussion of Mr. Spencer Miller's paper on Organizing for Industrial Preparedness.

Among others, F. O. Hoagland stated that while the Government has at times placed small contracts for rifle-ammunition manufacture, no private manufacturer has ever made the 0.30 Springfield rifle, nor has he any special tools, fixtures, or gages necessary for making them. Quick service is not to be expected unless several of these concerns are placed in condition to meet the demand. Mr. Hoagland estimated that it would take about twelve months to prepare the special equipment of fixtures, tools and gages necessary for the production of, say, 100 military rifles per working day, and about half that time to prepare for 100,000 cartridges per day even when a factory has at the start a fair organization for similar work. The Government arsenals could be of great assistance in preparing the special equipment of fixtures, tools and gages, but a few leaders and workmen in each plant who are thoroughly familiar with the requirements are absolutely necessary in order to get quick and sure response.

In a joint discussion of the same paper, Frank O. Wells and Charles E. Smart pointed out the need for our machine shops to be equipped to manufacture munitions of war at short notice. While for over two years all the machine shops in the United States had been working for the Allies, yet new designs for jigs and fixtures were still upon the drawing boards and new gages and tools were being made in hundreds of shops all over the country. As a conservative estimate, they said, it would require 50 engineers, designers and draftsmen at least 50 weeks to prepare the drawings for the 17 sizes of shells now used by the United States Army, together with drawings for gages, fixtures and tools. To produce the latter would require probably 800 men well trained and in well-organized factories at least five years, calculating 300 working days per year. And this does not cover the question of aeroplanes, rifles, battleships, or a large number of other important parts of equipment which also must be provided for.

The manufacture of rifles formed the subject of a communication by Fred E. Rogers luminously covering the very points which Representative Robbins doubted the wisdom of making public at the present time. "The manufacture of rifles," wrote Mr. Rogers, "is a complete process, requiring special skill and experience, and with the exception of our Government arsenals, there was at the outbreak of the present war perhaps not one plant in the United States properly equipped and manned for manufacturing military arms. There are about 800 principal machine operations involved in making the parts of the simplest military arm, including the wood stock and hand guard. Many of these operations require special machinery, and practically all the parts must be in jigs or fixtures while machining. When we consider the fact that to provide equipment for an army of 1,000,000 from 2,000,000 to 3,000,000 rifles are required, the size of the task of equipping an army of 1,000,000 with shoulder guns alone becomes apparent. *What the condition of this country would be in a sudden emergency we can only guess. Judging from the experience of some of our ill-advised manufacturers who undertook to make shells, it would be of great confusion and enormous waste.*"

K. A. Juthe, in discussing the experience of American manufacturers in the production of rifles for foreign governments, stated that the gage problem was one of the greatest magnitude, as it was found that it would take at least 300 first-class gage makers to furnish the first working set, inspector's set, and the master set necessary for guns in quantities. And when 1000 complete rifles per day is figured on, it means that the working sets would be increased from one to ten, and the inspectors' sets from one to five, keeping the master set simply for reference. It was shown conclusively that among the total of practically 2500 to 3000 first-class gage makers in the country there was no adequate means of tackling several different propositions at the same time.

In regard to tool making, it was found that the jigs, fixtures and small tools required would take a small army of tool makers. It would take at least 1000 tool makers one year to furnish tools of this kind for the output of 1,000 rifles per day. Therefore, should our Government require, say, 500,000 or 1,000,000 rifles per year, our tool plants would be taxed to the utmost.

It appears, therefore, that what Representative Tilson stated in Congress did not disclose any military secrets, but as J. H. Brophy said at the meeting, "I am under the impression that it will take years of pounding away at the facts to enlighten the people on this great undertaking of Industrial Preparedness."

The way the situation has worked out, as announced by the General Munitions Board on May 15, is that the British Enfield rifle, chambered for regulation U. S. Army cartridges, will be used for our troops; and field guns of tried foreign types, but of American manufacture, will be introduced into the service. Manufacturing facilities for the Springfield rifle are not adequate to supply the number of rifles required for the force which the United States will raise and to replace the wastage of such a force. Fortunately the existing small-arms factories which have been turning out quantities of rifles for the British army are equipped to manufacture the Enfield rifle in more than sufficient number.

Engineering Committee of National Research Council

The first meeting of the Engineering Committee of the National Research Council was held on May 3 in the rooms of the National Advisory Committee for Aeronautics, Munsey Building, Washington, D. C., with Gano Dunn, Mem. Am.Soc.M.E., as Chairman. There were in attendance the following members of The American Society of Mechanical Engineers: Gano Dunn (Chairman), John A. Brashear, Wm. F. Durand, John R. Freeman, Hollis Godfrey, George E. Hale, F. H. Newell, S. W. Stratton, Ambrose Swasey, and Charles D. Young.

Mr. Dunn explained the necessity for coöperating with the engineering societies and for fixing the relations between the Engineering Committee of the National Research Council and the Committee on Science and Research of the Advisory Commission of the Council of National Defense, of which Dr. Hollis Godfrey is chairman. The scope of the work of the Engineering Committee as explained by the chairman is to be engineering incidental to research work and not original engineering work unconnected with research, although it was pointed out at the same time that the line of demarcation between these two fields is not very clear.

Dr. F. H. Newell then spoke of the work of the Institute for Government Research. This institute is financed privately and the work is conducted solely for the purpose of helping the Government to simplify its procedure and hence to economize, and its work has the active sympathy of the Council of National Defense and the National Research Council.

Dr. George E. Hale spoke generally of the relations of the National Research Council to other organizations engaged in national defense, in working out certain problems of great importance, the first of which was protection against torpedo attacks.

As regards the matter of the organization of the Engineering Committee the meeting adopted the suggestion of John R. Freeman, to the effect that a single head of the Engineering Committee resident in Washington should be appointed and confer with the other members of the committee and with the members of the National Research Council in Washington. Wm. F. Durand was appointed Washington head of the Engineering Committee—to be known as Vice-Chairman of the committee, with Mr. Dunn remaining as Chairman.

The matter of dealing with inventions next came up for discussion, i.e., whether inventions should be referred to the Naval Consulting Board or the Engineering Committee should undertake to pass upon them. After considerable discussion the matter was left to be determined by the Engineering Committee, but the consensus of opinion was that when it is a question of passing on an invention without relation to any other aspects of the matter, it should be referred to the Naval Consulting Board. In other cases the Engineering Committee should consider the matter.

It was generally agreed that as much publicity as possible should be given to the needs of the Government in the solution of its engineering problems by the engineering societies, with the understanding, however, that there are certain matters which cannot properly be made public.

At the conclusion of the meeting Dr. Godfrey spoke at length with regard to the relations of his Committee on Science and Research of the Council of National Defense to the National Research Council; but explicitly disclaimed any intention of doing research work or of passing upon research work in his committee, and stated that all research work, whether engineering or scientific, would be referred directly to the National Research Council.

New Equipment on the Lehigh Valley

THE general tendency in American railroad equipment to use heavier and bigger tractive units is well exemplified by the recent steps taken by the Lehigh Valley. This railroad succeeded in materially reducing its train-miles in freight service on several divisions by the use of powerful Pacific type and 2-10-2-type locomotives built by the Baldwin Locomotive Works.

By the use of the Pacific-type locomotives between Manchester, N. Y., and Coxton, Pa., a distance of 175 miles, two fast freight trains which were previously hauled by heavy 10-wheel locomotives having a tractive effort of 31,000 lb. have been consolidated. This achievement is all the more significant as the stretch is by no means an easy one. From Coxton to Summit, N. Y., about 120 miles, there is a steady upgrade with many curves, the gradient running as high as 0.4 per cent.

On the Wyoming Division, between Pittston and Athens, Pa., the Pacific-type locomotives are also used for heavy express passenger traffic. These locomotives are among the most powerful of their type, with a tractive effort of 48,700 lb., or more than twice as much as the tractive effort of the 10-wheel locomotives which they replace. While in many respects they resemble the latest design of the Lehigh Valley Mikado locomotives they differ from the greater part of the motive-power equipment on the Lehigh Valley in that they are designed for burning bituminous coal.

The 2-10-2-type locomotives are used in slow freight service between Manchester, N. Y., and Sayre, Pa., a distance of 88 miles, with 0.4 per cent grades. Each of these locomotives will haul 4000 tons and make the 88-mile run in 6½ hours, thus replacing two heavy consolidation locomotives. They burn a mixture of fine anthracite and soft coal.

The boilers for both of these types have a conical ring in the middle course by which the diameter is increased from 83¾ in. to 94⅞ in. The seam of the smokebox ring is welded along the top center line of the boiler. All the seams in the firebox, including those in the combustion chamber, are welded. The side and crown sheets are in one piece, being ⅜ in. thick; the door sheet is likewise ⅜ in. thick.

In both types of these locomotives the reciprocating parts are of special steel to reduce their weight. The piston heads are made of rolled steel of light section, 1 in. thick at the piston-rod hub and 11/16 in. thick at the outside of the web. Hunt-Spiller bull rings are held in place on the piston head by a retaining ring which is welded to the piston head. The packing rings are also of Hunt-Spiller metal. All extended piston rods are of Mikrome steel.

The crankpins, connecting rods, stop straps and extended piston rods are made of Mikrome steel. The piston rods are held in the piston head by a single nut provided with a nut lock made from a disk 5/16 in. thick in the body and ⅛ in. thick at the circumference. After the nut has been drawn up tight this disk is cut and bent over on to the faces of the nut. These nut locks are made of dead-soft steel and are used only once.

For the foregoing information credit is here given to *The Railway Mechanical Engineer*, May 19, 1917, pp. 231-234 (vol. 91, no. 5).

National Advisory Committee for Aeronautics

FROM a letter from the Committee dated April 27, 1917, is taken the following information supplementary to the article describing its constitution and activities in the May issue of THE JOURNAL (p. 454). This covers all information to date, of which some was not available at the time when the May issue went to press.

To facilitate the work of the Committee the following sub-committees have been established:

Aerial Mail Service. Brigadier General George O. Squier, U. S. A., Chairman.

Aero Torpedoes. Lieut. J. H. Towers, U. S. N., Chairman.

Aircraft Communications, Dr. Michael I. Pupin, Chairman.

Airplane Mapping Committee, Brigadier General George O. Squier, U. S. A., Chairman.

Bibliography of Aeronautics, Prof. Charles F. Marvin, Chairman.

Design, Construction and Navigation of Aircraft, Brigadier General George O. Squier, U. S. A., Chairman.

Governmental Relations, Dr. Charles D. Walcott, Chairman.

Nomenclature for Aeronautics, Dr. Joseph S. Ames, Chairman.

Patents, Dr. Charles D. Walcott, Chairman.

Physics of the Air, Prof. Charles F. Marvin, Chairman.

Power Plants, Dr. S. W. Stratton, Mem. Am.Soc.M.E., Chairman.

Relation of the Atmosphere to Aeronautics, Prof. Charles F. Marvin, Chairman.

Standardization and Investigation of Materials, Dr. S. W. Stratton, Mem. Am.Soc.M.E., Chairman.

Foreign Representatives, Dr. Charles D. Walcott, Chairman.

The Second Annual Report of the Committee has just been issued and copies may be had on application to the Committee. This publication contains reports on the following subjects:

General Specifications Covering Requirements of Aeronautic Instruments

Nomenclature for Aeronautics

Mufflers for Aeronautic Engines

Gasoline Carburetor Design

Experimental Researches on the Resistance of Air.

The Committee has also investigated the facilities available in various colleges, technical and engineering institutions, and among manufacturers and aeronautical societies, for carrying on special investigations.

At the present time the Committee is proceeding with the establishment of a field experimental station, near Hampton, Va., for the scientific study of aeronautical problems.

The Committee expects to have a testing laboratory, wind tunnel, and machine shop, and specifications for the necessary buildings are being prepared. The operations of the Committee will be in conjunction with the Army and Navy.

An investigation of air propellers, under the direction of the Chairman, Dr. Wm. F. Durand, Mem.Am.Soc.M.E., is being conducted at the Leland Stanford Jr. University, and a special wind tunnel has been installed there in connection with this work. It is expected that the results of this investigation will appear in the Third Annual Report of the Committee.

Work now being carried on at the Bureau of Standards comprises the testing of aeronautical materials, spark-plug investigations, and the study of carburetor design.

The patent situation in the aeronautical industry, which appeared to threaten its development, is in a fair way of being cleared up satisfactorily to all concerned, as a result of the interest taken in this matter by the Committeee.

The Committee will directly attack the more important problems of aeronautics as soon as its field experimental station is established.

If an examination of the ordinary hacksaw machine is made, it will be found that often the slides of the saw frame are narrow and do not have any convenient and durable method of maintaining alignment. The device for maintaining saw tension often is weak and cannot be locked to prevent loosening while the saw is in operation. These two features are important because unless the machine is well designed saw breakage will be excessive.

This Month's Abstracts

THE relation of horsepower to weight in an automobile and conditions affecting the output of same is discussed in an abstract of an article by A. Ludlow Clayden. Among other things, the writer points out the tempting ease with which fake power curves can be obtained, and touches in an interesting manner upon multi-valve engine design.

The relation between the chemical constitution and grain structure of bearing bronzes on one hand and their mechanical properties on the other is discussed in an article abstracted from the *Iron Age*. The writers claim that by scientific and skillful foundry methods a bronze containing lead may be produced without an impairment of its mechanical strength.

The tendency towards elimination of wastes is well illustrated in two articles on practically the same subject: one by Prof. J. W. Cobb, on The Utilization of Low-Grade Fuels, taken from an English publication; and the other on Coke Braize and Its Utilization, by W. A. Hamor, from *Coal Age*. These two articles show that economic burning of fuels, which until quite recently have been entirely wasted, may be considered an accomplished fact.

Wm. J. Leenhouts, from data secured in the Laboratory of the University of North Dakota, attempts to establish the basis for a scientific specification of gasoline. He rejects the gravity test, but considers volatility as the basic property of gasoline. At the same time he makes clear that with modern carburetors, products having a wide range of boiling points may often be economically burned. It is therefore suggested that if any specification be adopted by the Government, it should cover only the application of the name "gasoline" to a particular fuel, but should not restrict the sale of other fuels if marketed as "motor fuels" simply.

The application of regenerative principle to the design of gas furnaces is discussed in an article by W. C. Buell, Jr. Among other things, a graphic comparison of temperatures in the various parts of recuperative and non-recuperative types of gas-oven furnaces is given.

From the *Electrical World* is abstracted the description of the Montague City Station of the Turner's Falls Power and Electric Company, a large plant with a proposed output of 36,000 kw. Special attention is called to the enumeration of measuring and recording instruments used and the description of precautions taken against the spread of transformer fires.

In the section Measurements are given advance abstracts of three papers to be published by the Bureau of Standards, furnished to THE JOURNAL by courtesy of the Director of the Bureau.

The McClellon water-tube firebox is described and illustrated in the section Railroad Engineering, where will also be found an abstract of an investigation carried out at the University of Illinois on the resistance of passenger cars.

The deterioration of Curtis-Rateau turbine blading forms the subject of a paper presented by A. Fenwick to the South African Institution of Engineers and abstracted in the section Steam Engineering. An interesting part of this investigation is that referring to the use of aluminum bronze, which was found to be very satisfactory in the low-temperature stages, but entirely unsuited for the high-temperature stages. Attention is also called to the improved inlet nozzle, in which the cutting out of a portion of the vane eliminated troublesome breakage.

From a discussion of a paper on the Burning of Blast Furnace Gas Under Boilers, before the Engineers' Society of Western Pennsylvania, are abstracted data on the aspirating characteristics of various burners.

REVIEW OF ENGINEERING PERIODICALS

SUBJECTS OF THIS MONTH'S ABSTRACTS

Automobiles

Horsepower Facts and Fallacies, A. Ludlow Clayden

Discussion of the relation of horsepower to weight in an automobile, horsepower curves and conditions affecting output.

There is a limit to the power which can be used in an automobile, this being the amount of driving effort that can be exerted without causing the wheels to slip, which again is a function of the weight on the driving wheels. Actually, however, as the writer shows, the horsepower developed is rather below one-half of what the respective cars could transmit, providing the usually assumed coefficient of friction between the tire and road is correct.

The writer disagrees with the statement made that the steam engine is nearer the ideal for automobile use than the gas engine. While in the steam engine the power output is more constant than in the gas engine, what is particularly desirable in a car is constant tractive effort, and this is no more easily obtainable with steam than with gasoline.

As regards this latter, Fig. 1 shows curves of tractive effort per 1000 lb. of car weight plotted against speed for some cars of different types, fours, sixes, eights and twelves, of good makes. It is immediately noticeable that the best performance of any gives an effort under 16 lb. at the best speed compared with 25 lb., which is theoretically possible. The six or seven designers have apparently aimed at the best torque at low speed, leaving the high speed to take care of itself. The great difference in the shape of the curves is also very striking, especially as the curves from which these illustrations were made, had been submitted to the writer confidentially, and are, therefore, rather more accurate than the general run of "publicity" curves. None the less, there is some suspicion that the curves are not entirely reliable throughout their length.

In this connection the writer calls attention to the possibility of faking up power curves. An imaginary example of such a curve is shown in Fig. 2. The lower curve is probably obtained from the stock engine in normal condition, and then the upper curve obtained by tuning it up. Now, the normal condition curve is fairly accurate, and so is the tuned-up curve *above a certain speed.* But the upper curve cannot possibly coincide with the lower curve over the slow-speed range as shown in the illustration, and the departure from the truth is caused by drawing a good-looking straight line downward from the last observation (this is still more clearly brought out in the following paragraph).

Among other things the article discusses in an interesting manner the question of multi-valve engines. Fig. 3 gives a comparison of two curves made from the same engine with carburetors of similar design but different sizes. The better high-speed curve fairly coincides with the lower one at 800 r.p.m., and here the better curve really ends. With the larger carburetor, steady pulling at 700 r.p.m., with full throttle, was possible, but was not reliable. With a smaller instrument full-throttle operation down to 400 r.p.m. was certain, but at the

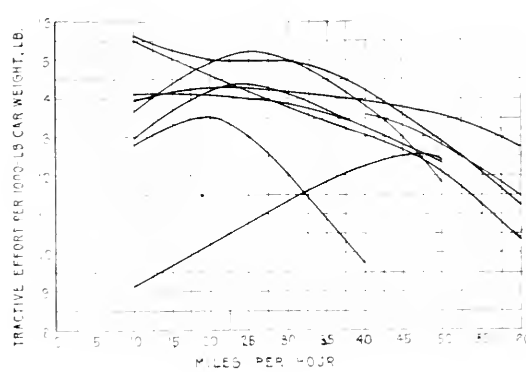

Fig. 1 Diagrams of Tractive Effort in Pounds per 1000 lb. of Car Weight Plotted Against Road Speeds from 10 to 60 m.p.h.

expense of loss of power at from 1500 r.p.m. up. Here one can see how easy it is to make a misleading curve. From having investigated the range from 800 to 2000 r.p.m. on the large carburetor, we should have a beautiful straight-line power curve, which looks just as though it would continue down to about 100 r.p.m.; but it does not.

The most interesting thing about these tests is, however, that even the largest carburetor used was far smaller than the "breathing capacity" of the engine. Hence, even with the largest carburetor, it would probably be found that, while the maximum power might be raised 20 per cent by using the full breathing capacity of the engine, it would not be possible to use full throttle below 1000 r.p.m., corresponding to about 25 m.p.h. with normal gearing. This brings the writer to the conclusion that increasing the valve size or lift, or using more than two valves per cylinder, would not help the power curve *throughout* the range of normal operation.

What the author thinks, however, is that the problem could

be [illegible] by [illegible] the power the same and [illegible] the weight of the car 10 per cent. This cannot be done at present, but the knowledge gained in light-engine build[illegible] from aviation work holds out a great promise

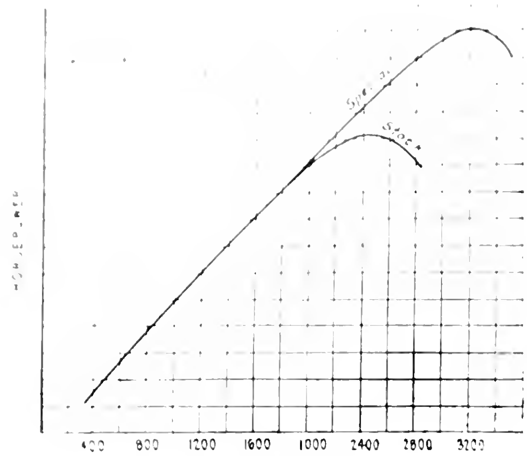

Fig. 2 An Imaginary Example of Fake Power-Curve Drawing

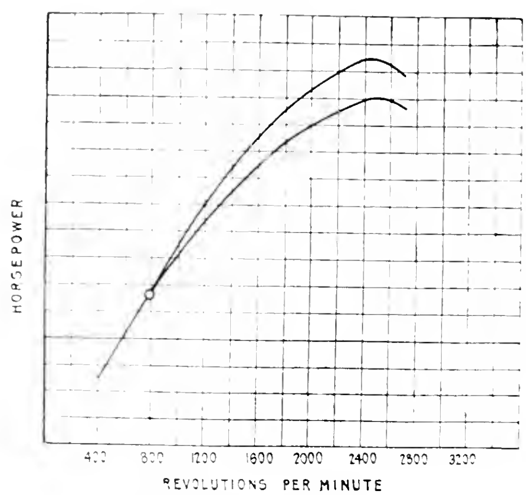

Fig. 3 Actual Curves Made from the Same Engine, but with Different-Sized Carburetors of the Same Make

for the future. (*The Automobile*, vol. 36, no. 17, April 26, 1917, pp. 820-824, 8 figs., *d*)

Statements that operation on kerosene as compared with gasoline gives a greater mileage per gallon if carburetion and compression are properly cared for, seem to be borne out by a recent A. A. A. test of a new system for using kerosene in which a distance of 25.5 miles per gallon was run on kerosene as against 23.0 m.p.g. of gasoline with a Ford car and stock carburetor.

This test was under sanction of the American Automobile Association and under the supervision of E. A. Hillman, representative of the A. A. A. contest board for this territory, Chicago. With the same setting of the carburetor at which the economy test was made, an acceleration from 10 to 15 m.p.h. was made in 15.6 sec. With that adjustment the car idled down to 10 m.p.h., but with a richer adjustment its running was good at 4 m.p.h. The car had been in service since last fall.

Engineering Materials

Bearing Bronzes and the Microscope, C. H. Bierbaum, Mem.Am.Soc.M.E., and Verne Skillman

Discussion of the relation between the chemical constitution and grain structure of bearing bronzes on one hand, and their mechanical strength in various respects on the other hand, and also discussion of the influence of lead on the properties of bearing bronzes.

In this case three bronzes were investigated. Two of these were found to be almost identical in chemical composition, but under tension test one was more than 50 per cent stronger than the other. This was explained when photomicrographs of these bronzes were taken. These photomicrographs are reproduced in Fig. 4, and show that apparently the lower tensile strength of bronze *A* was due to improper metallurgy and defective foundry practice in its production.

TABLE 1 CHEMICAL ANALYSIS AND MECHANICAL PROPERTIES OF THREE BEARING BRONZES

a Chemical Analysis

	Bronze *A* Per Cent	Bronze *B* Per Cent	Bronze *C* Per Cent
Copper	86.75	86.0	86.0
Tin	10.79	11.0	9.5
Lead	....	0.5	2.5
Zinc	2.40	2.5	2.0

b Mechanical Properties

	Bronze *A*	Bronze *B*	Bronze *C*
Elongation, per cent	1.5	8.0	6.0
Yield Point, lb per sq. in.	16,000	17,500	17,000
Tensile Strength, lb. per sq. in.	20,500	32,500	25,000

This would indicate the importance of making a microscopical examination in addition to chemical, physical and mechanical tests of metal alloys.

Another rather unexpected condition was found in two of these bronzes (*B* and *C*) whose principal difference in composition was that bronze *C* contained 2.5 per cent lead, while *B* contained none. The bearing value of lead in bronzes is well known, and it is also supposed that it weakens the metal. It has, therefore, always been a matter of compromise in the making of leaded bronzes as to how much strength should be sacrificed for a gain in bearing qualities. But if the strength of a bronze can be increased by scientific and skilful foundry methods, the bearing value of that bronze can be greatly increased by the presence of lead. This is claimed to have been done in the production of bronze *C*, where the presence of lead, while enhancing its bearing value, does not prevent it from having a higher strength than bronze *A* which contains no lead (cp. analysis in Table 1).

The two tables reproduced as *a* and *b*, Table 1, are of interest in that they give a basis for a comparison between the chemical composition and mechanical properties of the three bronzes above referred to. (*Iron Age*, vol. 90, no. 16, April 19, 1917, pp. 946 and 947, *d*)

Firing and Fuels

THE UTILIZATION OF LOW-GRADE FUELS. PROF. J. W. Cobb

Discussion of various methods of using very small fuel or dust. The difficulty of burning such fuel under a boiler is that a bed of it acts like a large sandlute, which acts, in its turn, as a gas sieve. The resistance of the numerous but minute channels through the fuel is so very high that, although the structure is quite porous, no reasonable pressure will drive any considerable quantity of air through it; while excessively raising the pressure results in the lute "blowing" in weak places.

In this connection, the writer describes the Bettington boiler, in which a blast of air carries the coal from a separator, through a fine sieve, to the bottom of a vertical water-tube boiler, and the mixed blast burns as a huge jet through a water-cooled nozzle vertically into the combustion chamber. The time which a particle, in passing through a boiler of this kind, can spend in the combustion chamber is remarkably small and therefore the combustion itself is usually somewhat incomplete.

Attempts have also been made to gasify coal in an air-dust stream, which only carries oxygen enough for the purpose of gasification, leaving the completion of combustion to be effected by a secondary air supply either in a furnace or in an internal-combustion engine. In other words, the dust system has been attempted with a measure of success for the manufacture of producer gas; e.g., by Marconnet. In this producer a fine fuel is fed into a hopper, from which it falls on a revolving plate driven by a friction wheel. From this plate a small scraper feeds a fine rain of coal by way of a sloping plate to a fan which carries the air thus charged with particles of coal to the producer. The speed of the fan determines that of the revolving plate and therefore the supply of coal varies automatically with that of the air. The air-dust stream enters tangentially at the bottom of the producer, while the gas leaves at the top.

Considerable quantities of dust coke have been effectively disposed of in Mond gas producers in England. Further experiments have also come to the attention of the writer in which very fine fuel was gasified with some measure of success by mixing with an equal proportion of breeze from a puddling furnace.

From this the writer passes to a brief consideration of the use of low-grade fuel in the form of briquets, and finally to a method of treating coal proposed by Bergius and consisting essentially in heating coal to fairly high temperatures (300 to 400 deg. cent.) in an atmosphere of hydrogen maintained under very high pressure. (*The Iron and Coal Trades Review*, vol. 94, no. 2,565, April 13, 1917, p. 419, [illegible])

COKE BRAIZE AND ITS UTILIZATION. W. A. Ha[illegible]

In by-product coke-oven practice it is customary to call braize, or breeze, that portion of coke which passes through a screen having $\frac{1}{2}$-in. square openings. The calorific power of dry braize approximates 12,500 B.t.u. per lb., so that it is actually a fairly high-grade fuel. It is, however, difficult to burn by ordinary means, and the use of forced draft is essential to its proper utilization.

Recently, however, combustion appliances have been developed for its utilization and several types of equipment originally designed for the combustion of anthracite culm have been found readily adaptable to the burning of coke braize.

In this connection, the writer describes in detail the Coxe traveling grate, which is now being successfully operated with coke braize in several plants (Fig. 5).

In this grate the fuel-supporting surface is made up of keys called grate tops, which are small castings approximately $\frac{3}{4}$ in. wide, 9 in. long, and 2 in. deep. The top surface is curved and the front end of each key matches the rear end of the next key.

The stoker shafts are of cold-rolled steel and each shaft carries keyed to it two cast-iron sprockets located just inside of the side frames. Cast-iron flanges project inward from the side frames. To these flanges are bolted sheet-steel plates, forming a floor between the side frames about 10 in. from the bottom thereof, with vertical air baffles at each end of the stoker. On top of the floor are built two air boxes, or [illegible] boxes, extending across the stoker between the side frames and communicating, on one end through rectangular openings, with one side frame with the air connections from the [illegible]-draft air duct.

It is recommended that the air for combustion be supplied at a static pressure of 2 to $2\frac{1}{2}$ in. of water. The fuel is fed to a hopper extending across the front end of the stoker above the grate from which it is deposited on the grate, the thickness of the fuel on the grate being regulated by the adjustable coal gate. There are three or four air compartments each extending crosswise in the furnace, and in each of

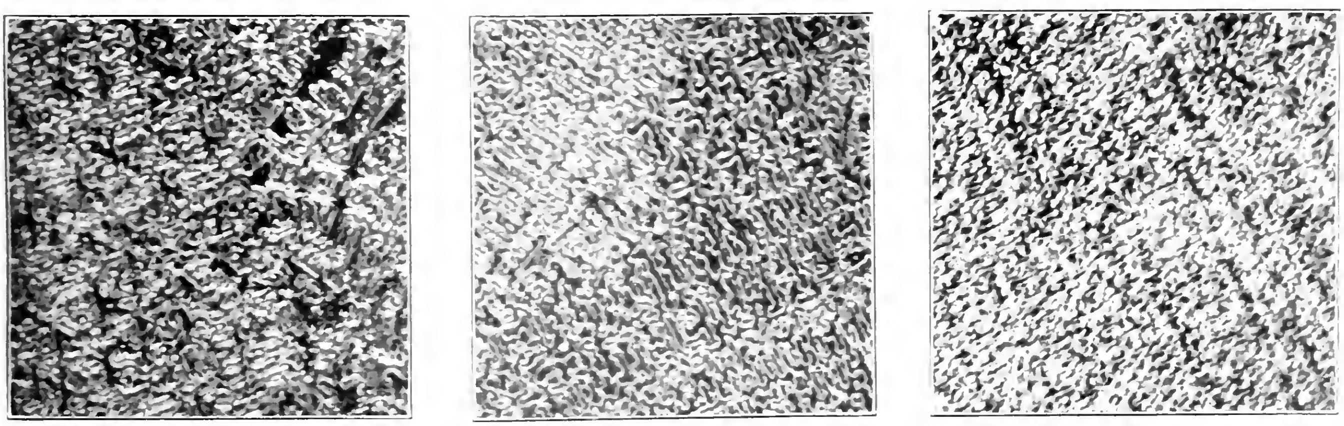

FIG. 4 PHOTOMICROGRAPHS OF BRONZES *A*, *B*, AND *C* (REDUCED ABOUT ONE-THIRD FROM THE ORIGINAL MAGNIFICATION OF 50 DIAMETERS) ETCHED WITH FERRIC CHLORIDE

that the air pressure may be independently regulated. It is thus possible to vary the rate of combustion over each air compartment as desired.

The three compartments may for convenience be called the ignition, combustion, and burning-out compartments; the function of these compartments being to enable the operation to vary the pressure under the grate in accordance with the thickness of fuel immediately above that section.

Under regular operating conditions in connection with a 500-hp. boiler, one of these stokers is stated to develop from 150 to 200 per cent of boiler rating with efficiencies ranging from 65 to 70 per cent.

The Parsons distributor has also been successfully used for burning coke braize. It consists of a steam-driven injector blower, which intermittently draws gas from the boiler furnace and projects it at high velocity against a small portion of the fuel which is simultaneously delivered into the path of the gas by a reciprocating pusher. A test (by C. J. Bacon, Mem.Am.Soc.M.E.) showed the efficiency and capacity of the

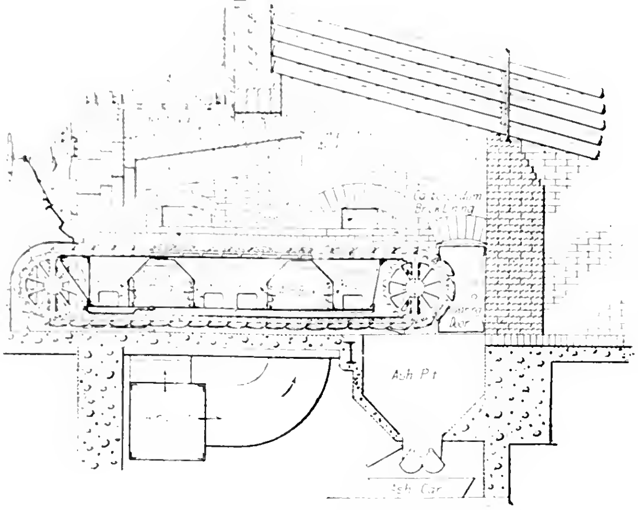

Fig. 5 Section of Cone Grate and Setting

distributor to be nearly the same with coke-dust as with coal. (*Coal Age*, vol. 11, no. 18, May 5, 1917, pp. 780-782, 2 figs., *d.*)

Gasoline Supply and Its Relation to Specifications, Wm. J. Leenhouts

Discussion of the supply of gasoline and its relation to consumption, the properties of modern gasolines and the bases of possible specifications.

Like every one else, the writer points out the probable inability of the present supplies of gasoline to hold out if the present rate and tendencies of consumption continue. He likewise points out that the great demand for gasoline has changed its quality very much. From year to year the residue in the gasoline has increased, which means that a larger portion of kerosene is being added continuously. The mixture of kerosene with gasoline does not, however, necessarily mean a poor motor fuel, as this depends on the amount and the portion of the kerosene range used in the mixing.

On the other hand, the claims made by many refiners for the superior power-producing qualities of their gasolines are largely without foundation. Automobile owners who have cars of suitable construction and necessary adjustments can get as good results out of cheap gasoline as out of expensive "high-test" product.

The problem of making a gasoline specification by legislation is not an easy one. The first question is what the specification shall be based on. The gravity test has been discarded by Director Manning of the Bureau of Mines. The investigations of the present writer show also that the gravity test may be entirely misleading. In the Petroleum Laboratory of the University of North Dakota there are two gasolines whose boiling range is nearly parallel and similar, but whose gravities are 49 and 55.5 deg. B. respectively. Further, the writer compares a gasoline of 49 deg. B. with the kerosene of the same gravity, and finds a difference of over 100 deg. in their initial boiling points, and a difference of 200 deg. in their end points. Because of this difference in the gravity for gasolines of a given volatility, gravity has been discarded as a criterion for rating a gasoline.

The basic property which determines a gasoline is volatility, or range of its boiling points. It is desirable to have a certain percentage of fairly-low-boiling constituents, so that engines may start more readily, but a large proportion would be undesirable because of loss through evaporation, and accidental ignition or explosion. A reasonable amount would probably be about 3.5 per cent at 158 deg. fahr. At the University Laboratory the average percentage of distillate at 158 deg. fahr. of all low-grade gasolines analyzed was 3.4 per cent for the year 1916 and 3.6 per cent for the year 1915. Again, a reasonably low end point is desirable in order to insure complete vaporization, but it makes an expensive gasoline. The average end point of low-grade gasoline is approximately 375 deg. fahr., with a residue of 37.5 per cent at 284 deg. fahr. The average end point for 1916 of all low-grade gasolines analyzed was 377 deg. fahr. and the percentage residue at 284 deg. fahr. was 37.6.

The grade of a gasoline is a variable factor when it comes to types of cars and their ages. Cars built three or four years ago were built for gasoline sold at that time, while a more modern car has a carburetor which can work efficiently with rather low-grade gasolines as put on the market to-day.

Hence, specifications, if made, must be broad enough so as not to exclude any type of gasoline from being sold.

The author suggests that perhaps specifications should cover only products sold under the name of *gasoline,* while all other products might be sold as *motor fuels.* Further, he suggests that any motor fuel might be placed on the market, but that it be labelled as to its 20 per cent and 90 per cent distillation temperatures, so that the purchaser would know the degree of volatility of the fuel he is buying.

If specifications are made, they should not be rigid and reduce the quantity of gasoline produced from a gallon of crude, nor should they in any way work against conservation of natural petroleum resources, and against the development of the petroleum industry.

In summarizing, the desirable properties of a gasoline are stated as follows:

1 Gasoline should not give a disagreeable odor before or on combustion. This is objectionable to users of automobiles and shows poor refining.

2 It should be free from matter not hydrocarbon, such as water, sediment, acid and sulphur. Acid and sulphur have a tendency to act upon the metal parts of an engine.

3 It should not contain excessive percentages of unsaturated

hydrocarbons because they have a greater tendency to carbonize.

4 It should not contain too large a percentage of volatile products because of loss through evaporation and danger of accidental ignition and explosion.

5 It should not contain a high percentage of heavy products which will not volatilize.

These are the requirements for a good gasoline. It still remains to fix the limits to these requirements. (*The Quarterly Journal of the University of North Dakota*, vol. 7, no. 3, April 1917, pages 251-260, 8 figs., *g*)

COMBUSTION IN THE FUEL BED OF HAND-FIRED FURNACES, Henry Kreisinger (Mem.Am.Soc.M.E.), F. K. Ovitz and C. E. Augustine

The main object of the investigation was to determine the conditions governing the process of combustion in the fuel bed in a hand-fired furnace. The results furnished data for correct design of coal-burning grates and furnaces and their efficient operation. They also cast light on the problem of clinker trouble as related to fusibility of ash, and indicated the possibility of a high rate of gasification of coal in gas producers.

The paper describes in detail the method of carrying out the tests and making various measurements involved, and presents the results in the form of tables and curves.

Among other things these tests indicate that with the 6-in. bed of Pittsburgh or anthracite coal the oxygen is all used up in combustion at a distance of 3 to 4½ in. above the grate. The CO_2 content reaches a maximum of about 15 per cent at a distance of 2 to 3 in. above the grate, and then decreases until, at the surface of the fuel bed, it is 7 to 10 per cent. At the surface of the fuel bed there is 20 to 32 per cent of combustible in the gases and practically no oxygen, but the percentage of the combustible in the gases increases rapidly beyond 3 in. above the grate.

With 12 in. beds of all three fuels tested and with the 6 in. bed of coke all of the oxygen disappears 4½ to 6 in. above the grate. But in all tests there was at the surface of the fuel bed a large percentage of combustible in the gas and no oxygen to burn it, showing that the fuel bed of any hand-fired furnace acts primarily as a gas producer. In many tests the gas at the surface of the fuel bed would be considered a fairly good grade of producer gas.

It was found that at the surface of the fuel bed and 1½ in. above it, the gases contained more oxygen, more CO_2 and less combustible than 1½ in. below the surface. This change in the composition of the gases was caused by air reaching the surface of the fuel bed from above, along the walls of the furnace, as shown in Fig. 6.

The effect of this downflow of air was much more marked with low rates of combustion than with high rates, because with a high rate the large volume of gases leaving the fuel bed more nearly filled the space above it and prevented the air from flowing down.

The fact that with coke the oxygen does not disappear as quickly as with the Pittsburgh and anthracite coal, is ascribed to the higher percentage of ash in coke and its uniform distribution through the combustible.

THE THREE COMBUSTION PROCESSES

The writers believe that combustion in the fuel bed consists mainly of three processes: namely, the oxidation of carbon to CO_2, the reduction of CO_2 to CO, and the distillation of volatile matter, this latter being of great importance with bituminous coal. The combustion is the result of contact of two streams, air flowing up through the grate and fuel which is fed from the top and gradually sinks toward the grate. At the bottom the air contains 21 per cent of oxygen and the fuel bed but little combustible; at the top of the fuel bed there is practically no oxygen and a high percentage of combustible.

The rate of oxidation of the lower part of the fuel bed depends almost entirely on the rate at which air flows through it. Next comes the reducing zone, in which the rate of reduction of CO_2 to CO depends on the temperature of the fuel bed and, up to a certain limit, on the length of time that the CO_2 is in contact with the hot carbon. The limit of reduction is the equilibrium between CO_2, CO and carbon at the temperature existing in the fuel bed, but at the high temperature which actually exists there the reduction of CO_2 to CO is a rapid process.

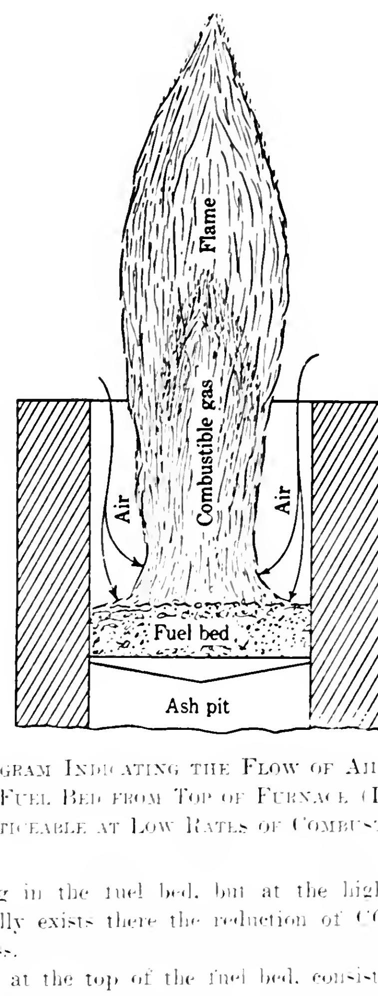

FIG. 6 DIAGRAM INDICATING THE FLOW OF AIR TO THE SURFACE OF FUEL BED FROM TOP OF FURNACE (DISTINCTLY NOTICEABLE AT LOW RATES OF COMBUSTION)

The layer at the top of the fuel bed, consisting mostly of fresh fuel, is the distillation zone. It overlaps the reduction area and extends about 2 in. below the surface of the fuel bed. There is, however, no sharp line of demarcation between the three zones, and particularly between the reduction and distillation zones. The rate of distillation depends on the rate of heating of the coal, which again depends on the temperature in the furnace, but with a given temperature the distillation is independent of the air supply, since when coal is heated the volatile matter distills off whether air is supplied or not.

Part of the combustible leaves the fuel bed in the form of soot, tar and cinders. The weight of soot and tar has been determined on eight tests with Pittsburgh coal, and comprises, roughly, about one-quarter of the combustible rising from the fuel bed. This quarter of the combustible is in a form which is difficult to burn in the combustion space, and if no provision

If the combustion is made a large part of it may go out of the chimney in the form of black smoke. It appears that smoke formed near the surface of the fuel bed and goes up to the chimney because the air supply is inadequate for its combustion. It is also possible that a large part of the volatile matter leaves the coal as tar, which immediately begins to break down into gaseous hydrocarbons and soot.

As to the temperatures in the different layers of the fuel bed, it appears that the temperature is highest between the oxidizing and the reducing zone, approximately at the point of maximum CO content in the gases. Further away from the grate in the reducing zone the temperature gradually drops, which is due to the reduction of CO_2, a heat-absorbing process.

Within wide limits the rate of feeding air has practically no effect on the composition of gases within the fuel bed, but affects directly the rate of combustion. In other words, if the rate of air forced through the fuel bed in a given time be doubled, the rate of combustion of the fuel is doubled, but the *weight of air forced through the fuel bed per pound of fuel burned or gasified is constant.*

For complete combustion air must be added over the fuel bed as the gases rising from the fuel bed contain a high percentage of combustible and no free oxygen, and this deficiency cannot be remedied by increasing the rate of air supply through the fuel bed.

Forced-draft apparatus cannot, however, supply enough air through the level fuel bed to insure complete combustion, and additional air must always be introduced over the fire in such a manner that it will mix with the combustible gases; otherwise a large percentage of them will escape unburned. The writers are careful, however, to emphasize that this does not make desirable admission of air through holes in fires and leaks in the furnace setting. The ideal way to supply additional air over the fuel bed is to introduce it as close to the fuel bed and in as large a number of small streams as possible. The nearer the air is introduced to the surface of the fuel bed, the more combustion space is utilized for mixing air with the combustible gases and for burning the mixture.

A thick fuel bed is undesirable because it increases the tendency of the coal to form troublesome clinker. Perhaps the only apparently defendable excuse for carrying a thick fuel bed is the fact that the chances of burning holes in the fuel bed are reduced. A skillful fireman avoids holes in the fuel bed by firing frequently and placing coal on the thin spots. A claim that fuel beds can not be kept in good condition if carried thin is a confession of neglect and lack of skill.

A fuel bed is understood to be only the layer of incandescent and freshly fired fuel, and does not include the layer of dead ashes and clinker on the grate.

The ash fuses in the upper layers of the fuel bed, and as it sinks it solidifies 2 to 4 in. from the grate. In most cases the fusion occurs in a reducing or partly reducing atmosphere, consequently in studying the fusibility of ash the determinations should be made in a partly reducing atmosphere.

As at the surface of the fuel bed the gases contain 20 to 32 per cent combustible gas and practically no free oxygen, to obtain complete combustion, additional air must be introduced over the fuel bed. This statement is true of all the fuels tested, including coke. As a general statement, about one-half of the 15 lb. of air used to burn 1 lb. of coal in a boiler furnace is supplied through the fuel bed; the other half must be supplied over the fuel bed. (*U. S. Bureau of Mines Technical Paper 137*, 1916, *etA*)

Furnaces

TESTS OF RECUPERATIVE GAS OVEN FURNACES, W. C. Buell, Jr

The regenerative-furnace principle has been applied to apparatus requiring high heat, such as open-hearth or glass furnaces, and has produced in addition to high flame temperature a material saving in fuel. To those operations in which close temperature limits are imperative, the regenerative principle cannot be applied directly, as the temperature of the heating chamber and the work of the regenerative furnace are highest just after the furnace is reversed. In fact, the pyrometer chart of the heating chamber of the regenerative furnaces resembles the edge of a saw, each sawtooth representing a reversal of the furnace.

The recuperative gas furnace described here has been designed primarily for the purpose of decreasing fuel costs. Of all the fuel used in a furnace from 25 per cent to frequently as much as 50 or 60 per cent is lost through the vent.

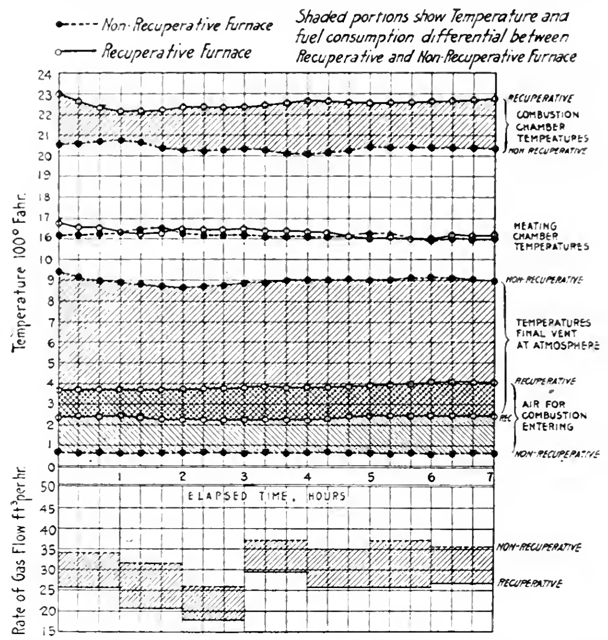

FIG. 7 GRAPHIC COMPARISON OF TEMPERATURES OF THE COMBUSTION AND HEATING CHAMBERS, FINAL VENT TO ATMOSPHERE AND ENTERING AIR, AND THE GAS FLOW FOR RECUPERATIVE AND NON-RECUPERATIVE TYPES OF GAS OVEN FURNACES

Economy to be secured by the utilization of the waste heat at this point is quite great, and in addition a further saving in fuel may be secured by the increase in flame temperature of the fuel through its preheating.

The chart reproduced in Fig. 7 is said to be typical of test runs with a Tate-Jones recuperative oven furnace and a non-recuperative one of the same size. A balance sheet from the same furnaces is presented in the original article with figures covering an average hour of operation after the furnaces had reached an equilibrium at 1600 deg. fahr.

From this balance sheet it can be said that 28,920 B.t.u. were required to maintain this furnace temperature with a recuperating attachment, and 36,400 B.t.u. were required when no recuperator was used. With the recuperator there was returned in the air only 1712 B.t.u., which represents a fraction less than 6 per cent of the total B.t.u. used, but in spite of the fact that only this amount was returned in the air, a *net* saving in fuel was secured of approximately

20 per cent. The additional 14 per cent saving was secured by the increase in flame temperature.

The same table shows to what extent the flame temperature operates towards economy. Combustion-chamber radiation losses were, for example, 17,122 B.t.u. in the regenerative furnace and 19,200 in the non-regenerative furnace. The final vent loss into the atmosphere was 3700 B.t.u. from the recuperative furnace, and 10,250 B.t.u. from the furnace without recuperator. The chart shows the increase in the combustion-chamber temperature due to the increase in the flame temperature.

The article discusses also the conditions at the outlet of the recuperator as an indication of the low temperature of the gases leaving the vent and the improvement in working conditions surrounding the furnace. (*Iron Age*, vol. 99, no. 18, May 3, 1917, pp. 1082-1083, *de*)

Hydroelectric Plant

Montague City Station of the Turner's Falls Power and Electric Company

The new 36,000-kw. generating station of the Turner's Falls Power and Electric Company at Montague City, Mass., is the largest hydroelectric station thus far built in New England. It supplies energy to 66,000-volt lines extending from the Greenfield District to Springfield, Mass., and generally covers the low-distribution networks in the Middle Connecticut River Valley.

At present only four of the six units for which the station is designed are installed. The wheels are of the vertical single-runner type, rated at 9700 hp. each. Each wheel drives a 7500-kva. General Electric 6600-volt three-phase revolving-field alternator at a normal speed of 97.3 r.p.m., the system frequency being 60 cycles.

The governors are connected with the shafts by flexible-gear drive, which is claimed to eliminate the troubles sometimes arising from belting. Each generating unit has a lignum-vitæ guide bearing lubricated by water received from the scroll case through a Terry cloth filter.

Since operation began the company has installed a water-cooling coil in each thrust bearing consisting of 145 ft. of 1¼-in. copper tubing per unit. Fifteen gallons of oil per minute are required to carry off the heat developed in each thrust bearing. The water for auxiliary cooling service can be taken either from the canal or from the municipal supply. The governor pumps are I. P. Morris horizontal centrifugal units rated at 325 gal. per min. each against a 525-ft. head, and are directly driven by 100-hp. induction motors. The sump tanks are installed in the pump pit and are cross-connected to a suction main from which the pump suctions are taken. The pumps discharge into a pressure main to which is connected a pair of accumulator tanks mounted on the operating-room floor, the governor-operating cylinders being fed from the pressure main, and discharging into a receiving main leading back to the sump tanks.

The guide and thrust bearings of the generating units are lubricated with ordinary machine oil supplied by gravity from a tank and filter located on a gallery, about 65 bbl. of oil being maintained in the system.

At each generating unit on the operating-room floor are located the governor with tachometer and gate-position indicator, the air-brake valve for controlling the rotor brakes, an engine-telegraph stand to connect with the switchboard gallery, a Peterson oil meter, one Schaeffer and Budenberg and three Peterson thermometers reading to 60 deg. cent. and connected with the oil piping, valves controlling the supply of oil and water to the generator bearings and governors, a Schaeffer and Budenberg recording thermometer on the thrust-bearing oil-discharge piping and a field-switch panel.

The following provisions have been made for isolating transformer fires. The transformers are located in a fireproof base on the east side of the operating room. All of the transformers are of the water-cooled type, with the circulating water furnished from the canal through the twin strainers and with an auxiliary town-water connection also available. The transformers are mounted on wheels, so that any unit can easily be removed by crane. Rolling firedoors, held open by fusible links, are provided for each transformer bay. Under the transformers are reinforced-concrete pits 18 in. deep which are connected with the river through traps for emergency oil discharge. The valve handle controlling this discharge is extended through the bay wall into the operating room to enable the oil to be discharged even when the firedoors are closed. Alarm devices are provided for indicating when the temperature of transformers exceeds 80 deg. cent., when the transformer cooling water is interrupted, when the governor-system water supply is too high or too low, when the bearing-oil supply is too high or too low, when the thrust bearings overheat and when the guide-bearing lubrication is interrupted.

Hourly readings are taken on the floor at each generating unit of the flow of oil to the thrust bearing, the oil temperature at the inlet and outlet of the thrust bearing, water temperature at the outlet of the guide-bearing gate opening and governor hydraulic pressure. The temperature of the transformers in each bank is also taken hourly. (*Electrical World*, vol. 69, no. 16, April 21, 1917, pp. 740-744, 8 figs. *d*)

Measurements

The Effusion Method of Determining Gas Density, Junius David Edwards

The effusion method of determining gas density, which is based upon the fact that the times required for the escape of equal volumes of two gases under the same pressure through the same small orifice are approximately proportional to the square roots of the densities of the gases, was investigated in order to determine the accuracy of the method and its sources of error. In coöperation with a number of men employing this method in the natural-gas industry, a series of experiments was made using their apparatus under field conditions. It was found that results in error by more than 10 per cent were not unusual.

The theory of the effusion process was studied in order to determine the influence of the numerous variables affecting the apparent specific gravity. The effect of differences in physical properties upon the relative rates of effusion of air and hydrogen, argon, methane and carbon dioxide at different pressures was determined. A more detailed treatment of the theory in the light of these results will be given in another paper. The facts observed in this study together with the observations made on the effect of the effusion pressure, the confining medium, and the shape and size of the orifice have been used in determining the most favorable conditions of operation for this method.

It is very important that the orifice be of the proper size and shape. Recommendations have been made as to the most suitable type and form of apparatus for use and specifications given to guide in the construction of the orifice.

It has been shown that the apparent specific gravity, as determined by this method, can be varied within rather wide limits by changing the conditions. However, by the observance of certain precautions in the construction and use of apparatus, it is possible to obtain results accurate to about 2 per cent. The greatest precision is obtained where the physical properties of the gas tested show the least difference from those of air. Some further increase in accuracy and particularly in reliability can be gained by standardizing the apparatus as recommended. (*Bureau of Standards*, advance abstract of Technologic Paper No. 94.)

The Relative Sensibility of the Average Eye to Light of Different Colors and Some Practical Applications to Radiation Problems, W. W. Coblentz and W. B. Emerson

In the present investigation the methods are practically the same as used by previous experimenters. In the visual measurements the spectral light was compared with a standard white light by means of a flicker photometer, and also an equality-of-brightness photometer. The source of white light was a standardized vacuum tungsten lamp. A cylindrical acetylene flame was used as a source of spectral light. The distribution of energy in the spectrum of the acetylene flame was determined with great care in view of the fact that the disagreement in previous work seemed to be due, in part, to uncertainties in radiometrically evaluating the light stimulus.

Visibility curves were obtained on 130 persons, of whom 7 were known to be color-blind. The visibility curve of the average eye, using 125 observers, is wider than previously observed.

As was to be expected, the visibility curves of no two persons appear to be exactly alike. When a visibility curve does not coincide with the average there is usually a marked departure from the average visibility in a given spectral region. This gives rise to (1) wide visibility curves with the maximum shifted toward the red, i.e., "red sensitive," (2) narrow curves with a sharp maximum in the green, and (3) curves with the maximum shifted toward the violet.

The data available indicate that 60 per cent of the cases examined fall into three quite evenly divided groups (i.e., 20 per cent roughly estimated in each group) which are either (1) red sensitive, (2) blue sensitive, or (3) average. Similarly, 30 per cent of the cases examined are quite evenly divided into three groups which fall below the average either (1) in the red, (2) in the blue, or (3) in both the red and the blue, thus giving rise to an apparently high sensibility in the green. One person in about 20 has a very wide visibility curve as compared with the average.

The point of maximum visibility is very different for different observers, and for the 125 persons the maximum is at 0.5576. The curve of average visibility, when corrected for selective transmission of the ocular media, including the yellow spot, is very symmetrical.

The complete paper gives a mathematical equation of the average visibility curve, and application of these data to physical photometry. Further applications are given in a separate paper.

Calculations are given showing that the eye responds to light having an intensity less than 1×10^{-16} watt.

This paper gives also data on diffused light and on the spectroscope used, and a screen is described which transmits radiations proportional to the average eye. (*Bureau of Standards*, advance abstract of Scientific Paper No. 303)

An Aneroid Calorimeter for Specific and Latent Heats, Nathan S. Osborne

The principle of the unstirred or "aneroid" type of calorimeter has been embodied in an instrument especially designed for determinations of the specific heat and latent heat of several substances in general use as refrigerating media.

Heat developed electrically in a coil located in the central axis of the cylindrical shell comprising the calorimeter is distributed by conduction to the calorimeter and contents whose initial and final temperatures when in thermal equilibrium are measured by a platinum-resistance thermometer.

Heat from other sources is excluded by enveloping the calorimeter with a metal jacket separated from it by the air space and keeping this jacket during measurements at the same temperature as the calorimeter surface, using multiple thermocouples to indicate this equality.

The calorimeter is adapted for use between —50 deg. and +50 deg. cent. and for pressures up to 70 atmospheres in experiments where the measured heat added is used either to change the temperature of the contents or to evaporate a portion of the contents withdrawn as superheated vapor; in the first case the specific heat and in the second the latent heat of vaporization being obtained when proper corrections are made. Such experiments are described in separate papers, this paper being devoted to the description of the instrument and its calibration.

Several features to which special attention has been given are:

1 Refinements to reduce errors in the evaluation of thermal leakage. These refinements include the following details:

a Location of the heater in the central axis of the calorimeter so that abrupt thermal irregularities produced by the heat developed therein may be subdued before affecting the surface

b Distribution of metal connections between calorimeter and jacket in such a way that the lead conduction is unaffected by inequalities in the surface temperature of the calorimeter

c Protection by means of superficial copper sheaths of calorimeter surface from abrupt variations in temperature such as may occur within during calorimetric measurements

d Method of indicating relative mean surface temperatures of calorimeter and jacket by means of multiple integrating thermocouples, which permits the evaluation of, and usually the annulment of, the thermal leakage.

2 Provision by means of a system of radial metal vanes for the distribution of heat throughout the contents.

3 Provision for insuring the dryness of vapor withdrawn by means of baffle-plate system.

4 Installation in the calorimeter of a strain-free type of platinum-resistance thermometer selected to give requisite accuracy.

5 Device for rapid cooling of the calorimeter consisting of a copper ring which can be moved within the jacket so as to thermally short-circuit the insulating air space and permit the escape of heat to the cooled jacket.

6 Thermo-regulated bath for keeping the temperature of the isothermal envelope or jacket always under control of the observer in order to avoid any unmeasured heat increments by thermal leakage.

Many other details are described which have a bearing on the convenience or accuracy in the use of the instrument.

The method of manipulation in making measurements of heat capacity is described, and the results given of an ex-

tended series of observations in the temperature range from —50 deg. to +50 deg. cent. to determine the heat capacity of the empty calorimeter. (*Bureau of Standards*, advance abstract of Scientific Paper No. 301)

Railroad Engineering

Mallet Articulated Locomotives for the Philadelphia & Reading Railway

Description of a heavy Mallet compound locomotive designed for pusher service over 3 per cent grades. These locomotives are of the 2-8-8-2 type and develop a tractive force of 98,400 lb. They are of special interest because of the restricted clearance limits imposed. The boiler center is placed 9 ft. 9 in. before the rail, and this apparently low elevation has increased the difficulty of working out some of the details of the design. The boiler is one of the largest Wooten boilers thus far built, with a diameter at the throat of 102 in. and a grate area of 108 sq. ft. It is designed for a pressure of 225 lb., but in service the safety valves are set at 210 lb. The equipment includes a Street stoker and power-operated firedoor and grate-shaker.

Owing to the restricted clearance limits it has been necessary to mount the safety valves in a specially designed casting which projects downward into a 26-in. circular opening in the boiler shell. This opening is placed just ahead of the combustion chamber. The rest of the equipment is not materially different from the usual practice on the Baldwin Mallet locomotives. (*Railway Review*, vol. 60, no. 18, May 5, 1917, pp. 620-622, 3 figs., *d*)

McClellon Water-Tube Firebox

The McClellon water-tube firebox has been in the process of development for a number of years and a few years ago one was built and applied to a Boston & Maine locomotive.

Another design has been recently made on two units installed on locomotives on the N. Y., N. H. & H. R. R.

It has been the aim of the designer to eliminate the use of staybolts and to divide the firebox into individual units which may better resist the expansion and contraction forces in service and may be removed with but little difficulty. The only staybolts used in the firebox are in the throat and the foundation or mud ring, which is a chamber $7\frac{1}{2}$ in. by 6 in., extending along the sides and back of the firebox. The sides and back head are made up of 6-in., $5\frac{3}{8}$-in. and 5-in. water tubes and the crown is made up of three drums as shown in Fig. 8. The tubes connect the drums with the foundation ring. The boiler is also provided with a combustion chamber $44\frac{1}{2}$ in. long, the sides of which are made up of tubes. These tubes follow the inside contour of the shell and extend from the outside drums to a circulating chamber which extends between the tube sheet and the throat. The chief method of construction of the firebox is by autogenous welding.

In the original article a photograph of the steam drums is reproduced. These drums were made from $1\frac{1}{4}$-in. plate planed down to $\frac{1}{2}$ in. in thickness. The front end of these drums is shaped to fit the barrel of the boiler and to make suitable connection with the tube sheet. The two side drums are butt-welded for $12\frac{1}{4}$ in. back from this end to facilitate shaping, and for the remainder of their length have a single riveted butt seam with $5\frac{1}{2}$ in. by 7-16 in. inside and outside welt straps.

The sides of the firebox are made up of fifteen 6-in. tubes equally spaced for over a distance of 91 in., which gives sufficient space between each tube to allow for expansion.

The combustion chamber is $44\frac{1}{2}$ in. long and contains from the front to the back two $2\frac{1}{2}$-in. tubes, eight 4-in. tubes and one 5-in. tube. These tubes extend between the side drums at the top and the circulating chamber at the bottom, being curved to the shape of the boiler shell. The circulating chamber consists of a $\frac{5}{8}$-in. flanged plate. There is a direct connection between the boiler barrel and the circulating chamber and also between it and the throat.

These fireboxes were applied to two Mikado locomotives weighing a little over 250,000 lb. The firebox heating surface of the ordinary boiler was 239 sq. ft., and of the McClellon boiler 308 sq. ft. Also, there was a little larger amount of heating surface in the fire tubes in the McClellon boiler and the total square feet of heating surface, including the super-

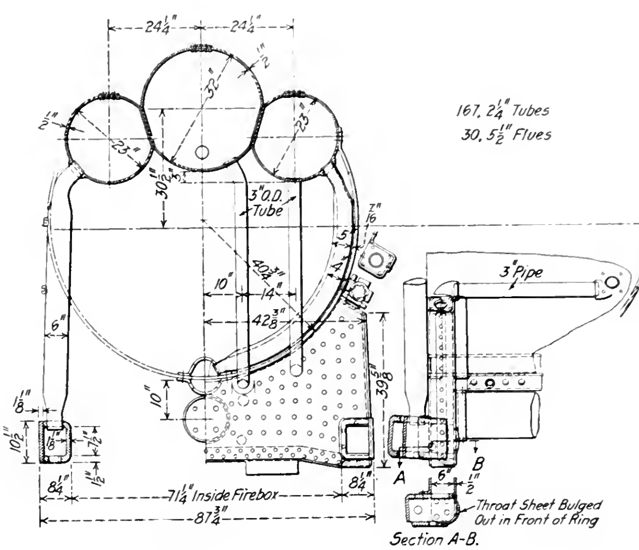

Fig. 8 Sections Showing General Details of the McClellon Firebox

heater flues, was 2827 sq. ft. for the ordinary boiler and 2937 sq. ft. for the McClellon boiler.

The locomotives with the McClellon boilers have not been in service long enough to determine the results. (*Railway Mechanical Engineer*, vol. 91, no. 5, May 1917, pp. 239-242, 6 figs., *d*.)

Resistance of Passenger Cars, D. C. Schmidt and H. H. Dunn

Data of an investigation of which the purpose was to establish the relation of resistance to speed for cars of various weights. The tests were made in regular through passenger service and it was found that the specific resistance is materially affected by the weight of the cars composing the train, and decreases as the average weight of the car increases.

The apparatus used with the dynamometer car produced continuous graphical records of the gross resistance of the train, the speed, time, brake-cylinder pressure, wind direction and wind velocity. All resistance values have been corrected for grade and for acceleration. The immediate purpose of the test was to define for each train the relation between net resistance and speed. All of these curves are brought together in Fig. 9.

The figure shows that at 20 m.p.h. the range of resistance [illegible] between [illegible] lb. per ton, and at 70 m.p.h. between 8.0 and 11.1 lb. per ton. This variation is chiefly due to the difference in the average weights of cars composing the different trains. Trains composed of relatively light cars have greater resistance than trains composed of heavy cars.

The relation between resistance and average car weight [illegible] graphically established in the following manner. [illegible] Fig. 9, at the point corresponding to 20 m.p.h., a perpendicular is erected. It will cut the curves in 18 points, each of which pertains to a particular train and defines for that train the average value of resistance at a speed of 20 m.p.h. If each of these resistance values are plotted with respect to

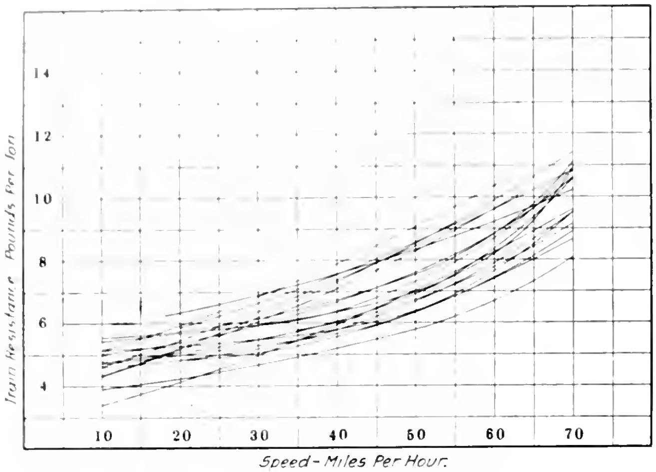

Fig. 9 Relation Between Resistance and Speed for the 18 Trains Tested

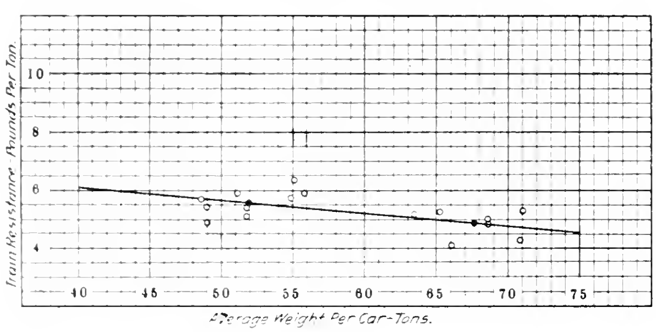

Fig. 10 Relation Between Resistance and Average Car Weight for the 18 Trains Tested at a Speed of 20 m.p.h.

the average car weight of the train to which it pertains, the diagram shown in Fig. 10 is obtained, which indicates that as the car weight increases the specific resistance decreases, the average weight of this decrease being shown by the straight line.

Six other straight lines have been determined defining this relation at 10, 30, 40, 50, 60 and 70 m.p.h.

As regards the numerical values appearing in the curves it should be borne in mind that they apply to trains running on level track at uniform speed in warm weather and under favorable conditions. Cold weather and high winds will both operate to increase the resistance above the amounts shown. (*American Railway Engineering Association*, Bulletin 194, abstracted through the *Railway Mechanical Engineer*, vol. 91, no. 5, May 1917, pp. 247-248, 5 figs., *e*.)

Steam Engineering

The Deterioration of Curtis-Rateau Turbine Blading, A. Fenwick

A paper devoted to the record and discussion of the behavior of certain materials used in turbine blading, based on a six years' experience in operating and maintaining the turbine plant of the Rand Power Company.

The turbines are of the combination Curtis-Rateau type. After passing through the first row of Curtis moving blades and a row of stationary blades fixed to a steel segment bolted to the turbine casing, the steam discharges into the casing in which the Curtis wheel revolves. The Curtis casing is a closed compartment separated from the Rateau portion by a cast-iron diaphragm. On the outer periphery of this diaphragm is a ring of guide blades forming nozzles which convert the steam pressure into velocity and give the steam the correct angle for impinging on the moving blades. The first ring of guide blades directs the steam from the Curtis casing on to the first Rateau wheel—termed in this paper the second-stage wheel.

Two main types of guide blading are in use, the first, termed a guide-blade ring, consists of inner and outer retaining rings cast round the blades. The guide ring is in two halves which butt together at the horizontal joint of the turbine casing.

The second type, the diaphragm, forms an integral part with the retaining rings, the complete diaphragm being cast in two halves. This type is called a guide-blade diaphragm.

The paper discusses the turbines by classes, starting with the 3000-kw. type. In this size in the Curtis stage and the first three low-pressure stages two materials have been tried, aluminum bronze and 5 per cent nickel steel. With the steel no particular trouble has been experienced from corrosion, and some sets have been running for six years.

The aluminum-bronze blades, on the other hand, proved quite unsuitable for this part of the turbine. The aluminum content disappears from the surface of the metal leaving a very brittle layer of copper. Where the section of metal is thin, as at the inlet and discharge edges of the blades, it breaks away like glass with light tapping. With continued use the outer layer cracks and flakes off, exposing the part underneath, which in turn flakes off until the blade is split up into several layers. Where a section of the blade is fairly heavy, as in the Curtis stage, the shape is gradually lost, but the body of the blade remains sound and seldom fails.

On the whole, the Curtis blades have a shorter life than the later stages, due apparently to the higher temperature in the Curtis casing. After leaving Stage 4 the deterioration takes a different form, erosion or pitting at the back or convex portion of the blade being usual. In fact, the pitting in Stages 5, 6, 7 and 8 looks as though chemical action had taken place, and may be due to certain impurities in the steam becoming active in the presence of moisture.

The same unsatisfactory experience with aluminum bronze in the Curtis blading was found in the 9600-kw. class. On the other hand, the brass blades in Stages 6 to 9 have been found to be in excellent condition from a deterioration point of view, but in several cases have been severely damaged mechanically from various causes and successfully straightened out.

The aluminum-bronze blades in Stages 10, 11 and 12 have proved satisfactory, but in Stage 13 breakages of the blades have occurred. The blades are secured to the wheel by a tee, headed root and fracture frequently occurs across the neck of the tee. The stress at the point is not excessive, approximately 3 tons per sq. in. A new blade was tested at the Government Laboratory and showed an ability to stand 44.9 tons, but an

old blade before fracture had a strength of only 29.8 tons per sq. in. Although there is very little difference in outward appearance, it would seem, therefore, that the material has lost a good deal of its original strength. In some cases the blades have fractured about $1\frac{1}{4}$ in. above the rim of the wheel, i. e., just above the distance piece.

The experience with the 4000-kw. compressor-turbine class was essentially similar to that with the main turbines.

As a general conclusion the author expresses his belief that aluminum bronze is totally unsuitable for use as a blade material in the high-temperature stages, but excellent results have been obtained with it in the low-temperature stages. Five per cent nickel steel has so far given good service where used. Brass stands the temperature well and in some cases has replaced aluminum bronze with satisfactory results.

A similar set of observations is reported on stationary blading. In this connection the writer comes to the conclusion that while cast iron is far from being the best material for inlet nozzles, it is very much cheaper than anything else and for this reason should receive consideration. Steel blades were tried and after running 3000 hours on a 9600-kw. turbine were found to be in excellent condition.

An interesting observation was made in this connection. A nozzle was quite damaged and a test was run with it on the efficiency of the turbine. It was found that actually the turbine was as efficient as if nozzles in good condition had been used. Hence it was obviously sound practice to remove that part which invariably broke away and the nozzle shown in Fig. 11 has therefore been made with a V-shaped portion cut out. Since this nozzle has been used on the main turbines they have been practically free from breakage of nozzle vanes.

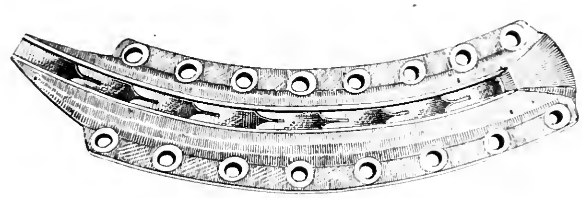

FIG. 11 IMPROVED INLET NOZZLE FOR STEAM TURBINES WITH A PORTION OF THE VANE CUT OUT

Aluminum bronze was originally used on several turbines but proved totally unsuitable, as the metal rapidly disintegrates, owing to temperature. Twenty-five per cent nickel steel stood up well for a time, but became brittle with use. Five per cent nickel steel stands up very well and is now used exclusively for all *main* turbine stationary segment blading.

A similar discussion covers the subject of guide blading. The article also discusses in detail in an interesting manner the question of stresses imposed on the blades. This part cannot be abstracted, because of lack of space. (*The Journal of the South African Institution of Engineers*, vol. 15, no. 8, March 1917, pp. 143-178, 25 figs., *eA*)

BURNING BLAST-FURNACE GAS UNDER BOILERS

Herman C. Siebert, Experimental Engineer of the Duquesne Works, Carnegie Steel Company, presented the following data of experiments with various burners in connection with different boilers giving their air-aspirating characteristics.

The common type of Kennedy blast-furnace-gas burner with its aspirating characteristic is shown in Fig. 12. There is in the furnace an auxiliary bridge wall and a cooled grate between it and the main bridge wall, also a metal screen which permits varying the air opening between boiler and burner. The amount of air is varied by moving the screen in and out over the burner. The characteristic of this type of burner shows that the proper amount of air is established at a pressure of 2 in. when the screen is open. When the screen is closed, the correct amount of air is drawn in at 1 in. gas pressure. At all other gas pressures the air supply is positive or negative in amount of excess. Fig. 13 gives characteristics for two other types of aspirating burners, both similar to that of Fig. 12, except that the proper amount of air is aspirated at a different gas pressure. Fig. 14 shows the characteristic for a special burner and indicates what can be accomplished in the way of air supply if the port area is large enough and is varied to suit the different gas pressures. In this case the air supply was controlled by gas analysis taken from the combustion chamber and the port area.

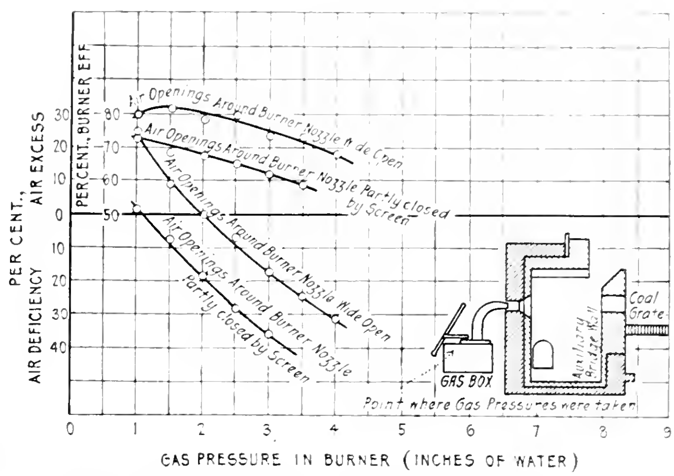

FIG. 12 AIR-ASPIRATING CHARACTERISTICS AND BURNER EFFICIENCIES OF KENNEDY BLAST-FURNACE-GAS BURNERS

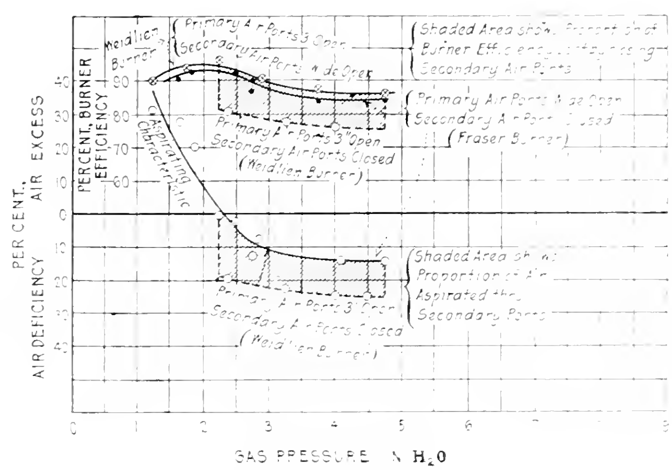

FIG. 13 BURNER EFFICIENCIES AND ASPIRATING CHARACTERISTICS OF KLING-WEIDLEIN-FRASER AND BRADSHAW BLAST-FURNACE-GAS BURNERS

Some experiments were also made with a mixing burner in which an explosive mixture was burned, leaving the nozzle at a velocity greater than the ignition velocity (very low for blast furnace gas). With this type of burner up to 270 per cent of boiler rating was developed.

S. G. Brigel, of the Huessener Engineering Company, Pittsburgh, stated that when running Stirling boilers on loads varying from 130 to 160 per cent, he found stack temperatures

[illegible] temperatures [illegible] between 600 [illegible] boiler, he found [illegible] On the [illegible] with similar temperatures [illegible] Babcock & Wilcox boilers, [illegible] Babcock & Wilcox [illegible] did not rise nearly as quickly [illegible] stack temperature [illegible] A large number of figures taken [illegible] load. [illegible] over 100 Babcock & Wilcox boilers fired [illegible] low stack temperatures ranging from 530 [illegible] fahr. for an average load of 165 per [illegible]

As [illegible] difference in boilers which do or do not [illegible] primary mixing of gas and air, the speaker stated that any burner can be regulated in such a manner that it gives complete combustion with a very low excess of air. But such regulation may require constant attention and in ordinary practice be beyond the capacity of the usual boiler house crew.

In this respect a test which was made at one of the Eastern steel works may be of interest. Two boilers, one equipped with a burner working with secondary air only, the other with a burner working with primary air only, were tested side by side after they had been adjusted in such a manner that both boilers showed 22 per cent CO_2, 1.0 per cent oxygen, and no CO in the combustion chamber. The three successive tests taken on both boilers under identical conditions showed that the boiler utilizing primary air only changed the combustion of the gas in the combustion chamber due to change of gas pressure, to a lower CO_2 of 19 per cent, without any unburnt CO; whilst the boiler working with secondary air went down as low as 17 per cent CO_2 with 6 per cent unburnt CO. This appears to be an excellent illustration of the effect of varying boiler draft on the condition of the combustion chamber. (*Proceedings of the Engineers' Society of Western Pennsylvania*, vol. 33, no. 3, April 1917, pages 167-198, 7 figs., *ep.*)

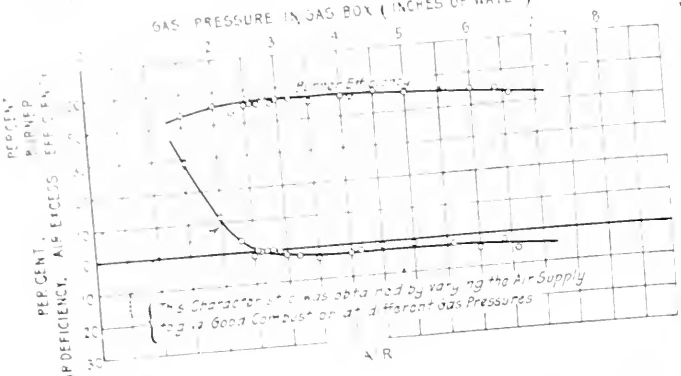

FIG. 14 AIR-ASPIRATING CHARACTERISTICS AND BURNER EFFICIENCY OF SPECIAL BLAST-FURNACE-GAS PRODUCER HAVING LARGE PORT AREAS AND WIDE ADJUSTMENT TO SUIT DIFFERENT GAS PRESSURES

Varia

HYDRAULIC TEST OF PIPE CONNECTIONS

Data of tests conducted under the supervision of F. H. Sibley, Mem.Am.Soc.M.E., in the Machine Construction Laboratory of the University of Kansas. They refer to determination of the relative strength of welded and screwed connections in steel pipe of various sizes when subjected to internal hydraulic pressure. The article briefly describes and illustrates the apparatus used.

The pipe samples ranging from 2 to 4 in. in diameter were cut from standard black steel pipe, the welded specimens being made by operators of a commercial acetylene welding company, while the screw connections were made with malleable-iron couplings and fittings by expert pipe fitters.

The 2 and 3-in. welded specimens failed by splitting along the longitudinal seams of the pipe, the break stopping at the welded section. The 4-in. welded specimens did not fail either in the weld or in the pipe seam (the pressure applied was 5100 lb. per sq. in.). The bursting pressures for the screw connections were considerably below those of the welded specimens and all failed in the fitting. Great difficulty was experienced in testing the screwed connections, because sand holes developed and water leaked through the castings to such an extent that it was almost impossible to reach the point of rupture.

The results of these tests appear to indicate that the strength of a welded-pipe connection is practically the same as that of an unwelded pipe and can be stronger than the rest of the pipe by building up the weld. It appears also that the strength of the welded pipe connection is greater than that of the malleable-iron screwed fitting. (*Iron Age*, vol. 99, no. 18, May 3, 1917, pp. 1070-1071, 1 fig., *e.*)

AIR DRYING FOR BLAST FURNACES, Leon Cammen

Brief characteristics of the main processes of air drying for blast furnaces, both cryogenic and chemical, and description of a process based on the fact that the drying action of a solution of calcium chloride depends on two things: the degree of concentration and the temperature at which the liquor is maintained.

The process involves the use of the following cycle of operations. In the first place, air is passed through a highly concentrated solution of calcium chloride maintained at a proper low temperature and is there freed of such moisture as it may contain. The cold brine which moves in countercurrent to the air after meeting it, proceeds to an evaporator where it is brought back to the initial degree of concentration. It is then sent along a series of cooling coils until it reaches the desired low temperature and is ready to meet the incoming air again. The essential feature of the process is the fact that in the evaporator only a concentration of the brine, and not drying of the salt (which latter is a process requiring a very large specific expenditure of heat), is carried on. This results in the use of comparatively low temperatures and economy of heat consumption.

The brine leaves the refrigerator at a temperature of 16 deg. fahr. and a concentration of 40 per cent. By the time it passes from contact with the incoming air, it has a temperature of, say 25 deg. fahr. and a concentration of 30 per cent. Attention is called in this connection to the fact that the incoming warm and moist air is first met by the comparatively warm brine. While brine of 25 deg. fahr. and 30 per cent concentration is still capable of taking out a large amount of moisture from air at say 80 deg. and a content of 7 grains of water per cu. ft. (the precompression system is apparently used here), the comparatively dry and by then fairly cool air in its last stage of flow passes through a layer of 40 per cent brine at 16 deg. fahr. which is intensely hygroscopic. In this way the most efficient system is adopted both as to the distribution of temperatures and distribution of concentrations. (*Proceedings of the Engineers' Society of Western Pennsylvania*, vol. 33, no. 3, April 1917, pp. 199-204, 1 fig., *d.*)

Mechanical-Efficiency Tests for Machine Tools, G. W. Burley

In dealing with mechanical-efficiency tests for machine tools the writer, in his book recently published, divides the subject into two parts: input determinations and output determinations.

The determination of the amount of input energy may be made in at least three different ways, the electric-motor method, the transmission-dynamometer method, and the cradle-dynamometer method.

The paper discusses in detail the various types of dynamometers and the dynamometer curves referring thereto, such as the transmission dynamometer and the torsion dynamometer.

Among other things, as a method of determining the output of a motor is mentioned the use of a hydraulic piston and cylinder filled with oil or kerosene, and an ordinary pressure or engine indicator. This method does not yield the true output of the motor, however, and does not cover the mechanical losses in the bearings.

An article on the determination of the output of machine tools is promised in a future issue. (*Railway Gazette*, vol. 26, no. 13, March 30, 1917, pp. 386-388, 5 figs., *d*)

Report on Heat-Insulating Materials

Results of tests by Sargent and Lundy, Consulting Engineers, of Chicago, of various heat-insulating materials compared with tests of common firebrick.

The first object of this test was to determine the relative thermal insulating value of materials examined.

The materials were used in dimensions of standard bricks, so as to have the samples equal in this respect. The idea worked on for comparison was to subject the brick to a high temperature at the end *A*, Fig. 1. Then if the top, bottom and sides were thoroughly insulated the heat would be radiated

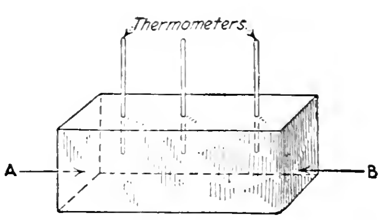

Fig. 15 Diagram Showing Location of Thermometers in Experimental Brick

from the exposed end *B*, and thermometers placed at various distances between *A* and *B* would show a uniform drop in temperature. With the same temperature at *A*, a brick made of a good insulating material would give lower readings on the thermometers placed in the brick than would be the case for a poor insulating material and the temperature gradient would have a different shape.

This process involves the difficulty of thoroughly insulating the top, bottom and sides of the bricks, but in the course of the test it was found that if the top, bottom and side insulation was made practically the same for each material, the comparison would be reliable. The method of testing was to read all thermometers, then place the gasoline torch in position and take readings every 15 or 30 min., the idea being to keep the high temperature source of heat as steady as possible. The gasoline torch did not possess much flexibility and was difficult to regulate satisfactorily.

Another method of test involves the use of an electric heater.

On the whole, it was found that materials have not as good an insulating value at high temperatures as at low ones. To express this variation in insulating value with the temperature, a relation similar to Ohm's law has been derived. The unit taken has been called "the thermal ohm," and is expressed by dividing the temperature difference by the B.t.u. radiated per hour. The values for some of the materials have been calculated and are given in Fig. 16. They show practically straight

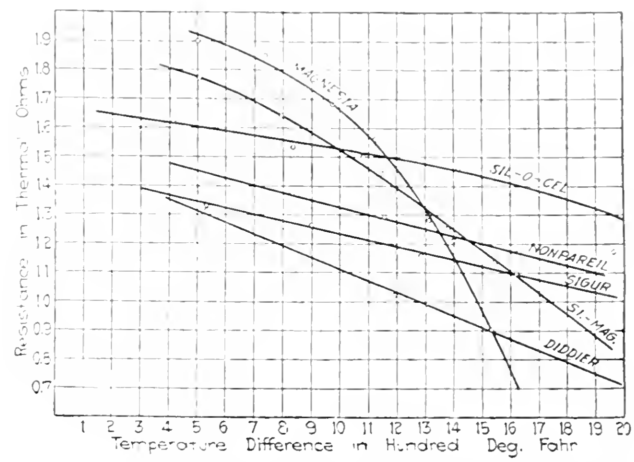

Fig. 16 Curves Showing Heat-Resisting Properties of Various Insulating Materials

lines, except for two materials, of which one, Si-Mag (combination of sigur and magnesia), shows the thermal resistance, which decreases directly as the temperature difference.

Magnesia falls off so rapidly at the high temperature because it becomes disintegrated through a chemical change.

An effort was also made to find the equivalent thickness of material required to give equal insulation, for which purpose it was necessary to demonstrate experimentally the laws of thermal resistance.

Further tests were made to secure some data on the physical properties of insulating materials: in particular, the weight of water absorbed; and it was found that in some cases insulating materials absorbed considerably more than their own weight of water. (*Power*, vol. 44, no. 18, May 1, 1917, pp. 593-596, 14 figs., *e*)

Translation of Formulæ, P. M. Heldt

Discussion of the transformation of equations from one system of units to another, with additional reference to rational equations, which are universally true so long as the rational system of units is used.

If a formula is based on the metric system and the design to which it is applied is in inch units, the question of transformation becomes an important one. Of course, in isolated cases it is possible to convert the inch measurements in the design into metric units, apply the equation and reconvert the result, which would be in metric units, into inch units. Apart from being rather tedious, the process is, however, not conveniently applicable where a number of operations of this nature have to be carried out, and in such cases it becomes necessary to find a simpler way of applying equations derived in units of one system to problems in which the data are expressed in another system.

A certain class of formulæ is universally true so long as a rational system of units is used. Such equations are called rational, and the test of a rational equation consists in substituting for each factor representing a physical quantity, the dimensions in terms of the fundamental quantities (length, mass, time), and seeing whether, when thus transformed, the equation holds true.

In many equations, however, two different units are used for the same quantity. For example, in the equation where the speed of a car is expressed in terms of wheel diameter, engine-speed revolution and gear reduction, two different units of length are generally used—the inch for the wheel diameter and the mile for the distance covered per hour—and two units of time—the minute for the engine speed, and the hour for the car speed. This equation may, however, be transformed into a rational equation by using only one unit of length, say, the inch, and one unit of time, the minute. In this case the equation becomes

$$s = \frac{d\pi n}{r}$$

where s = speed of car, d = wheel diameter, n = engine revolutions per unit of time and r = gear reduction. This equation would give the car speed in inches per minute, but if the engine speed is given in revolutions per minute, the wheel diameter in inches, and the result is required in miles per hour, the equation becomes

$$s = \frac{nd}{336r} \text{m.p.h.}$$

Now, if metric units were used, the wheel diameter given in millimeters and the result required in kilometers per hour, s would be 1.608 times as great (1 mile = 1.608 kilometers) and d 25.4 times as great (1 in. = 25.4 mm.). Therefore, denoting the numerical coefficients by $1/x$,

$$1.608s = \frac{nd \times 25.4}{xr}$$

which would give for x the following equation:

$$x = \frac{336 \times 25.4}{1.608} = 5310$$

and hence the metric formula would read

$$s = \frac{nd}{5310r} \text{ km.p.h.}$$

Of course, it is not necessary to go through all these intermediary steps the next time, and a simple conversion factor $x = 5310$ can be used.

As examples of the application of the methods of transformation of equations from one system of units to another, the writer gives the formula for determining the tax horsepower of automobile motors in Germany, and the formula for the absolute pressure of saturated steam as a function of the absolute temperature in deg. fahr. That part of the article dealing with the latter is here reproduced.

The equation for this relation is:

$$\log p = 10.515354 - (4873.71/t) - 0.00405096t + 0.00000139296t^2$$

Now, suppose that it is desired to transform this equation so the temperature may be inserted in deg. cent. (absolute) and the pressure will be obtained in kg. per sq. cm. We then have:

$$\log(p/14.22) = a - b/0.555t - 0.555\,ct + 0.309dt^2$$
$$\log p - \log 14.22 = a - b/0.555t - 0.555ct + 0.309dt^2$$
$$\log p = \log 14.22 + a - b/0.555t - 0.555ct + 0.309dt^2$$
$$\log p = 1.1529 + a - b/0.555t - 0.555ct + 0.309dt^2$$
$$\text{and}\quad 10.515354 - (4873.71/t - 0.00405096t + 0.00000139296t^2 = 1.1529 + a - b/0.555t - 0.555ct + 0.309dt^2$$

This equation can be satisfied only if the factors in both terms containing the same power of t are equal, that is:

$10.515354 = 1.1529 + a$	$a = 9.3624$
$b/0.555t = 4873.71t$	$b = 2705$
$0.555ct = 0.00405096t$	$c = 0.00729$
$0.309dt^2 = 0.00000139296t^2$	$d = 0.000004515$

Hence the absolute pressure p'' of saturated steam in kg. per sq. cm. is given by the following equation, in which t'' is the absolute temperature in deg. cent: $\log p'' = 9.3624 - 2705/t'' - 0.00729t'' + 0.000004515t^2$. (*Horseless Age*, Engineering Edition, vol. 40, no. 2, April 15, 1917, pp. 1-2 (Engineering Section). *pm*)

Technical Paper 137 of the U. S. Bureau of Mines, of which an abstract will be found in the present issue of THE JOURNAL, is likely to become classical as an investigation of a difficult subject unusually free from unessential details. Among the conclusions established by this investigation, the two probably most important are that the weight of air forced through the fuel bed per pound of fuel burned or gasified is constant; and next, that above a certain distance from the fuel bed there is a large percentage of combustible in the gas and no oxygen to burn it. The investigation is rich in practical suggestions, and must be considered as a valuable contribution to our knowledge of the processes going on in a hand-fired furnace. As regards the numerical values obtained, however, it must be borne in mind before they are used in the design of commercial equipment that they were obtained from an experimental installation using picked fuel.

According to the *Iron Age* for May 3, 1917, J. W. Flavelle, Chairman of the Imperial Munitions Board in Canada, has furnished the Finance Minister with a striking statement showing the extent of the business in munitions built up in Canada with the financial assistance furnished by the Dominion Government. The total value of orders received by the Imperial Munitions Board of Ottawa is $850,000,000, which is equal to the entire international trade of Canada, imports and exports, of 1912. The value of the munitions shipped to March 30 was $470,000,000, the total disbursements to April 30 being $543,000,000. There are 630 factories, chemical and loading plants in operation carrying out the orders of the board. The cash disbursements for March were $41,000,000 and for April will be $43,000,000. Toward the financing of this immense business the Dominion Government has contributed $200,000,000 as a loan to the Imperial Treasury, and arranged with the Canadian banks for advances aggregating $100,000,000.

Official announcement has been made from Ottawa concerning the proposed extensive shipbuilding program, which was foreshadowed some six weeks ago. Orders have been placed for steel ships in Canada up to the full limit of the steel plates available during the next 15 months, and a good many wooden vessels will be built in the Dominion as well. The Dominion Government's part consists in advancing a loan of $10,000,000 to the Imperial Munitions Board, Ottawa. This Board has recently placed large orders for steel plates and will probably be placing additional orders in the near future.

Hours, Fatigue and Health in British Munition Factories

The following outline of the main conclusions arrived at by the British Health of Munition Workers Committee is taken from reprints of the memoranda of this committee made by the Bureau of Labor Statistics of the United States Department of Labor (Bulletin. Whole No. 221, or Industrial Accidents and Hygiene Series, No. 15, April 1917).

This committee was appointed in September 1915 by the Minister of Munitions, and on the basis of evidence taken in various industrial centers has compiled and published some fifteen memoranda dealing with various aspects of the subject. As these memoranda are the work of men especially qualified by technical knowledge and wide experience, they are of particular value in this country at the present time.

As regards Sunday labor, the committee states that the evidence adduced has led it strongly to hold that if the maximum output is to be secured and maintained for any length of time a weekly period of rest must be allowed. Except for quite short periods continuous work in its view is a profound mistake and does not pay—output is not increased.

The committee also makes the significant statement that, in their opinion the higher management even more certainly require definite periods of rest. These individuals have never spared themselves; they carry a heavy burden of responsibility and, moreover, cannot be replaced. The committee has with regret noted among them obvious signs of overwork, and it is of primary importance in the interest of the nation that they should be allowed that rest which is essential to the maintenance of their health.

As regards hours of work the committee calls attention to the fact that overtime fell mainly to the lot of the most highly skilled workers (tool and gage makers, tool setters, etc.) as they are the most difficult to obtain. At one time cases of men working as much as 90 hours per week were met, and while more recently there has been a tendency to reduce the hours, weekly totals of 70 to 80 hours are still frequent. The committee is satisfied that hours such as these cannot be worked with impunity, and most strongly urges that every effort should be made to extend the shift system to this branch of industry as rapidly as possible.

The committee has not found that as yet the strain of long hours has caused any serious breakdown among workers, but there is medical evidence to the effect that long hours are beginning to make themselves felt upon the older men and upon those who suffer from physical infirmity. There is reason for believing, however, that the better food that workers have been able to enjoy in consequence of increased pay has helped to counteract the strain of long hours.

Among the executives and foreman there is evidence of considerable fatigue, and numerous instances have been brought to the notice of the committee where men of this class have had to be allowed special holidays to enable them to recuperate. The committee, therefore, while recognizing that overtime must continue, suggests certain definite restrictions to which it should be submitted, especially in the case of women and girls.

As regards the work of women engaged in moderately heavy work the committee has come to the conclusion that in order to attain a maximum output such women should not work more than 60 hours a week. In fact, an equally good total output would be maintained if the actual working hours were reduced to 56 or less per week. For example, one group of operatives, 17 in number, worked only 51.8 to 62.6 hours per week for five weeks in June and July and during the last three weeks of this period their hourly output was 18 per cent greater than that of another group of 14 operatives who were working the usual long hours.

As regards men engaged in heavy labor, data are not very complete, but as regards boys of 14 to 17, a reduction in the hours of labor from 73.3 to 57 produced an increase of output to the astonishing extent of one-third to one-half, which indicates that the boys must have been overworked by long hours and that a reduction of 8 to 12 hours materially accelerated their rate of production.

On the whole, the committee comes to the conclusion that the hours of labor should be varied between wide limits according to the character of the work performed, and not maintained uniform for all types of labor and for workers of both sexes; and that where long hours of labor on the part of munition workers are necessary, an effort should be made to have them shut up in the factories for as short a time as possible.

In this connection attention is called to the importance of greater promptness in starting work. There can be no necessity for the waste of 25 min. in starting and stopping work, as was the case in a shop under investigation.

The custom in many munitions works is to work for a spell of 5 hours and then after an hour's interval for another spell of 4½ to 5 hours, which leads to spells which are undoubtedly too long in many types of munition work. A better plan would be to arrange for regular rest pauses in between. For instance, a 10-min. break in the middle of the morning and afternoon spells during which the operatives remain at their machines to take tea or other nutriment.

Other memoranda discuss the subjects of industrial fatigue and the special diseases connected with the manufacture of munitions, in particular various forms of poisoning due to the handling of explosives.

A new type of gas engine recently announced is essentially an internal-combustion engine in which air is compressed and mixed with oil which is atomized and ignited by an electric spark. The resulting intensely hot flame of combustion is brought into contact with small quantities of water which cools the gases to a practical working temperature while generating a desirable amount of steam, which, combined with the gases of combustion, enters the power cylinders.

The following claims are made for the engine: Starting without any previous heating, directly with the oil, by hand or electric cranking or by compressed air. Only one spark plug is used, regardless of the number of cylinders. When the engine is under way, the current is turned off. Ignition outfits are not required, as a battery with coil and spark plug will suffice. No heat is lost through water jackets, and little power is wasted in the low-pressure exhaust. The water used is easily condensed and returned to the tank. There are no objectionable carbon deposits. No data of tests of the engine are yet available.

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

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[illegible]

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[illegible] Aeronautics vol [illegible] pp. [illegible]-310, 4 figs.

[illegible] vol. 103, no. 2676, April [illegible]

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LIBRARY NOTES

From the Libraries of the Four Founder Societies and the United Engineering Society, in the Engineering Societies Building, New York City

EVERY library has two problems: to collect the material of interest to its patrons and to make it accessible to them with the greatest possible ease.

The history of the Library of the Engineering Societies illustrates an endeavor to meet these two problems. Started as four independent libraries, nothing was more logical than the consolidation of the four into one, with a consequent avoidance of the waste due to duplication. Instead of libraries of civil, mining, mechanical and electrical engineering, we have a library of engineering, equipped to meet the requirements of an inquirer, regardless of the specific subject in which he may be interested.

The Library covers these four main branches of engineering very effectively. It is especially well supplied with periodicals, the most important depository of modern professional literature. The standard reference books and the more important texts are also included. As it becomes possible, the literature of other technologic subjects is being added, in the hope that there may sometime result the ideal collection, able to supply the records of all important previous work on any professional problem which an engineer may meet. To accomplish the ideal will require time and money, but the acknowledged value of the result will more than compensate for the expense. Engineers who wish to assist in the advancement of engineering should consider the benefits which will accrue from additions to the endowment fund of the Library.

Side by side with the extension of the collection, the problem of making it accessible must be faced. Most engineers are too busy to spare the time needed to search through long files of periodicals, or to make copies of desired articles, so it is necessary to provide assistance. To meet this need, the Library Service Bureau has been established as an adjunct to the Library. The Bureau will make lists of references to the articles on any topic, and will, if desired, make copies of them or translate them from other languages. It will send notices of new articles on any topic as they appear in the current periodicals. In fact, its possible forms of service are too various for listing, all that can be said is that it stands ready to undertake any work dealing with professional literature. For this type of work it has been necessary to arrange a schedule of fees, covering the cost of this work to the Library. Information on this subject will be given gladly. The Service Bureau has been of assistance to engineers all over the world, saving time for those to whom libraries are accessible and providing a practical method of reference for those in localities where books are not available.

The future work of the Library is to develop the greatest possible efficiency in these two directions, in the hope that it may ultimately become the largest engineering library in the world, and that it may be able, through a corps of highly trained expert bibliographers, to provide definite references to any material in point. Such an institution will be one of the most valuable aids in the promotion of the profession. It will have an international usefulness, as it will not duplicate the work of any existing institution.

HARRISON W. CRAVER,
Librarian.

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Steam Boilers; their theory and design. By H. de B. P[illegible]. Ed. 5. *New York City, [illegible]* Purchase.

Steam Turbines; a Treatise Covering U. S. Naval Practice. By G. J. Meyers. *Annapolis, Md. The U. S. Naval Institute, [illegible]* Gift of publisher.

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——— 1915. Part II. South Atlantic and Eastern Gulf of Mexico Basins. Water Supply Paper 402. Part VII. Lower Mississippi River Basin. Water Supply Paper 407. *Washington, 1916, 1917.* Purchase.

Telegraphy: a Detailed Exposition of the Telegraph System of the British Post Office. Ed. 3. By T. E. Herbert. *New York. The MacMillan Co., 1916.* Gift of publisher.

Telephony. A comprehensive and detailed exposition of the theory and practice of the telephone art. By Samuel G. McMeen and K. B. Miller. *Chicago, 1916.* Purchase.

Thermochemistry. By Julius Thomsen, translated from the Danish by Katherine A. Burke. *New York, 1908.* Purchase.

The Thirteenth Amendment and the General Railway Strike. By B. Lee. Reprinted from the Virginia Law Review. *March, 1917.* Purchase.

Triangulation and Primary Traverse, 1913-1915. U. S. Geological Survey. Bulletin 644. *Washington, 1916.* Purchase.

Trus Con Laboratories. Architects' specifications hand book of waterproofing dampproofing, technical paint, etc. *Detroit, n. d.* Gift of Trus Con Laboratories.

Trussed Concrete Steel Company. Kahn Road Book devoted to concrete roads and pavements. *Youngstown, 1916.* Gift of Trussed Concrete Steel Co.

Tube Milling; a Treatise on the Practical Application of the Tube Mill to Metallurgical Problems, by Algernon Del Mar. N. Y. *McGraw-Hill Book Co., Inc., 1917.* Gift of publisher.

Unified Accounting Methods for Industrials. By C. E. Woods. *New York, 1917.* Purchase.

U. S. Geologic Atlas. Eureka Springs-Harrison Folio, Arkansas-Missouri. Folio 202. *Washington, 1916.*

——— ——— Tolchester Folio, Maryland. Folio 204. *Washington, 1917.* Purchase.

U. S. Geological Survey. Annual Report of the Director. 37th. *Washington, 1916.* Purchase.

U. S. Reclamation Service. General Reclamation Circular. Laws and regulations relating to the reclamation or arid lands by the United States. *Washington, 1916.*

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——— ——— List of engineering articles, reprinted from the 12th and 14th Annual Report of the U. S. R. Service. *Washington, 1914, 1916.*

——— ——— Progress in reclamation of arid lands in the Western United States. By J. B. Beadle. *Washington, 1916.*

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Use of Water in Irrigation. By Samuel Fortier. N. Y., ed. 2. *McGraw-Hill Book Co., Inc.* Gift of publisher.

Useful Minerals of the United States. U. S. Geological Survey. Bulletin 624. *Washington, 1917.* Purchase.

Valuation, Depreciation and the Rate-Base. By Grunsky, Carl Ewald and Carl Ewald Grunsky, Jr., N. Y., *John Wiley & Sons, Inc.; Chapman & Hall, Ltd., 1917.* Gift of author and publisher.

Valuation of Railroad Right-of-Way. By A. M. Sakolski. Reprinted from American Economic Review, *June, 1916.* Gift of author.

THE VENTILATION HAND BOOK. The Principles and Practice of Ventilation as Applied to Furnace Heating, Ducts, Flues and Dampers for Gravity Heating, Fan and Fan Work for Ventilation and Hot Blast Heating, by Charles L. Hubbard. N. Y., Sheet Metal Publishing Co. *1916.* Gift of publisher.

WALLACE & TIERNAN COMPANY, INC. Protecting the Water Supply of Greater New York. *New York, 1916.*

——— The cost Hypochlorite vs. Liquid chlorine. *New York, 1916.* Gift of Company.

WHY DO THE RAILWAYS OF THE SOUTH ASK THAT THEIR FREIGHT RATES SHALL BE INCREASED AT THIS TIME? Statement before the Interstate Commerce Commission, March 27, 1917. Purchase.

THE WORLD'S MINERALS, with an Appendix by W. D. Hamman. *New York. Frederick A. Stokes Co., 1916.* Gift of publisher

GIFT OF CARLETON GREENE.

COLLINSON, JOHN. Explorations in Central America, from Proceedings Royal Geographical Society of London, 1867.

COUVREUX, A. & HERSENT, H. Les nouvelles installations maritimes du Port d'Anvers. *Paris, 1879, 1880.*

DE ROUCHMONT, QUINETTE. Notice sur le port du Havre. *Paris, 1875.*

NEW YORK BOARD OF WATER COMMISSIONERS. Brooklyn Water Works and Sewers. A descriptive memoir. *New York, 1867.*

REYNAUD, LÉONCE. Memoir upon the illumination and beaconage of the coasts of France. *Washington, 1876.*

U. S. DEPARTMENT OF STATE. Reports upon the survey of the boundary between the territory of the United States and the possessions of Great Britain from the Lake of the Woods to the Summit of the Rocky Mountains. *Washington, 1878.*

——— ——— Joint maps of the northern boundary of the United States from the Lake of the Woods to the Summit of the Rocky Mountains.

WILLIAMS, J. J. Isthmus of Tehuantepac. *New York, 1852.*

TRADE CATALOGUES.

AMERICAN SMELTING & REFINING COMPANY. New York, N. Y. Safety Review. March, 1917.

DEISTER CONCENTRATOR COMPANY. Fort Wayne, Ind. "The Table with the Capacity and Efficiency." Feb., 1917.

DIAMOND POWER SPECIALTY COMPANY. Detroit, Mich. Power Notes. March, 1917.

FOUNDATION COMPANY. New York, N. Y. Industrial Plants. Descriptive pamphlet.

SUPPLEE-BIDDLE HARDWARE COMPANY. Philadelphia, Pa. Monel Metal. April, 1917.

THWING INSTRUMENT COMPANY. Philadelphia, Pa. Pyrometers for Clay Burners.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY. East Pittsburgh, Pa.

CATALOGUE 1-A. Westinghouse Lightning Arresters. May, 1916.
——— 2-B. Switchboard Accessories. Feb., 1917.
——— 5-B. Railway Accessories. Feb., 1917.
LEAFLET 3164. Type C. switchboard Watthour meters.
——— 3892. Type E. Elevator Brake Magnets for alternating current circuits.
——— 3931. Westinghouse type 3-19 automatic electric range.
——— 3937. Type 2-19 automatic electric range.
——— 3940. Type 2-19 non-automatic electric range.

A.S.M.E. Accessions

CONTROL OF PLUMBING WORK BY WATER DEPARTMENTS. By Dr. Wm. Paul Gerhard. n.p. Reprinted from The Sanitary Engineer. *Toronto, 1916.* Gift of author.

GRAPHICAL CONTROL ON THE EXCEPTION PRINCIPLE FOR EXECUTIVES. By Frank B. Gilbreth. Reprinted from the April 1917 issue of Journal of A.S.M.E.

INTERNATIONAL WHO'S WHO, 1910-1911.

NATIONAL FIRE PREVENTION CONVENTION. Official Record of the first American, Oct. 13-18, 1913. *Philadelphia, 1913.*

NEW BEDFORD (MASS.) WATER BOARD. Report. 1916. *New Bedford, 1917.* Gift of Water Board.

NEW YORK CITY BOARD OF WATER SUPPLY. Information for bidders, forms of bid, etc. for furnishing and erecting fences around Hill View Reservoir in the City of Yonkers, and Silver Lake Reservoir, in the Borough of Richmond, N. Y. Contract no. 176. Gift of Board of Water Supply.

——— Information for bidders, forms of bid, etc., for applying surface treatment to waterbound macadam pavements at the Ashokan Reservoir in the towns of Olive and Marbletown, Ulster Co., N. Y. Contract 182. Gift of Board of Water Supply.

PENALTIES AND LIQUIDATED DAMAGES. By Wm. B. King. Reprinted from The Architectural Forum, Feb. 1917. Gift of Messrs. King & King.

RAILWAY STATISTICS OF THE UNITED STATES OF AMERICA. 1916. Prepared by Slason Thompson. *Chicago, 1917.* Gift of author.

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AMERICAN BLOWER COMPANY. Detroit, Mich. "Sirocco" Service.

DIAMOND POWER SPECIALTY COMPANY. Detroit, Mich. Power Notes. April, 1917.

FLANNERY BOLT COMPANY. Pittsburgh, Pa. Staybolts. April, 1917.

TEXAS COMPANY. New York, N. Y. Lubrication. April, 1917.

VALLEY IRON WORKS CO. Appleton, Wis. The Beater. March-April, 1917.

PUSEY & JONES COMPANY. Wilmington, Del. The Super-Calendar. Feb., 1917.

PERSONALS

IN these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by June 16 in order to appear in the July issue.

CHANGES OF POSITION

HORACE H. NEWSOM, formerly factory manager of the Perfection Spring Company, Cleveland, O., has become affiliated with the Standard Parts Company of the same city.

L. C. WELCH, formerly connected with The Imperial Oil Company, Ltd., Sarnia, Canada, has become identified with The Midwest Refining Company, Casper, Wyoming.

JOHN D. RIGGS, formerly associated with the Indestructible Wheel Company, Lebanon, Ind., has entered the employ of the Link-Belt Company, Indianapolis, Ind.

GEORGE B. PRESTON, formerly assistant professor of steam engineering, Columbia University, New York, has become associated with The J. G. White Engineering Corporation, New York.

I. ALBERT BAUM has severed his connection as city engineer of Texarkana, Ark., and has accepted the position of assistant manager of the LaSalle Engineering Company, Chicago, Ill.

GEORGE F. READ has severed his connection with E. I. duPont de Nemours and Company, Penns Grove, N. J., and has accepted a position with The Celluloid Company of Newark, N. J.

ALBERT BUENGER, formerly heating and ventilating engineer with Smith Hinchman and Grylls, Detroit, Mich., has become identified with the Charles L. Pillsbury Company, St. Paul, Minn.

ULRIC THOMPSON, JR., formerly chief engineer of the T. A. Gillespie Company's plant at Parlin, N. J., has become associated with Westinghouse, Church, Kerr and Company of New York.

EUGENE L. BROWN, JR., formerly chief deputy inspector of boilers and elevators of the City of St. Louis, Mo., has accepted the position of engineer with the Illinois Stoker Company of Alton, Ill.

BARRETT W. MORRISON has left the employ of the Westinghouse Machine Company, East Pittsburgh, Pa., and has accepted a position with the Great Western Sugar Company, Billings, Mont.

RUSSELL J. HAWN, formerly with the Ohio Chemical Company, Springfield, Ohio, in the capacity of manager, has become associated with the Oakland Chemical Company, Rossville, S. I., N. Y.

EMILE H. NATE has become consulting engineer with Hammerston and Nate, New York. He was, until recently, associated with the Nate-Earle Company, Inc., New York, as president and treasurer.

W. R. CRUTE has assumed the duties of chief engineer of the Champion Fiber Company, Canton, N. C. He was formerly engineer with the Norfolk and Western Railway Company, Pocahontas, Va.

ARTHUR L. JENNINGS, formerly connected with the McGill Metal Company, Valparaiso, Ind., as general manager, has accepted the position of treasurer of the John T. Robinson Company, Boston, Mass.

JOHN J. EASON, formerly assistant superintendent of the mechanical division of the Panama Canal, Balboa, Canal Zone, has been appointed assistant shop superintendent at the Navy Yard, Norfolk, Va.

WELLES H. SELLEW, formerly mechanical engineer with the Canadian Car and Foundry Company, Kingsland, N. J., has accepted a similar position with the American Chicle Company, Long Island City, N. Y.

HARRY A. WARD, formerly in the employ of the Sterling Blower Company, New York, as sales engineer, has taken up the duties of engineer of plants with the American Oak Leather Company, Cincinnati, O.

JACOB L. MUELLER, until recently metallurgist with the Springfield Facing Company, Springfield, Mass., has accepted the position of mechanical engineer with the American Chain Company, Inc., Bridgeport, Conn.

GEORGE S. BARKER, formerly designing draftsman of the Niles-Bement-Pond Company, New York, has accepted the position of mechanical engineer with the Lucey Manufacturing Corporation, Chattanooga, Tenn.

HARRY O. HAGSTROM has become affiliated with the Elevator Supplies Company, Inc., Philadelphia, Pa. He was until recently connected with the Elevator Supply and Repair Company, New York, as sales engineer.

GRAHAM H. ANTHONY has severed his connection with the William L. Gilbert Clock Company, Winsted, Conn., as equipment superintendent, to take a position with The Allen Manufacturing Company, of Hartford, Conn.

BENJAMIN C. SHAW has accepted a position with the Boston Duck Company, Bondsville, Mass. He was formerly associated with the Warren Cotton Mills, West Warren, Mass., in the capacity of master mechanic.

ERNEST H. HAWKINS, formerly connected with the Allis-Chalmers Manufacturing Company, Philadelphia, Pa., has become associated with the purchasing department of E. I. duPont de Nemours and Company, Wilmington, Del.

ARTHUR D. STANCLIFF, until recently associated with the Hawkeye Portland Cement Company, Des Moines, Ia., has assumed the duties of superintendent of the Western States Portland Cement Company, Independence, Kan.

LOUIS H. MESKER has become affiliated with The Cleveland Milling Machine Company, Cleveland, O. He was until recently connected with Kearney and Trecker Company, Milwaukee, Wis., in the capacity of sales manager.

JAMES H. OAK has resigned his position as general foreman of the New England Westinghouse Company, Chicopee Falls, Mass., and has assumed the duties of superintendent of the National Automatic Machine Company, Brattleboro, Vt.

JOHN J. CHISHOLM has resigned his position as superintendent of power for the Tennessee Coal, Iron and Railroad Company at Ensley, Ala., and has taken up similar duties with the New Orleans Railway and Light Company, New Orleans, La.

CLAYTON A. SWIGGETT, formerly associated with the Western States Portland Cement Company, Independence, Kan., as superintendent, has entered the employ of the Lehigh Portland Cement Company, Iola, Kan., in a similar capacity.

EDGAR T. SPIDY, until recently connected with the Canadian Pacific Railway Shops, Winnipeg, Canada, in the capacity of shop engineer, has assumed the duties of production engineer with the Canadian Ingersoll-Rand Company, Sherbrooke, Que., Canada.

ROBERT H. WALLACE, until recently connected with the Remington Arms and Ammunition Company, Bridgeport, Conn., in the capacity of experimental engineer, has assumed the duties of shop superintendent of the Bailey Meter Company, Boston, Mass.

LEE E. WALKER has accepted a position with the Haynes Stellite Company of Kokomo, Ind., with headquarters in Philadelphia, Pa. He was until recently connected with the Baldwin Locomotive Works, Eddystone, Pa., as foreman of the French Shell Shop.

FRANK H. SCHUBART, formerly district manager for the Wheeler Condenser and Engineering Company, St. Louis, Mo., has become associated with the Union Electric Light and Power Company of the same city, as assistant chief engineer of power plants.

EDGAR G. SCOTT, until recently connected with Ludlow Manufacturing Associates, Ludlow, Mass., in the capacity of superintendent of power and repair shops, has become identified with the Joseph Campbell Company, Camden, N. J., as mechanical engineer.

AUGUSTUS W. SHALLCROSS has severed his connections as draftsman and designer with the Layne and Bowler Company, Houston, Tex., and has accepted the position of designer and chief draftsman with R. P. Clark and Company, engineers of the same city.

GEORGE H. JEWELL has resigned as manager of sales of the Lytton Manufacturing Corporation, to become identified with the Chicago office of the Builders Iron Foundry of Providence, R. I., manufacturers of Venturi meters and special recording instruments.

ROBERT W. ELLINGHAM has become affiliated with The Bilton Machine Tool Company, Bridgeport, Conn., a new corporation formed by the consolidation of The Standard Manufacturing Company and The Parsons Foundry Company. Mr. Ellingham was until recently connected with the Remington Arms and Ammunition Company, Bridgeport, Conn., in the capacity of assistant superintendent.

ANNOUNCEMENTS

PERCY H. THOMAS has been granted a patent for a system of electrical distribution.

PAUL WEEKS has become associated with the Holt Engineering Company, of Stockton, Cal.

RALPH BLUMENFELD has entered the employ of the Bayonne Steel Casting Company, Bayonne, N. J.

WALTER J. WARDER, JR., has accepted a position with [illegible] Brothers and Company, Chicago, Ill.

AMASA M. HOLCOMBE has accepted a commission as Captain in the Ordnance Section of the Officers' Reserve Corps, U.S.A.

J. M. SPITZGLASS, mechanical engineer of Chicago, Ill., has become associated with the Republic Flow Meters Company of Chicago, Ill.

ALEXANDER ENGBLOM, formerly mechanical superintendent of Sidney Blumenthal and Company, Shelton, Conn., expects to go to Sweden shortly.

W[illegible] whose capacity [illegible]

[illegible] been asked by [illegible] W[illegible] Board for the [illegible] M[illegible]

[illegible] M[illegible] Factor formula for [illegible] the basis of govern[illegible]

[illegible] has been commissioned as [illegible] Officers' Reserve Corps, and [illegible] Kansas.

[illegible] engineer with the International [illegible] has been transferred to Milwaukee, Wis[illegible] the Milwaukee Works of the company.

W[illegible] F. D[illegible] and CHARLES P. STEINMETZ have been elected [illegible] of the American Philosophical Society. Professor Durand [illegible] elected a member of the National Academy of Sciences.

DANA W. WILBER, of Rochester, N. Y., has been ordered to Madison Barracks, New York, with recommendation for the rank of Captain in the Engineer Officers' Reserve Corps, from the War Department.

CLARENCE E. BILTON, president of the Bilton Machine Tool Company, Bridgeport, Conn., has been elected president of the Manufacturers' Association of that city, to succeed James G. Ludlam, resigned.

WILLIAM D. ENNIS, since 1907 head of the department of mechanical engineering in the Polytechnic Institute, Brooklyn, N. Y., has been appointed Major of the Ordnance Section, Officers' Reserve Corps, under date of May 5, 1917.

EDWIN J. PEIRCE, JR., production engineer of New York, has returned from a trip to Kansas City, Mo., in the interests of the Automatic Bookkeeping Register Company. Mr. Peirce is making a specialty of organizing for increased production.

FREDERICK U. CONARD, formerly with the Jennings Lace Works, Brooklyn, N. Y., and now employed by the Public Service Gas Company of Newark, N. J., is at present on leave of absence on account of military duties. He holds a commission as Second Lieutenant in the Engineer Officers' Reserve Corps and is stationed at Fort Oglethorpe, Tenn.

CHARLES WHITING BAKER has retired from the position of editor of *Engineering News-Record* and has become consulting editor of the journal. FREDERICK E. SCHMITT, who was associate editor of *Engineering News* from 1902 until its consolidation with *Engineering Record* as *Engineering News-Record*, a few weeks ago, succeeds Mr. Baker as editor.

JOHN P. FLIPPEN, formerly chief engineer of the C. H. Wheeler Manufacturing Company, Pittsburgh, Pa., is now district manager of that company's interests in Western Pennsylvania, Ohio and West Virginia, with offices in Cleveland and Pittsburgh. Mr. Flippen is operating in conjunction with the Baker Dunbar Allen Company, contracting engineers.

FRED. A. GEIER, president of the Cincinnati Milling Machine Company, Cincinnati, O., and a former trustee of the University of Cincinnati, has made a gift of \$25,000 to the University which will be known as the Fred. A. Geier Students' Loan Fund. The annual interest is to be used to provide loans to students of the coöperative engineering course who need financial assistance.

WILLIAM H. WINTERROWD, assistant chief mechanical engineer of the Canadian Pacific Railway, has just returned to this continent after an absence abroad of over $3\frac{1}{2}$ months. He accompanied George Bury, senior vice-president of the Canadian Pacific Railway to Russia, which was visited at the request of the British and Russian Governments in connection with transportation problems.

APPOINTMENTS

EDWARD FLAD, consulting engineer, of St. Louis, has been appointed to succeed John Kennish on the Public Service Commission of Missouri.

ARTHUR S. HAWKS, formerly assistant chief engineer of the Busch-Sulzer Bros.-Diesel Engine Company, St. Louis, Mo., has been appointed chief engineer in the company.

JULIAN KENNEDY, Vice-President, Am.Soc.M.E., of Pittsburgh, has been appointed a member of the State Committee on Public Safety by M. G. Brumbaugh, Governor of Pennsylvania.

WILLIAM SMITH has been appointed general master mechanic of the Brandywine Works of the Midvale Steel Company, Coatesville, Pa. He was formerly associated with the company as assistant to superintendent of the special forge department.

CHARLES R. RICHARDS, professor of mechanical engineering at the University of Illinois, and head of the department since 1911, has been appointed dean of the College of Engineering and director of the Engineering Experiment Station to succeed Dr. W. F. M. Goss, who has become president of the Railway Car Manufacturers' Association.

AUTHORS

W. KNIGHT is the author of an article on Explanation of the Failures of Materials, which appears in the May 10 number of the *American Machinist*.

J. PAUL CLAYTON has contributed an article entitled Electric Cooking in Small Cities, to the May 5 issue of the *Electrical Review and Western Electrician*.

WILLIAM T. DONNELLY has contributed an illustrated article on the Problem of the Wooden Cargo Ship, to the May issue of *International Marine Engineering*.

C. F. HIRSHFELD presented a paper on Some Low-Temperature Electrothermic Processes at the Detroit convention of the American Electrochemical Society, May 2 to 5.

JOHN A. MATHEWS presented a paper on Comments on the Electrical Steel Industry at the May 2 to 5 meeting of the American Electrochemical Society, held in Detroit, Mich.

SAMUEL S. WYER is the author of Electrolysis Damages from Single-Trolley Electric Railways which appears in Vol. 23, No. 11 of *Case and Comment*, The Lawyer's Magazine.

H. COLE ESTEP, editorial director of the Penton Publishing Company, Cleveland, O., addressed the Philadelphia Foundrymen's Association, May 2, on The Cleaning of Castings.

ALLEN F. BREWER is the author of an interesting article in the *Engineering News-Record* for April 19, comparing the suitability and cost of portable frame buildings with canvas tents for use in modern military encampments.

RICHARD G. WILLIAMS presented a paper on The Grinding Wheel—A Connected Link between the Electric Furnace and the Automobile, at the 31st general meeting of the American Electrochemical Society, held in Detroit, May 2 to 5.

VICTOR W. ZILEN is the author of an article on Reversible Steam Turbine for Driving Locomotives, which appears in the May 1 issue of *Power*. This article deals with the preliminary design of steam turbines and with locomotive turbine performance.

CLAUDE HARTFORD has contributed articles on Up-to-Date Methods of Selling Steam, and the New Station of the New York Steam Company, which appear in the April issue of *The Heating and Ventilating Magazine* and the April 15 number of *The Bulletin of the National District Heating Association*, respectively. He is also the author of an article entitled New High-Pressure Central Steam Plant, which appears in the February 6 issue of *Power*.

THE NEW BOOKS

ALL books received by The Journal will be listed under this heading, generally accompanied by brief descriptive notes. Works of special importance to mechanical engineers will be commented on at length by members and others peculiarly qualified by reason of their experience and training.

Engineering Chemistry

Engineering Chemistry. By Thomas B. Stillman, M.Sc., Ph.D. Late Professor of Engineering Chemistry in the Stevens Institute of Technology, etc. The Chemical Publishing Co., Easton, Pa., 1916. Cloth, 5¾ x 8¾ in., 760 pp., 150 illustrations. $5.

The present edition of Engineering Chemistry is fully up to the reputation of its ancestors and is a fit memorial to its noted author. Notable improvements over the previous editions are found in the chapters on coal and coke, asphalt and paving materials, coal tar and derived oils, and gas analysis.

The work is planned primarily for the use of analytical and testing laboratories, for which it is invaluable. Although containing only 760 pages, it gives in excellent form methods for testing many of the common engineering materials. In addition to the chapters mentioned above, it includes methods for iron and steel, alloys, cements, building materials, oils, lubricants, soaps, paints, paper, and water for industrial purposes.

The general treatment of the various subjects may well be illustrated by the chapter on coal and coke. In this chapter there is given, first, in brief form, the technical methods of analysis and, then, in more detail, alternative and more exact methods. After this there follow notes and comments on the analytical methods, forms for reporting the analyses and tests, and, finally, specifications of large consumers of the various kinds of coal or coke. The determination of calorific value is described in a most satisfactory manner.

In the chapters on alloys and on oils and lubricants, Dr. Stillman has collected a great deal of information which it would be difficult to equal in another work of the same size. These chapters will be appreciated especially by those engineers who have been confronted, for example, with the necessity of determining quickly the composition of a sample of white metal or of detecting the presence of grease in a lubricant which has been found unsatisfactory.

The description of asphalt and pavement materials, and their physical and chemical examination, has been so expanded as to make this a chapter of great interest to municipal laboratories and highway engineers. The various asphalts and mixtures, methods for the examination of bituminous road materials, and the essential constituents for road construction and maintenance are discussed in considerable detail.

Since the book is of most value as a manual for the laboratory, it is not surprising that the author has found impossible the inclusion of lengthy theoretical discussions. Usually, only sufficient general descriptive matter is given to familiarize the chemist with those properties which are dependent upon compositions or conditions which may be tested for in the laboratory. While the effect of various ingredients on the hardness and other physical properties of iron or steel is stated clearly, we have found no mention of the different modifications of ferrite.

On the whole, the publication is a most valuable one and one which should be available to every chemist or engineer interested in analytical or testing work.

Charles L. Reese.

Steam Boilers

Steam-Boilers. By H. de B. Parsons, B.S., M.E., Consulting Engineer, Member of the Am.Soc.M.E., A.S.C.E., Soc. Naval Architects and Marine Engineers, etc. Longmans, Green & Co., New York, 1917. Cloth, 6 x 9 in., xvii + 377 pp., 157 illustrations. $4 net.

This book was written by a former professor of engineering and now a prominent consulting engineer in New York at first as a series of lectures to his pupils, and later, by certain changes, as a general book on boilers and collateral matters, such as the chemistry of combustion, fuels, boiler fittings, chimneys and other means of creating draft, smoke prevention, boiler coverings, etc. The first edition appeared in 1903, and the edition under review in 1917. Its purpose is to give its readers some general ideas concerning the matters mentioned above and of features of construction of the various common types of fire-tube boilers. Of water-tube boilers there is very little said, "because the manufacturers of such boilers issue complete illustrated descriptions and dimension sheets."

The author's aim is apparently not to go far beyond generalities, although he has evidently looked closely into details of construction, etc., and in them is well versed. He has succeeded well, and while designers of boilers seldom look into books, except the A.S.M.E. and similar Codes, young men will find the book very helpful, and any one interested in the subject of boilers will find it a good book to possess. In some respects the book is not up to date, as will appear below.

The diagrams were evidently prepared for this book, and it is gratifying that they are not taken from trade catalogues.

The book is what I suppose would be called "analytical," rather elementary, but sufficiently advanced for most purposes, and the illustrative examples are well worked out. The material is original as far as practicable in treating such a well-worn subject.

The early pages of the book are devoted to temperatures, specific heat, latent heat, factor of evaporation, combustion, cause and prevention of smoke, methods of firing, kinds of fuel, and definitions of fuel, combustible and efficiency.

I observe that the statement is made, as it is by many persons besides the author, that a large combustion volume is necessary for good results. I never accepted this dictum fully, for I have found that corrugated-furnace and locomotive-type boilers give as good gas analyses as others.

Chapter V begins with a general definition of boilers, and the distinction is made between "boilers" and "generators," the former being the fire-tube types and the latter the more modern devices for containing water in tubes and drums. Here, and in several other places, the author states that the "generators" contain less water than the "boilers" in proportion to their relative horsepowers. If the author should compute some of these volumes he might modify these statements. While speaking of the two types, the author calls them, except here and there, "fire tubular" and "water tubular" instead of the more common fire-tube and water-tube.

In discussing the rating of boilers I think the author attaches undue importance to the arrangements of surfaces.

the tops of tube plates of boilers not being very effective heating surface, but I have always considered such plates of fire tube boilers near the firebox as immensely effective.

I have stated that in some particulars the book is not up to date. Among the reasons for this statement are the engraving of the end of a cylindrical boiler which is made in four sections and a central patch instead of a head in one piece; a view of a horizontal return tubular boiler (Figs. 11 and 12) with both heads flanged in, which violates the principle which he lays down elsewhere that heads should be so placed that all joints can be riveted by a machine; the view of a vertical boiler (Fig. 15) which has a brick ashpit, and a cast-iron plate under the base or mud ring, both of which prevent calking the lower joints without raising the boiler; a fire-door opening formed in part by the mud ring and the remainder by a forged ring solid with it; the reversed flange wide and flat, both of which have caused disaster in many cases; and a form of smoke box covering which leaks air to a serious extent. Present-day construction employs a cast-iron ashpit which, at the top, is narrower than the mud ring and thus permits the bottom joints to be calked without removing anything. It also forms fire-door openings by flanging the plates and permitting the water to surround the opening. It is well to mention these things because the young engineer may feel justified in copying designs shown in a book by a prominent author.

It would have been well in discussing the submerged-tube-plate vertical boiler (Fig. 14) to have called attention to the complicated nature of the stresses in the upper tube plate and cone, the bending of the former when subjected to the test pressure, and the best manner of staying the cone. It may be well to call attention to the depth and double riveting of the mud ring in this figure, both of which are never employed except in some very large boilers, and then probably without sufficient reason.

A curious error in detail of boiler construction is given in Fig. 13, p. 81, in which the lower tube plate of a vertical boiler is flanged outside of the firebox inner plate.

In describing the different methods of supporting boilers it would have been well to have dwelt upon the importance of supporting all shell boilers at two points in the length, and mentioned that any such boiler regarded as a girder, is subjected to only an insignificant stress from its weight if supported only at the ends. Mr. Woolson's elegant three-point method is described but insufficiently praised. The method of supporting Lancashire boilers is that generally used, viz., by employing several supporting cradles; but even that boiler, long as it is, should rest on only two points. This method is employed in the Galloway boiler shown in Fig. 19.

There is very little to be said concerning matter relating to marine boilers as that is orthodox, but it would have been well to mention the great diameters, great thicknesses of plates, and high pressures employed at the present time, as for instance on the *Aquitania* and the new *Britannic*—recently sunk.

Reference is made several times to good steaming boilers, but to me it has always seemed as if a good steaming boiler is one that is large for its work, or that has a very strong draft.

The chapter on chimney draft is useful, but it would have been more logical to place it in another part of the book rather than between the descriptions of boilers and the materials of their construction.

The chapter on Materials is good and the A.S.M.E. Code is here made use of. In this chapter it is stated that "Many boilers have been exploded by permitting water to collect on top of cast iron stop valves." Is it possible that this is true?

In the chapter on Boiler Details the use of the elastic limit instead of the ultimate strength of plate in determining the thickness is advocated, which is, of course, correct. The late Mr. Leavitt is the only engineer that I have ever known to use this method. The boiler braces shown on pp. 200-201 have the usual defects of being able to straighten out where bent, and bringing most of the stress on one rivet.

The matter relating to riveted joints is deficient in illustrating a defective and obsolete type of joint in Fig. 75, and in not pointing out the defect of the prevailing type of butt joint used in this country, viz., that of having a narrow strap on one side of the joint and a wide one on the other. The defect is that the joint is non-central resisting, and therefore one which bends under stress, causes the plate to crack, and is likely to cause explosions. Tests of joints and experience show this. Nor is the advantage of butt joints with the straps of equal widths and all rivets in double shear in doing away with these defects mentioned.

It is gratifying to see that drilling holes from the solid is advocated, and I feel that this and the use of butt joints with all rivets in double shear are sure to be features of American boiler practice in the near future.

I am glad to see that the author condemns domes on stationary boilers as being useless and sources of weakness. I should advocate condemning brazed copper steam pipes, as they have caused several severe explosions.

Under the head of Boiler Fittings the down-draft grate is described and it is stated that for grates of equal area the capacity of a down-draft grate is greater than that of an up-draft. This is doubtful, inasmuch as in the latter the fire is drawn away from the fresh coal, and not through it.

The chapter on Mechanical Stokers is seriously defective because it gives nothing about the widely used underfed stokers known as the Taylor, Riley, Westinghouse, Combustion Engineering Co's. Type *E*, and Jones, nor any illustrations of chain grates which are so efficient in burning the western high volatile coals. Neither does it mention pulverized coal sufficiently, which has so recently become prominent and bids fair to be of immense importance to the railroads in utilizing the poorest coals and lignite, and in maintaining steady steam pressure.

The matter on Artificial Draft, Incrustation, Corrosion, General Wear and Tear, and Explosions does not call for special mention, but it is gratifying that a book now states that "Explosions occur when the steam pressure exceeds the restisting strength of the metal structure," instead of attributing them to mysterious causes.

Other matter relating to Chimney Design, Smoke Prevention, Testing Boilers, Boiler Trials, Boiler Coverings, Care of Boilers, and Superheaters is good.

F. W. DEAN.

Stresses in Wire-Wrapped Guns and in Gun Carriages. By Lieut.-Col. Colden L'H. Ruggles. John Wiley & Sons, Inc., New York, 1916. Cloth, 6 x 9 in, 259 pp., 94 illustrations. $3.

This work, which explains a number of the important engineering principles underlying the design of wire-wrapped guns and of gun carriages, was originally prepared for the use of the cadets of the U. S. Military Academy. Its chapters deal successively with elastic strength of wire-wrapped guns; determination of the forces brought upon the principal parts of the 3-inch field carriage and a disappearing gun carriage by the discharge of the gun; stresses in parts of gun carriages; toothed gearing; counter recoil springs.

MOBILIZATION

Mobilization consists in making all the resources of the country available.

The membership of The American Society of Mechanical Engineers possesses great resources of specialists in all branches of the profession of mechanical engineering.

Anticipating a large increase in demands for men, President Hollis appointed a Committee on Engineering Resources to carry out the work of immediately classifying all the members of the Society according to their capabilities for service. This Committee prepared a Professional Classification Sheet which has been distributed to the membership of the Society and from which 3,000 returns have been received to date.

The Council urges those who have not done so to give immediate attention to filling out their blanks and returning them.

Some members have replied that they have already filled out similar blanks for other organizations. While appreciating this the Council nevertheless hopes that every member will respond to this call.

No definite channel for mobilization of the engineers of the nation has yet been established, but undoubtedly the existing professional organizations will be availed of as they already have shown their capacity in the Industrial Census, and all agencies will be made to fit in with some official plan.

By the time that all returns from our members are received, the Committee on Engineering Resources hopes to have proceeded so far with classifying the replies, that it will have the means of supplying not only a particular man to fill a peculiar position, but to furnish the best man for that position.

General Information Regarding Presentation of Papers

THE American Society of Mechanical Engineers solicits original papers upon subjects of mechanical-engineering interest for presentation and discussion at its forthcoming Annual Meeting to be held in New York City, December, 1917, and also at its Spring Meeting to be held in Worcester, Mass., May, 1918. The manuscripts of such papers should be submitted to the Secretary, 29 West 39th Street, New York City, who will refer them to the Committee on Meetings for consideration.

Papers for presentation and discussion at meetings of Sections of the Society, which are organized in 21 cities throughout the country and which hold meetings monthly from September to May, are also solicited by the Society. Correspondence regarding Sections papers should be addressed to the respective Sections chairmen as follows:

Atlanta, Ga....Oscar Elsas, Fulton Bag & Cotton Mills

Baltimore, Md...W. W. Varney, 1221 Calvert Building

Birmingham, Ala...J. H. Klinck, 1146 Brown-Marx Building

Boston, Mass...A. L. Williston, 27 Kilsyth Rd., Brookline

Buffalo, N. Y...David Bell, 911 Lafayette Ave.

Chicago, Ill.....Alexander D. Bailey, 21 Elmwood Ave., La Grange

Cincinnati, O...Fred A. Geier, Cincinnati Milling Machine Co.

Detroit, Mich...G. W. Bissel, Michigan Agricultural College, E. Lansing

Erie, Pa........J. F. Wadsworth, 310 Commerce Building

*Indianapolis, Ind.*W. H. Insley, Insley Manufacturing Company

*Los Angeles, Cal.*Francis G. Pease, Mt. Wilson Solar Observatory, Pasadena

*Milwaukee, Wis.*Edward Hutchens, Federal Rubber Company, Cudahy

Minnesota, Minn. Edward A. Wilhelm, 1049 Van Slyke Ave., St. Paul

New Haven, Conn...H. B. Sargent, 247 Church Street

New Orleans, La...H. L. Hutson, 721 Lowerline Street

New York, N. Y...J. J. Swan. 29 West 39th St.

Ontario, Can...G. V. Ahara, 864 Dovecourt Rd.,Toronto

Philadelphia, Pa. Lewis F. Moody, 408 W. Chelten Ave., Germantown

Providence. R. I...J. A. Brooks, Brown University

San Francisco, Cal...B. F. Raber, 2027 Delaware St., Berkeley

St. Louis, Mo...R. L. Radcliffe, 701 Laclede Gas Bldg.

*Worcester, Mass.*George I. Rockwood, 33 Harlow Street

All papers accepted for a general meeting are printed in pamphlet form in advance of the meeting and are available to the membership of the Society. Also, comprehensive abstracts of the papers are printed in the monthly Journal in advance of the meeting.

After presentation and discussion, the revised papers are printed in the Transactions of The American Society of Mechanical Engineers, issued annually.

All papers presented at Section meetings are considered by the Publication Committee for publication in The Journal. The most meritorious Section papers are also assigned to general meetings and may be printed in the Transactions.

Authors of accepted papers receive twenty specially-bound copies with the compliments of the Society. Arrangements for the purchase of reprints at nominal price both from The Journal, size 9 in. x 12 in., and from the Transactions, size 6 in. x 9 in., can also be made through the Secretary.

[illegible]

G. W. Galbraith, Vice-Chairman

John T. Faig, Secretary-Treasurer

Fred A. Geier, Chairman

W. G. Franz

Cincinnati Executive Committee, in Charge of the Spring Meeting, 1917

George Langen

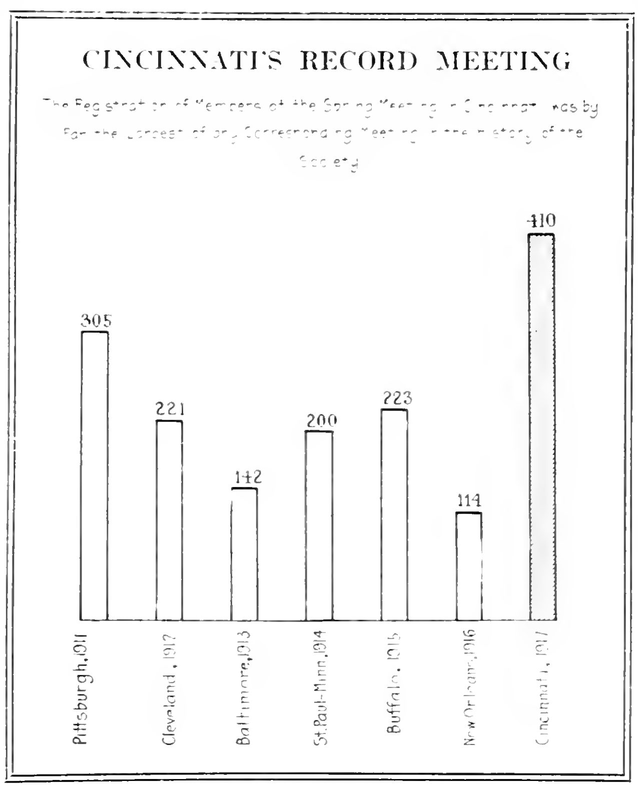
THE SPRING MEETING

WHILE not exactly logical to begin an account of the 1917 Spring Meeting in Cincinnati with a statement of the resolutions made in favor of the Cincinnati Local Committee at the close of the meeting, these resolutions so adequately express the sentiment of the gathering that perhaps the illogic may be excused. The resolutions follow:

WHEREAS, The American Society of Mechanical Engineers, assembled in convention May 21 to 24, 1917, at Cincinnati, Ohio has received a most cordial and spontaneous welcome from the members and friends of the Society in Cincinnati and vicinity: and has enjoyed the splendid coöperation and support of the local committees, through their tireless efforts on behalf of the Society, and their faultless preparation for the meeting, without which a convention of so marked a degree of excellence would have been impossible; and

WHEREAS, The visiting members and guests have been the recipients of a remarkably diversified and delightful entertainment bountifully provided on every occasion, and have had the opportunity to view many of the industrial wonders and other notable attractions of this remarkable center;

BE IT RESOLVED, That on behalf of the Society and of the visiting members and guests, a vote of thanks be extended to all who have participated in these substantial evidences of friendship and goodwill, with the assurance that such a formal resolution is but a poor and outward symbol of the deep sense of gratitude which each visitor personally feels. Further, that the Secretary be instructed to extend the thanks and appreciation of the Society, by written letter, to the local Executive Committee and the other local committees.



Those who were so fortunate as to be able to attend the meeting will testify that these resolutions are in nowise overdrawn. The Society did receive a most cordial and spontaneous welcome, the visiting members and guests being the recipients of a delightful entertainment. Evidences of goodwill were many, and the meeting was a complete success both from a professional and social point of view.

The headquarters was at the Hotel Sinton, and the total registration at the convention was 868, of which 410 were members and 458 guests. This was by far the largest attendance at any Spring Meeting the Society has yet held. The registration of members at the last six spring meetings is strikingly compared on the chart on this page, and shows the Cincinnati attendance far and away in the lead, in spite of the present national emergency exercising great restrictions on the time of professional men.

The exceptional attendance was no doubt largely attributable to the inclusion of sessions on munitions manufacture in the professional program. So many mechanical engineers and manufacturers throughout the country are expecting shortly to concentrate their whole efforts upon munitions work, and so many took advantage of the exceptional opportunity offered to benefit by the experience of those who have been devoting their energies to this class of work for nearly three years.

Another contributing factor to the large attendance was the holding of a joint session with the National Machine Tool Builders' Association. This is the first time such a session has ever been held. The presence of the Machine Tool Builders in convention at the same headquarters and at the same time as the Society contributed no small part to the success of our meeting.

The remarkable success of the Spring Meeting in all its features, however, must be directly attributed to the broad vision of the Cincinnati Committee, the systematic way in which its plans were laid, and the untiring efforts of its members in the execution of these plans. The members of the Executive Committee for The American Society of Mechanical Engineers were F. A. Geier, Chairman; G. W. Galbraith, J. T. Faig, W. G. Franz and George Langer; and for the National Machine Tool Builders' Association, J. B. Doan, Chairman; A. H. Teuchter, F. A. Geier, C. Wood Walter. A large number of sub-committees were appointed, all of which deserve the greatest credit for the perfection of detail in the conduct of the meeting. The Entertainment Committee, consisting of H. M. Norris, Chairman; A. J. Baker and A. A. Thayer, were constantly on the alert to see that no act should be omitted which would contribute to the pleasure of the guests. An account of the various entertainments will be found in the Society Affairs Section of this issue.

The social events began with an informal reception on Monday evening in the ballroom of the Sinton, with an address of welcome by the Mayor of Cincinnati and reply by President Hollis, followed by stereopticon views and dancing. The big social event for the members was the smoker on Tuesday evening, at which they were patriotically greeted at the Business Men's Club by the "Spirit of '76," and conducted to the assembly hall transformed to represent Losantiville, the Cincinnati of pioneer days, but modernized by brilliant kaleidoscopic lights. The evening's entertainment consisted of no less than eighteen numbers, concluding with the very gracious presentation by the Local Committee of a choice piece of Rookwood pottery to President Hollis.

The delightful boat ride on the river, the reception at the Country Club and the excursions to various institutions of the city and many of the modern manufacturing plants, all were greatly enjoyed. Further, Cincinnati's two dramatic

which both contributed entertainment which will long remain in the memory of those who were so fortunate as to witness their performances.

The professional program arranged for seven professional sessions: two munition sessions, one machine shop session, one gas power session, one industrial-safety session, one general session, and one joint session with the National Machine Tool Builders' Association. On account of the lively interest developed in the munitions sessions, these were ultimately expanded into three sessions.

The joint session with the National Machine Tool Builders' Association was a noteworthy event arranged by the Local Committees to show the consideration which is being given in Cincinnati to the humanitarian side of engineering. The addresses were by Dean Herman Schneider, the exponent of the cooperative system of education so successfully developed at the University of Cincinnati; and by Dr. Otto P. Geier, medical director of the Cincinnati Milling Machine Company, dealing with the work of the socially minded physician in industry. Both addresses touched a high plane and were an inspiration to the audience which filled the large ballroom of the Hotel Sinton. This joint session was followed by a timely motion picture exhibition, arranged by *Machinery*, showing the processes of manufacture of 9.2-in. shells.

As usual at the Spring Meeting, the sections of the Society, through their representatives, showed themselves to be very much alive, and enthusiastic conferences were held at which there were members in attendance from eighteen different cities.

The Cincinnati Committee prepared a complete program of the professional and entertainment features for our own Society and for the National Machine Tool Builders' Association.

In what follows is given a running account of the professional sessions with abstracts of such parts of the discussion as it is believed will be of greatest interest to the membership, while additional notes will be found in the Society Affairs Section. The professional papers have already appeared in the May issue of The Journal.

MACHINE SHOP SESSION, TUESDAY MORNING

The Machine Shop Session was called to order by Howard P. Fairfield, Secretary of the Sub-Committee on Machine Shop Practice, for the presentation and discussion of three important papers: A Foundation for Machine Tool Design and Construction, by A. L. De Leeuw; Machine Shop Organization, by Fred G. Kent, and Metal Planers and Methods of Production, by Charles Meier.

The session was well attended, a number of the recognized authorities on machine-tool design, construction and operation being in the audience, as well as many of the prominent machine-tool builders in Cincinnati, and the discussion was very representative and brought out many points of value.

As was anticipated, Mr. De Leeuw's paper in particular, embodying a questionnaire upon matters which should be settled before the design of machine tools can proceed in a thoroughly scientific manner, brought out the largest volume of discussion of the three papers and occupied most of the session.

MR. DE LEEUW EMPHASIZES THE NEED FOR RESEARCH IN CUTTING METALS

In presenting his paper, A. L. De Leeuw said that in it he tried to call attention to the fact that one of our biggest industries, the machine-tool industry, was not based on scientific principles, and yet it seemed that a scientific foundation would be perfectly possible. All the branches and all the phenomena of the cutting of metals could be reduced to mathematics, and this paper called attention to the fact that no branch of engineering progressed with any rapidity or certainty unless its facts and data were reduced to mathematics. Perhaps one of the reasons why the cutting of metals had not progressed along scientific lines was because it had been done for so long and by so many people.

The author further pointed out that the foundation for the design and construction of machine tools would probably lead to very important results. Some action should be taken toward the establishing of this foundation, and he hoped it might be taken under the auspices of the Society.

What was immediately needed was a research into the functions and actions of the cutting tool, the action of the cutting lubricant, etc. Experiments already made by him were outlined in the paper, and suggested lines of further experimentation were indicated.

The paper was discussed by Albert Kingsbury, H. Wade Hibbard, R. Poliakoff, A. Lewis Jenkins, Leon P. Alford, Frederick A. Waldron, Carl G. Barth, Arthur J. Baker, Charles Fair, Luther D. Burlingame, Ralph E. Flanders and Richard T. Wingo.

Albert Kingsbury contributed a written discussion of the action of lubricants on metal-cutting tools, in which he said that it was very well known that a proper lubricant applied to tools when cutting tough metals improved the cutting, but it was not obvious how the lubricant acted, since the cutting edge of the tool was apparently buried in the metal, and therefore it was not readily seen how the lubricant could reach the cutting edge.

He had made an experimental study of this question about the year 1895. A mild-steel bar was mounted in a lathe, held by chuck and center rest, and was cut by a parting tool with one side flush with the end of the bar. A microscope magnifying about 30 diameters was placed for examination of the chip during formation. The bar was rotated very slowly by using the back gear and pulling the belt by hand.

Figs. 1, 2 and 3 showed roughly successive stages of formation of the chip. The most important phenomenon was the fact that a crack in the metal preceded the cutting edge of the tool at all times. The crack began at the point C in Fig. 1; it extended in substantially the direction of the finished surface of the work, as in Fig. 2, up to a certain point where it suddenly turned outward about 45 deg. as in Fig. 3.[1] This action was cyclical, beginning again when the point C reached the cutting edge. The successive surfaces of these cracks formed the finished surface of the work, if the tool was sharp, thus giving the well-known cross-banded appearance of the tool marks; but if the tool was dull there was more or less rubbing of the tool over the surface after the cracks were formed, altering the appearance of the surface very noticeably. Oil being applied to the work, as the crack extended the oil was seen to flow into the crack, the flow being made evident by the motion of minute particles of steel suspended in the oil.

[1] Similar descriptions of the formation of the chip are given in Trans. Am.Soc.M.E., vol. 28, p. 75 and p. 333.

Thus the oil was enabled to reach the top surface of the tool, even to the cutting edge. The principal effect of the lubricant appeared to lie in the reduction of friction on the top face of the tool; this increased the frequency of the cyclical breaking of the chip, shortened the chip segments and reduced the length of the cracks in advance of the cutting edge, and thus made the finished surface smoother.

This phenomenon explained several facts regarding the lubrication of cutting tools, well known to machinists, as follows:

a Good lubricants of rather high viscosity, such as lard oil, were very effective when the cutting speed was slow, as in tapping and reaming by hand, but if the cutting speed was high, as in high-speed milling and drilling, lubricants of very low viscosity, such as soda water or soap and oil emulsions, were more effective. The lubricant was forced into the vacuum in the crack mainly by atmospheric pressure (capillarity probably being secondary if the cutting speed was high). Therefore, if the viscosity of the lubricant was high the cracks might not be filled fast enough.

Fig. 1 Fig. 2 Fig. 3

Figs. 1 to 3 Successive Stages in Formation of Chip

b In the case of a parting tool cutting off a bar, the tool lubricated well at the beginning of the cut, but not when the cut became deeper. In the deep cut the chip was "upset" and filled the slot, and therefore the lubricant could not readily enter the cracks from the sides of the cut. It had been found efficacious, in large work, therefore, to use two tools simultaneously in parting or slotting cuts, the leading tool being narrower than the following tool; thus both tools were fairly lubricated, the leading tool from both edges, and the following tool from one edge of each of its two narrow chips.

c In finishing cuts with broad tools, the lubricant must penetrate the cracks for long distances; thus it was necessary to run slowly and to use thin lubricants such as kerosene or turpentine. More viscous lubricants might be used if the speed of cutting were exceedingly slow. There must be sufficient time for the lubricant to flow in the cracks from the edges to the center of the cut.

d In slab milling, etc., it was found advantageous to notch the cutting edges at frequent intervals; this broke the wide chips into narrow ones and thus favored the entrance of the lubricant.

e In general, the more viscous lubricants were used only for slow speeds or narrow cuts, the less viscous for higher speeds or wider cuts. Even a poor lubricant, if it flowed readily enough to penetrate the cracks rapidly, was more effective than a good lubricant which was too slow in getting to the spot where it might be effective.

H. Wade Hibbard said that, as in thermodynamics, the fundamental consideration in machine designing was the ultimate constituency of matter. In a piece of steel there were millions of atoms held in relation to each other by "springs"—forces of cohesion and repulsion. If this piece of steel were heated, the forces that tended to separate the atoms were increased; if cooled, these same forces were diminished. To make a study of how to cut a piece of steel, one must consider what was being done with these "springs" connecting the atoms together.

All the forces applied to a piece of steel in cutting it, or in testing it, as Mr. De Leeuw had shown in his diagram of the tension test of a piece of steel, could be resolved into just two kinds of forces, the normal forces, plus or minus, and the tangential forces, either plain shear or rotating shear.

"Upon this theory of the ultimate constituency of matter, and the forces which hold atoms together," continued Professor Hibbard, "some of the things that puzzle us in machine-tool designing are made more clear. For example, the author asks, 'When we turn up a narrow disk by means of a square-nosed turning tool, of which the width is greater than the width of the disk, is the action of removing the chip purely a matter of tension? Or, if not, what is it?' No, it is not purely a matter of tension, because according to the above reasoning both normal and tangential forces are acting on the 'springs' holding the atoms together. Also, 'What is the nature of the lamination of the chip?' Its nature is almost purely the action of the tangential force upon those 'springs' holding two adjacent layers of atoms together.

"'We do not see at the present time how it is possible for the lubricant to influence the size, yet that it does do this has been observed a great many times,' the author states later. That, I believe, if we think of these two kinds of forces, the normal and the tangential, means that by lubricating the top of the tool we reduce the normal force, necessarily. In other words, we reduce the compression of the chip in the direction of the length of the chip, and that, of course, has its effect upon the size of the turned part which is left, after the part has been turned by the tool."

R. Poliakoff[1] said that in Par. 32 the author referred to a tool which was shown in Fig. 4, and observed that that tool after it had been used began to show scratches. Now, he did not know what was the plan of the tool, whether it had a round edge or not, but, if so, the scratches might be attributed to the fact that in leaving the work internal friction was developed among the elements of the chips, which caused them to rotate, one against another, and in this way to scratch the tool. He had started some experiments along this line, but had to abandon them when he came to the United States, but he hoped sometime to continue them. It would be better, perhaps, just to drill out the top of the tool, instead of making it flat, which would give a better tool, and also one that would take less power.

Regarding the circular tool, described in Par. 35, he believed Mr. De Leeuw originated that tool some two and a half years ago. He did not know how much experimenting had been done on the tool in this country, but as soon as he had read about it he had made one on the same lines, and wanted to experiment with it, but, unfortunately, was obliged to go away. However, in a remote factory in the Ural Mountains they did make a tool similar to that shown by Mr. De Leeuw, and they found that it gave them a great saving.

He thoroughly agreed with what the author said under the head of "Suggested Lines of Experimentation," but could easily see some objections from the so-called practical viewpoint—from the point of view of the practical shop man.

[1] Technical Institute of Moscow, Russia.

As Mr. De Leeuw suggested, if such low feeds were taken, the ordinary shop man would say, "that's all right." It might be all right in theory, but how about the practice. Perhaps the practical conditions would be quite different. In connection with this, he wanted to mention that very little in the way of experimental data had been published along these lines of cutting, especially as compared with the ordinary shop practice. Edward Herbert, however, had been working along these same lines for some time, had published some results which were very interesting with reference to the finishing cut, and had shown that the tool failed in a different way from what it did on the ordinary roughing cuts. When Mr. Herbert presented his valuable paper on this subject about four years ago, he had to encounter this same objection of impracticability on the part of the shop man. In order to meet this objection to a certain extent, Professor Poliakoff started some experiments on the finishing tool from the practical view of the shop man, and under the ordinary shop conditions, and had found that the result of his experiments exactly corresponded with Mr. Herbert's under ordinary conditions of speed. These results were printed in a paper about two years ago.

In Par. 30, it was stated by the author that the results should be in the direction of the saving of power. As to this, he would say that a Russian professor, Mr. Simon, had experimented along these lines, and published the results of his investigations about three or four years ago; they showed, or tended to show, that with different lubricants the consumption of power was different, other conditions being the same. While a saving in power might not always be necessary, yet by diminishing the power required, the strain on the machine would be decreased. So that the investigation of the lubricants used in cutting was naturally of very great importance.[1]

A. Lewis Jenkins said that, at the suggestion of Mr. De Leeuw, about three years ago a set of stationary cup-shaped lathe tools, similar to the tools shown in Fig 6 in the paper, was made at the University of Cincinnati. Something like 600 tests were made to compare the power required for the De Leeuw tool, as they called it, with a standard Taylor tool made by the O. K. Tool Company.

The cutting angles were varied from 16 to 90 deg.; the diameters of the tools were varied from 1.25 to 1.4 in., and the work specimen was a piece of steel 4 in. in diameter and 30 in. long. The machine employed was the LeBlond 21-in. all-geared-head lathe.

The tests were made by using a cradle dynamometer, and after taking the readings for one tool at a given feed, depth and speed it was removed and the other tool put in place without changing the speed, feed and depth of cut. The conditions of operation were therefore exactly the same for both tools.

The De Leeuw tool gave a higher finish than the Taylor tool. The De Leeuw tool made no chatter marks when the work was greater than 2 in. in diameter and the cutting angle less than about 80 deg., even on the heaviest cuts taken. The Taylor tool chattered on all diameters when taking the heaviest cuts. The results of these tests showed that a De Leeuw tool having a 40 deg. lip angle required about 90 per cent of the power required to drive a Taylor tool under the same conditions. For cutting angles greater than 60 deg. there was practically no difference in the power required for the two types of tools when operated under these conditions. The feeds varied from 1-64 in. to 1/8 in. and the depth of cut varied from 1-32 in. to 1/8 in.

Leon P. Alford said that a recent question before the Research Committee of the Society was: "What can this Committee do at the present time which might have a beneficial effect in helping this country at war?" One of the sub-committees brought in the suggestion that very little had been done in the direction of a study of the action of cutting tools and the cause of chip formation, and it was decided to concentrate the efforts of the Committee upon that topic. As a member of the Research Committee, he would like to ask Professor Jenkins if he would place in the Committee's possession all the information he had in regard to the series of tests described, and also if Professor Poliakoff would do the same thing in regard to the investigation he had made and from his experience with this tool in the Russian rifle works.

Richard T. Wingo thought that one of the things the Society could do to advantage was to organize the machine-tool shops, with a view to exchanging information regarding tool equipment and methods. His reason for saying that was that it would be found, in going into one machine-tool shop, that it was doing a certain thing in a certain way, but if a competitor came along, very frequently it would be found that that shop was under lock and key because it did not want to show a competitor how it was doing its work.

Of all the branches in mechanical lines, the automobile had brought about the most remarkable results, and it had been done by one concern showing another what it had been doing in every detail.

Frederick A. Waldron thought that in all this work there was a sort of eternal fitness of things, which should lead us to begin, if possible, with a classification of machine tools. This should be confined to machine tools in general, so as to cover the paper now presented.

The classification took the following form in his mind: *first*, machines of convenience; *second*, machines of precision; and *third*, machines of displacement. The machine of convenience was one principally for a jobbing shop not having too heavy work, in which the convenience of the operator, the interchangeability of face plates, of centers, gears, feeds, etc., was paramount. Machines of precision were designed principally for use in tool-room work and on work requiring the greatest precision. Machines of displacement were intended to remove large quantities of metal in the minimum time, with the maximum life of the tool and with the maximum life of the machine.

Carl G. Barth said that he was delighted with the manner in which Mr. De Leeuw had pointed out the part that mathematics played in the development of engineering, for there were as yet too many among those who practiced engineering who were sadly lacking in the everyday recognition of that fact.

However, he believed that, when it came to the art of cutting metals, we already had at our command a wealth of information that should be made more generally available and applicable in everyday machine design and machine-shop practice before we undertook to spend money and efforts in further experiments and investigations, even along the undoubtedly fundamentally sound and interesting lines suggested by Mr. De Leeuw, which at the same time did not promise enough in early results that might be immediately applied to increase the production of the present machine-tool equipment of the country through the present workers and their foreman.

[1] The above notes convey the purport of Professor Poliakoff's remarks. His full discussion, with illustrations will be published later.

Having for some fifteen years made it his principal specialty to increase the production of machine shops, he had, after all, found that the greatest difficulty in the way of increased efficiency was that of educating workers and their foremen to see the fundamental principles underlying their work.

In his judgment, the Society could do more immediate good by appointing a committee to gather together and formulate the knowledge now available, and then perhaps supplement this by further experiments with the various forms of cutting tools already in use; this committee finally instituting a regular campaign of education of the metal workers of the country to utilize the information compiled.

Personally, he stood ready to coöperate with such a committee and to give up the information he had, and to divulge the means he had from time to time devised to make this readily applicable in practice.

When he offered this counter suggestion to Mr. De Leeuw's proposition, it was merely as a practical expedient to obtain results quicker, for he was sure that he believed fully as much in getting to the bottom of things as did any other member of the Society, Mr. De Leeuw not excepted.

He had received his principal training through his coöperation with Dr. Taylor, and the latter had always said that it was better to concentrate on making use of whatever useful facts we had than to spend time on ascertaining even better facts.

Arthur J. Baker, referring to the type of turning tool shown in Fig. 4 of the paper, said that about eighteen years ago, in England, his firm was making tools for turning shackle pins for the Admiralty. These were large tapering pins, say, two or three inches in diameter at the small end, and running up from six to twelve inches in length, and were turned on rather large lathes. When they used the standard type of tool, the machine would not take the cut at a feed sufficient to enable them to produce the pieces in the time that they felt they should be produced in; so they slowed the machine down, but failed to reduce the feed. They then made a flat-topped form tool for the roughing operation, and sunk into its top surface a half-round cutter which left a flat lip or land about 1-32 in. wide on all of the cutting edges. This construction reduced the friction and enabled them to take a cut of almost twice the average that they were able to when using the standard type of cutter.

In regard to the circular turning tool shown in Fig. 9, he had been instrumental in placing a number of those tools in various lathe plants around the country. Some of the users employed them in experiments, and some, he rather thought, did not believe they were very practical and did not go further with them, but the Pennsylvania Railroad, at Altoona, used them on some of their larger rods, with quite satisfactory results, except for this one drawback: that the circular tool could not be used on any job where it was desired to cut up to the shoulder, because the retention of the rather thin cutting edge between the chip and the work usually caused a breaking as the tool was withdrawn. So that the real virtue of a tool of that kind was confined to its use on work that enabled one to pass quickly across the surface. The American Blower Company, of Detroit, had used one of these tools for turning pulleys, and the results were highly satisfactory indeed.

The cutting speed used in turning the Pennsylvania Railroad rods was about 65 ft. per min. They made no attempt to get high speeds. The cast-iron pulleys turned at the American Blower Company, in Detroit, were run approximately 130 ft. per min.—the iron was tolerably hard—which was the highest speed they had been able to use.

Luther D. Burlingame said he would like to offer a resolution, based on the idea that Mr. De Leeuw had brought forward a work of real importance and a work well worthy of attention, that the meeting urgently request the Council of the Society that suitable funds be put at the disposition of the Research Committee in order to carry on the experiments in regard to cutting tools, along the lines referred to in Mr. De Leeuw's paper.

Ralph E. Flanders asked whether it would be possible to secure the coöperation of Mr. Barth and his associates with the Research Committee, or any other proper committee that might be formed. It would seem to be possible, for instance, to put the information on lathe tools, speeds and feeds that was obtained by Mr. Taylor's work into some concise form so that it could be used by engineers anywhere in the machine shops of the country. It seemed to him that this would be a simple, direct and patriotic service that could be rendered to the country just at this time.

Charles Fair said that he agreed with Mr. De Leeuw that we would not get very far in our investigations so long as these investigations and tests were conducted by individuals in a more or less haphazard sort of way, and almost invariably by some short-cut method which usually resulted in not getting the necessary data that would make the tests of any value. It was too bad that more methodical consideration was not given to such investigations. He knew of no body more fitted to undertake this work than the A.S.M.E., and he would therefore like to suggest that this Society should carefully consider the subject with a view to the laying out, if possible, of some definite plan of action not only to be followed by the Society, but elastic enough so that it would be useful to the individual investigator who cared to coöperate with the Society. Much time was being wasted by a repetition of what might almost be called standard tests, while little thought was given to that which might seem to be secondary, but which, in reality, might be of great importance.

While he thought that some of the questions raised by Mr. De Leeuw might be satisfactorily answered, he was afraid that it would require considerable investigation before he would venture on even an intelligent guess as to the answers to a number of others.

CLOSURE BY MR. DE LEEUW

The author said, in closing, that Professor Hibbard had gone several steps further than he would want to go at the present time. We did not yet know very much about the ultimate constituency of matter.

In answer to Professor Poliakoff's question as to the shape of the tool that was used, he would say that this tool was of the square type, with a slightly rounded column and with an angle in both directions, and instead of the angle a groove was substituted in the direction of the feed. Most of the metal was not flying up tangentially to the direction of cutting, but it was flying off at right angles to the direction of the feed. The scratches were all in that direction.

There was no particular way in which the tool would fail: it would sometimes fail near the point, as if the tangential flow of metal would cause it, but more often it failed in the other direction. The importance of the scratches was simply that almost immediately after they began to form the tool would fail, showing, therefore, that the greatly increased friction over the surface of the tool caused the breaking down of

the tool probably on account of heat, and possibly on account of the increased force there.

Professor Pohakoff also mentioned that the idea of a very low speed would not appeal to the man in the shop. From what he knew about the man in the shop, he would not think that any experiment of that kind would appeal to him. The fact was, the man in the shop was not inclined to do experimenting and was very much opposed to it.

He was heartily in accord with Mr. Waldron's idea of a classification of machines. It was getting time that we should know what we were talking about. We were talking about machine tools, about a lathe, for instance, but a lathe might be used for so many different purposes. However, he believed that a very large portion of the work done by machine tools in modern industries was work of displacement. The lathe, as constructed at present, was utterly unfit for using a lighter tool. The conditions were so radically different that he did not believe the lathe could be used as it was at present. In the first place, a very much larger proportion of the power consumed had to go through the lead screw. In the second place, in order to get the best results the lathe should run at a very high speed. And, running at a high rate of speed with a bar perhaps five feet long, running 1350 revolutions, was a very dangerous proceeding. If the end should run off there would be some disaster. Furthermore, it was not possible to run the ordinary lathe at the speed required for that tool. One of the things to be done would be to arrange a lathe so that such a tool could be used to advantage. Still another thing: under those tests the carriage traveled 47 in. to the minute. Now, at that rate, it was not possible to throw out the feed by turning the knob; it was possible, but not within half an inch. In other words, if the left hand should fumble with that knob for just an instant—one second—it would run up against the operator's shoulder and there would be something doing! In regard to what was said about slide rules, that was really a matter that he did not wish to discuss; he did not wish to say whether a slide rule was going to improve the performance of the lathe or not; in fact, he knew it did, but that was a matter of management—a matter of the use of the knowledge we had at the present time. It was very far from his idea to suggest that we should not use the knowledge we had; his paper was not aiming at that at all. He neither advocated neglecting to use the knowledge we had, nor did he advocate its use. To advocate not using the knowledge we had would be a piece of foolishness, and to advocate using it would be almost an insult to the engineers present. What he was urging was to gather up knowledge. Whether it was practical at the present moment or not had nothing to do with the question. We all knew that before knowledge could be made practical, the knowledge must be available. There was no use in talking about the particular nature of the thing when we did not have the thing. The main thing that he would urge was that they should go forth and get it, and that they should try to find out some of the elementary knowledge about the art or science of cutting metals. Personally, he felt that when we had that knowledge we would be able to use it. The American nation had shone especially in the application of knowledge, but it had not shone in the gathering up of knowledge. He had no doubt whatever that there were a great many men in this country who were just as capable of finding and gathering up knowledge as there were abroad, but he believed that heretofore we had had the habit of looking at the mere gathering up of knowledge as something that had no particular value, but as merely a sort of a plaything for the professor who sat in his study and did his thinking and played with his thoughts, and then wrote it all down in a book and the book was put somewhere on a shelf in some library and was forgotten. But that should not be the case. Of all the knowledge that we gathered up, there might perhaps be a certain percentage that was not immediately usable, but he could not think of any great, or even fairly notable, discovery in science that had been made that wasn't at the present time employed in actual practice. If Professor Roentgen had first said, "Let me see what I can use X-rays for," and then, after he had made out what he could use them for, had said, "Now, let me see where that X-ray is—let me hunt it up"—we would have had no X-rays. If Professor Becquerel had first asked himself what he could do with those peculiar Becquerel rays, and how he could use them for transmitting knowledge from one end of the earth to the other, he never would have found the Becquerel rays; the Hertzian violet rays never would have been found, and we wouldn't have any violet rays at this time. Those simply gathered up the knowledge, and then there were other men who were, perhaps, working on different lines who took that knowledge and applied it. So that his plea was for definite knowledge. He had a profound belief in the ability of the American engineer to apply that knowledge after he had found it.

MR. KENT PRESENTS HIS PAPER ON MACHINE SHOP ORGANIZATION

In his paper on Machine Shop Organization, Mr. Kent outlined briefly the basic structure of an organization for a shop building the average line of machinery, applying his remarks to a shop employing 600 men or less.

It was the contention of Mr. Kent that the average shop should have the following departments: Works office, engineering department, pattern shop, tool design and storage, tool making and repair, plant engineering and power, machinery, and erection.

This paper was discussed by J. M. Spitzglass, Mark H. Landis, Elmer H. Neff and A. L. De Leeuw.

J. M. Spitzglass related an experience in shop organization or reorganization which was rather the opposite of the experience cited in the paper.

In this case, the shop was a very small one, having a few groups of two or three men in each group. The management of the shop was visibly incapable, the equipment poor, and the material, while not poor, was very poorly applied.

He could not be present there all the time at the beginning of the reorganization work, but he placed at the shop a very bright young man, in fact a genius in mathematics and system, to make a systematic study of the work and to help in the reorganization of the methods and workings in the shop.

During the first two months he had his hands full in keeping this young man back. He simply could not wait, but wanted to revolutionize, and, in fact, did revolutionize, many things from the very start.

Of course, friction arose from the first moment. The foreman of the shop openly objected to the various innovations. The men in the shop did not like them, though they seemed to be to their advantage, and Mr. Spitzglass, himself, had continuous missions on one side to pacify the shop, and on the other side to keep the young man back, and the latter was the harder job.

The author had pointed out that the time study and the bonus system should be considered only after all other leaks had been attended to. We should consider the fact that in the case of office reorganization we had to deal with men who

understood us at once. They were with us and helping in every way and, therefore, office reorganization was comparatively easy.

When it came to the time study of the men in the shop, we had to deal with individuals who were certainly not with us at the start. If they had anything against us they would not express themselves, and we were working in the dark, which was one more reason for taking sufficient time before the work of time study and bonus system could be started in the shop.

Mark H. Landis said that discussion of the question as to whether it was always right to arrange machines according to their function, led him to state an experience in his plant.

On the small parts—gears, shafts, etc., and the small parts in general that were put into the stock room—it seemed better to have those machines arranged in departments, according to their function, milling department, etc.; but, for the heavy castings, beds, turrets, etc., it seemed preferable to arrange those in departments, according to the castings themselves. In his shop, about a year or so ago, they made a diagram of the shop and all the machines, showing the path that the heavy castings followed through the shop, and it amazed him to see what a tangle of lines represented the moving of the heavy castings. Such a tangle was inevitable unless the shop was so arranged that the castings followed more or less straight lines.

Elmer H. Neff discussed the point that "the inspection department must be answerable to the works manager or his assistant only." One of the largest plants and perhaps the most successful in the country was organized on that basis many years ago, and he believed that that was one of the principal elements in the success of the plant, as he believed it would be in any case where it was consistently followed out. He wished to emphasize that point, because he believed it to be a very important one. There were shops in this country today in which the foremen were allowed to override the work of the inspector, and the results, according to his observation, were always disastrous.

Adolph L. De Leeuw did not believe that it was possible to arrange the machines in shops as Mr. Landis recommended. So many different factors entered in that he did not think it possible to make a general rule. If one had a shop small enough and with a small line of production, producing only comparatively few things, the plan was perfectly possible. If, on the other hand, in that shop they were making 250, or even only 25 different things, unless the output of each of the different classes of machines was very large, he thought such an arrangement would be impracticable, and that that shop would probably be arranged so as to have the larger parts follow the same route as the smaller parts.

If one went still further and took a shop where they made not 250 different varieties but 3000, there would be a reversion and the machines would be placed in groups.

He said that at the plant with which he was connected, there was one shop that assembled the machines, and there were others to furnish the parts. For example, one of the parts was so small that a dozen of them could be put in the vest pocket, yet there was a shop comprising perhaps twenty, thirty or forty machines, that did nothing else but make that part. And yet, even in that establishment they departed from that system again, because when it came to making sheet-steel pressed parts, which had to be handled in such a different way, if these parts had later on to be milled or drilled, or have some other process performed on them, the work was thrown back into the drill department because there the skill and knowledge required to get the best results in the process was such an absolutely individual thing that it would not pay to have the parts distributed over the entire shop.

Though the press parts all ought to be kept in the press shop, yet there were parts which required such particular knowledge of the function of that part after it was made, that it was better again to put the presses in the department where the part was made.

This was just exactly the condition that would be found in most shops. No general rule could be of any value unless a very careful study was made of the individual requirements of that shop and of the parts made in it. There were certain screws made in the screw department, but there were screws made in other departments, too, because there the important point was to understand the requirements of that particular screw; that was of greater importance than the making of the screw mechanically.

He would suggest that in discussing the arrangement of machines in the shop, we forget all about any general rule that might be presented, or that ever had been presented, and study the problem as we found it.

Carl G. Barth wrote that as Mr. Kent's paper read in the main as if it had been written by someone directly trained in the art of managing by Dr. Taylor, he most heartily agreed with nearly everything it contained. What the author said about leaving such matters as time studies and wage-payment schemes to the last, when reorganizing a shop, he believed in so fully that he wished it could be made a law in our statutes; for the introduction of these features of scientific management before the proper foundation for them had been laid was doing a great deal of harm around the country, particularly as only too often the men entrusted with that kind of work lacked the necessary knowledge and experience to do it properly at any time.

The ideal way of effecting a reorganization of a shop undoubtedly was, as Mr. Kent said, by putting a competent man at the head of the organization to do the work; but, unfortunately, there were not enough of that kind of men to go around, so that there was still a legitimate field for the professional outside reorganizer. Such a man should, however, as had now been his own practice for some ten years past, to the greatest possible extent do his work through someone in the permanent organization, whose education in modern management methods thus became his principal task.

In nearly all the shops that he had reorganized, the product had been of such a nature that his efforts had been to group similar machinery together; that is, adopt what might be termed the functional arrangement of the machines; but under certain conditions it would be absolutely preposterous to do this, and no hard and fast rule could be laid down in this matter. Each shop became properly a study of its own.

H. Wade Hibbard said, in criticism of Par. 5, that a wage-payment scheme was not necessarily involved in time study. Certainly time study should come early, preceded by analysis of an operation into its elements, then timing the elements. Often it was found that the company was itself the greatest time waster, and this waste could be eliminated without any reference to the wage-payment system.

CLOSURE BY MR. KENT

Fred G. Kent, in a written closure, said that the discussion seemed to make it necessary to reiterate what was said at the

beginning of the paper, namely, that this paper was confined to the treatment of an organization employing from 300 to 600 employees engaged in producing an average line of machinery.

A great deal of the discussion about the arrangement of machines according to classes or according to the pieces produced was very interesting, but was beside the point so far as this paper was concerned. However, it seemed to him that in a shop of any size, if its product was subject to any variation at all and to alteration of design, there was a fundamental principle which made possible a fairly general rule.

The most important factor in the grouping of machines was the need for getting the greatest skill obtainable in the organization applied to each operation. Skill of operation would far more than offset very considerable expense in the transportation of material which might result from the necessity of moving pieces even of considerable weight over considerable territory. In other words, the man in an organization who knew most about screw machines, should have all screw machines in his department and be responsible for all screw-machine work. The man who had made a specialty of planing and who treated it as his life work, would know far more about his job and would take far greater pains in his work than any man who had charge of the manufacture of one piece requiring many different machines other than the planer, and this man whose specialty was planing should therefore have charge of all the planers in the shop and be responsible for all planing work.

He had tried to show at various points in this paper, and wished again to emphasize the fact, that the most important factor to be dealt with in the shop organization was the human element. This factor was, of course, the least subject to the exact operation of formal rules. It was never long the same in any one shop and never the same in any two shops, and it was the most important thing to consider in the question of the time at which it was most advantageous to take up time study.

It was, of course, never amiss for the foreman of a department to study very carefully the efficiency of any of the operations carried on in his department, and to suggest and carry out changes, but the bringing into the department of some stranger, or a man whom the workmen looked upon as a stranger, to carry on a scientific analytical study of operations, was a thing to be taken up only after all obvious leaks were stopped and the confidence of the workmen firmly established. In fact, it was his belief that reorganization could be carried on with the greatest profit where the fact of reorganization was kept very thoroughly in the background and even not suspected by the average workman. It was true that conditions might sometimes be so bad that violent action was the only possible means of introducing a remedy, but in general it was safe to say that the best types of shop organization were like the best types of life everywhere: they were a matter of growth rather than revolution.

MR. MEIER PRESENTS HIS PAPER ON METAL PLANERS

The paper entitled Metal Planers and Methods of Production, by Charles Meier, presented by the author, described the evolution of the planing machine to provide the increased speeds and power to develop the possibilities of high-speed steel and to meet the increasing necessity for greater production. The paper also analyzed the operation of the planing machine and showed how, by improved methods of setting the work, measuring for rough cuts, fitting for finishing cuts and changing tools, the production of the machine could be greatly improved.

Mr. Meier's paper was discussed by Charles Fair and Carl G. Barth.

Carl G. Barth said that Mr. Meier's paper was interesting, as it was probably the first attempt in the way of a published statement of the actual gains obtained by the use of aluminum pulleys instead of cast-iron pulleys on belt-driven and belt reversing planers, as first done by the Cincinnati Planer Co. However, on investigating the experimental data set forth in the tables, he had found them far from consistent.

Frequently during the past seventeen years he had had to conduct similar experiments with planers of various kinds, in order to determine the length of time it took them to make any length of double stroke between a minimum and the maximum of each one, for the purpose of incorporating this information on his Planer Time Slide Rule, and in making such experiments he worked on the theory that the time consumed in stopping and reversing the planer table at the end of each stroke must be independent of the length of the stroke, and that it could hence be considered equal to the time it would take the table to travel an imaginary addition to its actual stroke, at its full forward and return speeds. Thus, if l designated the actual length of stroke, and a this imaginary or ideal addition, then the total time for a double stroke would be

$$t = \frac{l+a}{v} + \frac{l+a}{V} = \frac{V+v}{vV}(l+a) = C(l+a) \dots\dots [1]$$

v and V being respectively the forward and return speeds of the table.

Similarly, for $l = l_1$ and $t = t_1$,

$$t_1 = C(l_1 + a) \dots\dots\dots\dots\dots\dots [2]$$

and dividing [1] by [2] would give

$$a = \frac{tl_1 - t_1 l}{t_1 - t} \dots\dots\dots\dots\dots\dots [3]$$

Thus the experimental determination of the time for each of two double strokes only was necessary for the derivation of the value of a, and hence, if three values of t were determined experimentally, these must result in three derivations of a that must substantially be alike, if the experiments were conducted with care.

Mr. Barth then showed that Equation [3] applied to the data in Table 1 of Mr. Meier's paper would give for cast-iron pulleys the following three values of a: 7.72 in., 4.08 in., and 13.48 in., which were far from substantially alike. For the aluminum pulleys were similarly obtained for a the three unequal values 4.17 in., 5.37 in. and 7.18 in.

However, while data obtained by experiments with two different strokes only were theoretically enough for the determination of the value of a, the foregoing investigation showed the necessity of taking at least three strokes, as Mr. Meier had done, and then in addition to this, to work with such care and circumspection that the three values of a independently obtained would be near enough alike for all practical purposes. His method was to plot, as in Fig. 1, the simultaneous values of l and t, with the latter obtained by means of a stop watch on which was read the time it took for the completion of an exact number of double strokes of a carefully measured stroke.

It would readily be seen in Fig. 1 how a was graphically determined by the straight line AB drawn to pass through the three points C, D and E, when these represented a set of consistent results obtained.

After similarly plotting all of Mr. Meier's results, and taking it for granted that a only and not C in equation [1]

was affected by the substitution of aluminum pulleys for cast-iron pulleys, he had by inspection attempted to eliminate the grossest errors of Mr. Meier's observations and to write equation [1] as

$$t = 0.0354 \quad (l + 1.125) \quad \text{for cast-iron pulleys}$$
$$t = 0.0354 \quad (l + 0.45) \quad \text{for aluminum pulleys.}$$

If he had succeeded in getting closely to the truth in arriving at these equations, the value of 1.125 ft. = $13\frac{1}{2}$ in. for the cast-iron pulleys, as against only 0.45 ft. = 5.4 in. for the aluminum pulleys, was certainly the plainest way of showing up the superiority of the latter.

Mr. Meier gave the forward speed of the planer as 40 ft. and the return speed as 90 ft., which would make the value of C in these equations = (90 + 40) / (40 × 90) = 0.03611; but the plots he had made seemed to indicate that this value was too high, so the value 0.0354 was chosen. However, assuming $V/v = 90/40$, or $V = 2.25v$, and writing

$$C = 0.0354 = \frac{V + v}{vV} = \frac{2.25v + v}{2.25v^2}$$

gave $v = 40.8$ ft. and $V = 91.8$ ft., which were not very far from the figures given by Mr. Meier.

In Par. 11 Mr. Meier made the unqualified statement that the aluminum pulleys also "effect quite a saving in power," and then stated, by pointing to the figures in Table 2, that for a 76 x 62 x 32-ft. planer this amounted to 25 per cent, while he evidently had in mind only the maximum power expended during the period of reversal.

As the power during reversal was principally expended in overcoming the inertia of the pulleys, the total amount of this power must be more nearly proportional to the weights of the respective pulleys, while the 25 per cent of greater peak load could be explained by the well-known fact that a belt would pull the most when it slipped the most, as it no doubt would when forced to stop and start the heavier cast-iron pulleys.

However, the power expended in reversing was of no consideration as compared with the wear and tear on the belts themselves and other parts of the reversing mechanism.

Charles Fair said that Mr. Meier had brought out a number of important points which should receive serious consideration. For a long time he had felt, as Mr. Meier did, that neither the planer manufacturer nor the planer user had given the question of handling the work or the cutting anything like the consideration it deserved. It was generally admitted, for instance, that higher cutting speeds were possible if the tool entered the work slowly and then speeded up, yet information was very meager as to how seriously this would affect the work.

On heavy roughing cuts the spring due to the increased pressure on the tool while speeding up in the work would probably be noticeable with tools not properly shaped. If only roughing cuts were required, a fine degree of accuracy would not be essential. If roughing and finishing cuts were made, he doubted if the inaccuracies, due to speeding up in the light cut, would be noticeable. From such tests as he had made this difference was not great. He had again brought up this question of speeding up in the work because, should it be required, it was very easy to accomplish with the reversing motor drives, as is also slowing down before leaving the work to prevent breaking out the metal.

Production on planers could certainly be speeded up by a more liberal use of jigs and fixtures and in many cases double sets of jigs could be used to advantage where considerable duplicate work was being machined. This would be particularly true in cases requiring time to properly set the work.

Mr. Barth was a little hasty when he criticized Mr. Meier's paper, largely, he would judge, on the grounds of its being practical only and not consistent, presumably, with his theory. In this particular case, however, the correct theory did agree with the facts. Mr. Barth's whole theory was built on an incorrect assumption, namely "that the time consumed in stopping and reversing the planer table at the end of each stroke must be independent of the length of the stroke." This assumption on Mr. Barth's part was exactly where he erred and was presumably the reason why his theory and Mr. Meier's tests did not agree. The time of stopping and reversals varied materially with the length of stroke, as could be easily shown by tests, particularly in the case of the belt-driven planer. Further, this variation was noticeable in some cases up to a 10-ft. stroke; however, a 4- to 5-ft. stroke usually covered the noticeable variation. It would not only be necessary for Mr. Barth to substitute a variable in his equation for the different

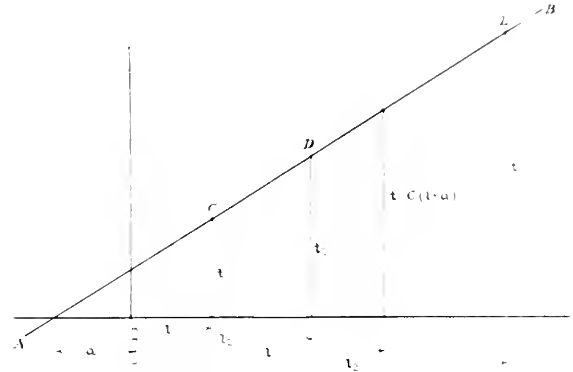


FIG. 1 METHOD OF DETERMINING VALUE OF a

lengths of stroke, but this variable in turn would necessarily have a different value when applied to drives of the single-belt-shifting type, the rocking-idler type, the double-belt-shifting, magnetic clutch, pneumatic clutch and direct-connected reversing motor drive. These in turn would all be affected by the different weights of the revolving parts, and in the case of the belt drives by the tension of the belts and by the time that it took for one belt to get from the loose to the tight pulley and the second belt from the tight to the loose pulley. There were, of course, many other elements that entered into the problem but the above were the main ones that would affect the constant a.

Mr. Barth's formula would be correct if V were a constant rate of speed instead of a variable rate of speed. An average velocity of V could not be used to determine a. Therefore, the formula would be good only in cases where the machine had reached full speed and then only under the conditions for which the actual value of a was obtained. If a were obtained under no-load conditions it would not apply when cutting if the shifting for the reverse occurred before the tool was out of the work. The changing value of V was even more noticeable when the machine was operating under load. Fig. 1 in Mr. Barth's discussion illustrated a very simple method of obtaining a provided it were an equation of the first degree. In reality, however, it was an equation of the second degree, which meant that a would have a continually changing value depending on the changing value of V and its effect on the stopping of the platen.

If Mr. Barth's Planer Time Slide Rule was based on the formula cited, it would have to be remodeled before any claim for accuracy could be made.

GENERAL SESSION, TUESDAY MORNING

The Business Meeting on Tuesday morning was followed by a General Session, at which four papers were presented and discussed, as follows: Tests of Uniflow Steam Traction Engines, F. W. Marquis; Relation of Efficiency to Capacity in the Boiler Room, Victor E. Phillips; Radiation Error in Measuring Temperature of Gases, Henry Kreisinger and J. F. Barkley; and Development of Scientific Methods of Management in a Manufacturing Plant, Sanford E. Thompson, William O. Lichtner, Keppele Hall and Henry J. Guild.

A paper on Disk Wheel Stress Determination, by S. H. Weaver, was also presented at this session by title.

PROFESSOR MARQUIS PRESENTS HIS PAPER

The first paper presented was that of Professor Marquis, giving the results of two series of tests of Baker uniflow steam traction engines. The steam consumptions of these engines were compared with those representative of the or-

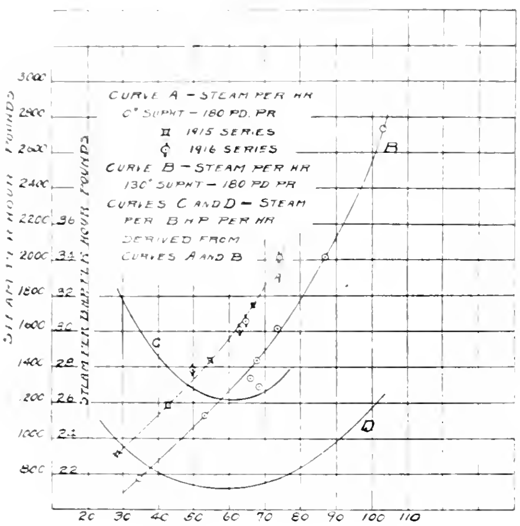


Fig. 1 Replot of Author's Curves

dinary counterflow type of engines, and the conclusion was reached that the uniflow engine tested, operating non-condensing with saturated steam, had a lower steam consumption than the compound counterflow engine under like conditions. Also, when operating non-condensing with superheated steam, it would have approximately the same steam consumption as a compound counterflow engine operating condensing on saturated steam.

Written discussions of this paper were contributed by J. E. Emswiler, George H. Barrus, L. V. Ludy and E. T. Adams. The paper was discussed orally by R. J. S. Pigott, C. H. Benjamin and A. G. Christie, and Professor Marquis replied to the discussion.

J. E. Emswiler, in a written discussion, considered that it would seem preferable, in most cases, to refer the steam consumption in the curves to b.hp. instead of i.hp., and especially so in these tests, where considerable discrepancy appeared if the i.hp. was plotted on b.hp. Such discrepancy must necessarily be blamed upon the i.hp. rather than upon the b.hp., since the latter was much more simply and easily determined in the tests.

The table for the 1916 series furnished some valuable information concerning the influence of superheat on steam consumption for a uniflow engine.

Test 7-180-4 was made with a load of 73.3 b.hp. and a superheat of 136 deg. Correcting the steam consumption to a load of 74 b.hp. gave a steam consumption per b.hp-hr. of 21.8. Test 16-180-4 at a load of 74 b.hp. gave a steam consumption per b.hp-hr. of 27.2 at 0 deg. superheat. This was a gain of 5.4 lb. for 136 deg. superheat, or 24.7 per cent, which was 18.2 per cent per 100 deg.

Again, test 10-180-3², at a load of 67.6 b.hp. and a superheat of 131 deg., showed a steam consumption of 21.3 lb. per b.hp-hr. Correcting in a similar manner to a load of 64.7 b.hp., the steam consumption became 21.6. Test 15-180-3, at a load of 64.7 b.hp. and 0 deg. superheat, gave a steam consumption of 25.6 lb. per b.hp-hr. This was a gain of 4.0 lb. for 131 deg. or 18,5 per cent, which was 14.2 per cent per 100 deg.

The average of the two examples was 16.2 per cent per 100 deg. of superheat, based on the steam consumption which accompanied the superheat.

Applying this correction factor to reduce the tests made with superheated steam to a common basis of superheat, say 130 deg., and plotting corrected steam per hour against b.hp., the curve *B* of Fig. 1 was obtained..

The curve *A* was obtained by plotting the steam per hour of the tests of both the 1915 and 1916 series, at 180 lb. pressure and 0 deg. superheat, against b.hp.

It was very instructive to plot the total steam per hour against the output, as was done in Fig. 1, for two reasons. In the first place, where a number of points were available, as was the case here, such curves served to distinguish those tests which were probably in error from some cause or other, from those which were accurate. It was evident from the curves of Fig. 1 that some discrepancy existed in connection with tests 6-180-3, 11-180-3², and 14-180-2.

In the second place, these curves were instructive as exhibiting a characteristic of the uniflow engine different from that of either a counterflow engine or a steam turbine. The steam-per-hour curve of the uniflow engine had a marked and continuous bend; while for the counterflow engine, or steam turbine, the curve was usually straight, at least for the greater part of its length.

The indicator diagrams in the paper showed a rise in the back pressure from the time the central exhaust ports were closed by the piston until the auxiliary exhaust port was closed. This was probably due to wiredrawing in the auxiliary exhaust port and represented some loss. Undoubtedly, from the standpoint of economy alone, the engine would be better without the auxiliary port, that is, operating on the strictly uniflow principle. However, it was presumable that the purpose of the additional port was to secure greater capacity, which it did by giving thicker diagrams than would be obtained without it.

George H. Barrus wrote that the tests reported were not tests of a " uniflow " engine, but they were tests of what might well be called a counterflow-uniflow engine, with the counterflow features in the lead.

There was nothing in the paper, so far as he could see, showing that the uniflow characteristics possessed by the Baker engine had anything to do with the superior economy reported. In fact, he could not see that these characteristics were sufficiently pronounced to produce any marked influence on the

results. The indicator diagrams were not materially different from those that would be given by any counterflow engine having the same valve gear and working under the same pressure and speed.

To justify the conclusion that the superior results given were due to any uniflow characteristic, a comparison should be made between the engine in question and an ordinary counterflow engine having the Baker valve gear, but the paper made no such comparison. All that the paper showed was the difference in economy between an engine having excellent steam distribution, such as that obtained by the Baker valve gear, and ordinary throttling slide-valve engines having defective steam distribution, which at best gave very poor economy.

If the title of the paper were changed to read Tests of Counterflow-Uniflow Steam Traction Engines, and the term "counterflow-uniflow" were substituted for "uniflow" throughout, the conclusions would be less liable to be misconstrued than they were in its present form.

L. V. Ludy reported the results of a series of tests on a Huber steam tractor a few years ago which gave some very interesting information in comparison with the tests reported in the paper.

The engine was fitted with a common D slide valve, which was unbalanced. The boiler was of the marine type, having a large flue extending throughout the entire length of the boiler, the back end of which served as a firebox. No superheater was provided. The method employed in carrying out the tests was exactly similar to that used by Mr. Marquis.

Table 1 gives the principal dimensions of the tractor, and Tables 2 and 3 the general results obtained.

In the results reported by Mr. Marquis, the maximum i.hp. in per cent of the normal rated hp. was unusually high. The results obtained from the 1915 engine were over 160 per cent and those from the 1916 engine about 600 per cent. Similar results reported by the writer gave this ratio of the greatest i.hp. to the normal rated hp. to be over 230 per cent, but in this case the engine was not operated at maximum load.

TABLE 1 PRINCIPAL DIMENSIONS OF HUBER TRACTOR

BOILER		ENGINE	
Number of tubes	18	Nominal horsepower	18
Outside diameter of shell, in.	41	Nominal speed, r.p.m.	220
Length of shell, in.	100	Diameter of cylinder, in.	9
Diameter of tubes, in.	3	Stroke, in.	11
Diameter of large flue at front, in.	24	Diameter of piston rod, in.	$1\frac{5}{8}$
Diameter of large flue at rear, in.	27	Diameter of flywheel, in.	36
Grate area, sq. ft.	6.59	Face of flywheel, in.	10
Total water heating surface, sq. ft.	173		

TABLE 2 SUMMARY OF ENGINE RESULTS

Length of test, min.	R.p.m.	Boiler pres., lb. per sq. in., gage	Average cut-off in per cent of stroke	I.hp.	Dry steam per i.hp., per hr., lb.
60	227.0	110.8	35.8	28.06	28.7
120	217.3	111.7	46.5	37.68	29.7
60	206.3	112.4	53.1	42.21	29.8

TABLE 3 SUMMARY OF BOILER RESULTS

Length of test, min.	Boiler pres., lb. per sq. in. gage	Coal fired per sq. ft. of grate surface per hr., lb.	Equiv. evap. per sq. ft. water-heating surface per hr., lb.	Equiv. evap. per lb. air-dry coal, lb.
60	110.8	14.3	5.58	10.25
120	111.7	24.5	7.75	8.30
60	112.4	27.1	8.72	8.44

E. T. Adams wrote that a moderate-power steam traction engine weighed at least 300 lb. per hp. It was therefore far too heavy for ordinary farm work and was really a portable power plant with its earning power practically limited to the threshing season. It was another example of a type of machine all too common on the farm which disintegrated from idleness rather than from use. The short earning and long rusting season was the vital disease affecting the traction engine. The remedy was a longer earning season, which might be secured by any change which would reduce the weight of these machines to a figure approaching 100 lb. per hp., thus making them available for plowing, disking, harrowing and seeding, as well as for threshing and other belt work. Increased economy could make this possible, but a minor increase would not be sufficient—it would have to be great enough to reduce greatly the size of the boiler, or even allow the use of a new type.

He thought that the A. D. Baker Company certainly deserved great credit for their endeavors to improve the economy of the farm tractor and had made a step in the right direction, because, although their coal consumption per b.hp-hr. in these tests was greater than that shown on single-cylinder tractors at the Canadian Industrial Exhibition tests in Winnipeg in July 1913, the steam consumption per i.hp-hr. was about 8 per cent. better when operating under the same conditions.

It seemed too bad, however, that they had not gone a step further. Their engine was undoubtedly a uniflow engine, in that it took steam at the end of the cylinder and exhausted at the center, but it did not use the thermal cycle which had made the engine commonly known as the uniflow engine so popular in Europe and, more recently, in this country.

The advantage of this European thermal cycle was illustrated by comparison of these tests of the Baker engine with tests made by Government licensed engineers on a portable engine of approximately the same horsepower and under about the same conditions, built by the Maschinenfabrik Badenia, of Weinheim. The Badenia engine had a normal brake horsepower of 120. The steam pressure was slightly lower and the superheat slightly higher than in the Baker engine. The Badenia engine showed an economy of 13.8 lb. of steam per i.hp-hr. and 1.83 lb. of coal per b.hp-hr. The Baker engine, therefore, required 38 per cent. more steam per i.hp-hr., and about 80 per cent. more coal per b.hp-hr.

As Mr. Marquis did not give the heat value of the coal used on the trials, it was impossible to get a close basis of comparison on the coal consumption. The coal used at Winnipeg had a heat value of 14,470 B.t.u. and at Badenia the heat value of the coal was 13,800 B.t.u. It would be noted that both the Winnipeg and Badenia trials were made by experts not in any way interested in the engines being tried.

R. J. S. Pigott said that in considering the curves of water rate and boiler efficiency he had found it extremely valuable to make use of the input and output, or Willans line, rather than the water-rate or efficiency curves.

In the first place, the Willans line for all throttle-governed engines, and for all turbines, up to the point where the relay valve opens, was substantially straight. For the automatic engine, the line was represented by an equation of the second

economy and was raised upward more or less. The valuable feature was that as these Willans lines were either straight or only slightly curved, and the zero steam consumption always fell within reasonably well defined limits—say 15 to 20 per cent of full load steam consumption, the direction of the curve could be very much more definitely settled, especially if the tests varied considerably from average. The water rate curve could then be plotted from the Willans line.

One feature of Fig. 12 of the paper which seemed peculiar was the crossing of the lower boiler pressure curves by the 175-lb. curve at low loads. This was very unusual, as in all cases he had seen, the raising of the boiler pressure improved the water rate and lowered the Willans line at all loads. The crossing of the water rate curves indicated that the Willans line also crossed those at the lower pressures, giving a high no-load steam consumption, which was extraordinary. He would in general suspect an error, especially as the tests seemed short for accurate results by the feedwater method. Quite large errors were introduced by the capacity of the system and the impossibility of getting accurate indications of water content of the boilers by gage glasses; the shorter the test, the larger the effect of the error.

A further suggestion to the author was that the results be computed in thermal efficiency, Rankine-cycle efficiency ratio, and B.t.u. per hr., all referred to brake horsepower; the variations with i.hp. were of little value for a comparison with other types of prime mover.

The thermal efficiency was a basic measure of the real economy; so was B.t.u. per b.hp-hr. Water rates were not basic and varied with every set of steam conditions. The Rankine-cycle efficiency ratio was a valuable means of comparing the design of one engine with another, since it showed how well the engine made use of its steam range, although the thermal efficiencies might be very different. For instance, the efficiency ratio of a non-condensing compound engine might be as high as 75 or 80 per cent, and its thermal efficiency only 7 to 10 per cent; that of a condensing compound, 55 to 60 per cent, and the thermal efficiency 16 or 17 per cent; showing, as we now well knew, the extremely low efficiency ratios of low-pressure cylinders under condensing conditions.

These two efficiencies were the only ones of value in comparing steam results with internal-combustion-engine results. Messrs. Stott, Gorsuch and the speaker had advocated, in a Prime Mover Committee report for the A. I. E. E., 1915, that the use of water rates be abandoned as not basic, and that the above efficiencies be substituted.

A. G. Christie wrote that the paper gave some excellent data of the effect of superheat in a uniflow non-condensing engine. Considerable emphasis had been laid on the comparison of the uniflow and counterflow engines, and the curves in Fig. 14 showed comparative performance curves for several types of engines. It did not seem that any of these curves showed compound-condensing units with superheat.

In large power plants there was a tendency to increase both steam pressures and superheat. The tests in this paper showed the highly beneficial effect of adding superheat in a non-condensing unit. Engineers should therefore be interested in the performance of a small unit with high pressure, high superheat, reheating between cylinders, feedwater heating and condensing.

When the new laboratories of Johns Hopkins University were built, a 75-kw. Buckeyemobile was purchased from the Buckeye Engine Co., and direct-connected to a 50-kw. generator. This unit had been used to carry the summer light and power load of the University, and for test purposes by the students during the winter months. A portion of the test results was given in Table 1; the results were obtained by members of the senior mechanical-engineering class in a series of tests made last winter. The unit was not prepared especially for test and was operated as in general service. It was felt that the results represented very closely average operating conditions, though other previous tests had indicated lower coal consumptions at the various loads.

TABLE 1 PART OF RESULTS OF TESTS ON 75-KW. BUCKEYEMOBILE

Dry coal per i.hp-hr.	2.32	1.57	1.40
Dry coal per kw-hr., lb.	4.06	2.55	2.27
B.t.u. in coal consumed per kw-hr..	57,453	34,540	31,280
Lb. of steam condensed per i.hp-hr..	10.80	10.5	9.63
Lb. of steam condensed per b.hp-hr.	12.65	11.32	11.0
Lb. of steam condensed per kw-hr	18.94	17.0	15.62
Efficiency ratio of engine based on indicated horsepower, referred to adiabatic expansion, per cent.....	64.3	67.0	72.7
Efficiency of boiler alone, per cent	36.8	55.1	55.4
Efficiency of boiler, superheater, reheater and feedwater heater, per cent	43.2	64.6	66.3
Efficiency of complete plant from kilowatts at switchboard to heat in coal as fired, per cent...	5.92	9.88	10.85

The unit had given very satisfactory service since it had been installed, and the operating and maintenance charges had been quite low. American engineers could well afford to give more attention to this type of unit with the rapidly increasing costs of fuel and labor.

PROFESSOR MARQUIS REPLIES

Professor Marquis, in replying, agreed with Professor Emsweiler that it was often preferable to refer steam-consumption curves to b.hp. instead of i.hp. In the present case the difference in the form of the curves would be very slight, and it was decided to use i.hp. in view of the fact that it proved more difficult to find results of tests of engines, with which it was desired to make comparisons, expressed with reference to b.hp.

In answer to Mr. Adams' question, the heat value of the coal used was approximately 13,700 B.t.u per pound, as fired.

In reply to Mr. Pigott's suggestion that the fact that the water rates were not in all cases lower, at all loads, with higher boiler pressure than with lower boiler pressure, indicated an error, and that the results might be adjusted with the aid of the Willans lines so as to eliminate this feature, he would like to call attention to the fact that if a Willans line was plotted for each boiler pressure of the saturated-steam runs, a very clearly defined tendency throughout for the higher-pressure lines to cross the lower-pressure ones at light loads would be evident. It was realized that the work doubtless contained some experimental errors, but it did not seem reasonable to infer that errors would occur in such a way as to consistently indicate the same thing. It did not therefore seem justifiable to adjust the results as suggested.

Moreover, it was evident that the cylinder condensation would be greater with high boiler pressures, due to the increased temperature ranges, than with lower ones. It did not seem unreasonable to infer that as the load became lighter and the cut-off earlier, a point would finally be reached where the loss due to increased cylinder condensation would overbalance the gain due to increased available energy, and the Willans lines cross, as actually indicated by the data presented.

He agreed entirely with Mr. Pigott as to the value of the use of the thermal efficiency, B.t.u per hour (or per minute), and the Rankine-cycle efficiency ratio, for comparison with other types of prime movers. The Rankine-cycle efficiency ratios referred to i.hp. would be found in column 12 of Table 2. The others were not presented in the paper.

PROFESSOR BENJAMIN TAKES THE CHAIR AND MR. PHILLIPS' PAPER IS PRESENTED

At this point, President Hollis appointed Vice-President Charles H. Benjamin to the chair, and Victor B. Phillips' paper on Relation of Efficiency to Capacity in the Boiler Room was presented by the Secretary in the absence of the author.

In this paper the author showed, by typical cost figures, that 90 per cent of the cost of producing steam was for fuel and fixed charges (including labor). He stated that these two charges were of almost equal importance, and that their reduction depended respectively on the attainment of efficiency and capacity. He then set about to establish the procedure for determining the relation of maximum efficiency at various loads to those variables of operation which the fireman might observe and over which he must exercise control. Test data on a B. & W. boiler, equipped with a Taylor stoker for a very wide range of operating conditions, were used to illustrate the procedure and to show the validity of the selection of variables.

The data applying to the furnace and boiler were shown respectively in charts having efficiency and capacity as coördinates, and the interrelation of the operating variables was indicated, as on steam charts, by lines of constant values. These two charts were then combined into a single chart having as coördinates overall efficiency and capacity of the steam-generating plant, and which graphically represented the two objects to be sought—efficiency and capacity—in terms of the variables of operation through the manipulation of which they might be obtained. The striking test results shown in the furnace-operation chart were discussed in an appendix, which also gave details of the procedure employed.

This paper was discussed orally by William Kent, L. C. Bowes, W. F. M. Goss and J. M. Spitzglass, and written discussions were contributed by R. C. Carpenter, Maxwell Alpern, George H. Barrus, Bryant Bannister, and N. G. Reinicker.

William Kent said that about twenty-five years ago he stated before the Society that the relation of efficiency to capacity of a boiler was not expressed by any curve or formula, but by a field the upper limit of which represented the results that could be obtained under the best possible conditions. The width of this field was very great, and was a measure of our ignorance concerning how to get the best conditions.

His studies for forty years had been directed toward helping to narrow the limits of this field, which had now been done to the extent that the action of a boiler could be predicted to within 5 per cent or less when the duty was known.

In regard to the thickness of the fire, some thirty years ago he made a 24-hr. test with pit coal and with every facility for making a good observation. The test was divided into 8-hr. periods and the first period was run with thin fires, the second with medium fires, and the third with thick fires. The best results were obtained with thin fires and with thick fires, and the worst with medium fires. From these data he did not think anyone could draw any conclusion.

In 1895 he made a series of 75 tests on a Babcock & Wilcox boiler, with a great many variable conditions. Some of these tests run with thick fires and strong draft gave results within 1½ per cent of those obtained with thin fires and moderate draft, again leading to no conclusion as to the merits of thin fires and thick fires.

In regard to carbon monoxide, he had a series of apparatus arranged so that gas samples could be taken from half way through the boiler tubes every minute. The first minute gave no oxygen and 7 per cent CO_2; the second minute 4 per cent CO_2 and a trace of oxygen, and at the end of five minutes 7 per cent free oxygen and no carbon monoxide. This showed the tremendous variation in conditions that could exist inside of five minutes.

This test led to no conclusion as to the CO_2 except that it was extremely variable. Results of 75 tests were plotted against every variable, and such conclusions drawn as could be.

What conclusions he had obtained in nearly forty years of making boiler tests were to be found in his Steam Boiler Economy. A little differential calculus had been used in dealing with the problem; but it seemed to him that all investigators had entirely ignored that study. He hoped Mr. Phillips would check his results against the things given in that publication and see if they did not reach more definite conclusions than in the paper.

L. C. Bowes thought the paper pointed out one very essential thing: that the maximum efficiency was gained at about 25 per cent overload. There seemed to be a great tendency at present for stoker manufacturers to recommend stokers to fire above the rated capacity of the boiler, for which tendency central-station practice had probably been responsible.

With a stoker and boiler giving a high overload capacity, with a 12-hr. peak, the loss in the boiler due to high overload capacity in order to operate the stoker at an efficient point would exceed the loss due to maintenance charges on additional boiler capacity, with stokers somewhere near consistent with the rating of the boiler. This point was very essential where there was a standing load on a 10-, 12- or 24-hr. peak.

In central-station practice, where there was only a three- or four- or sometimes a single-hour peak, high boiler capacity of course was required, but he would like to see some curves showing in some way the relation between the fixed charges and fuel cost dependent on varying relations between the stoker capacity and the boiler capacity.

W. F. M. Goss said that in our efforts to increase efficiency we were likely to lose sight of a matter of considerable present-day importance to which mechanical engineers should give due attention. He referred to the increase in the pollution of the atmosphere which resulted when boilers were driven to higher capacities.

The record of locomotive-boiler performance had long since disclosed the fact that stack losses in the form of solid particles of fuel constituted a most important factor in their effect on boiler efficiency. We knew that as we increased the capacity of a locomotive boiler we also increased the percentage of solid fuel passing up the stack. For locomotives in which a third and sometimes a half hp. was secured per square foot of heating surface, the relation of solids (fuel and ash) passing up the stack to rate of combustion was known for a considerable number of different fuels. There was very little similar information applying to boilers in power plants, notwithstanding the fact that we were constantly increasing the rates of combustion in such plants, and by so doing bringing stationary practice to a point where it overlapped a portion of the field covered by locomotive service.

Mechanical engineers were naturally interested in that

aspect of the question which affected boiler efficiency. His present purpose was to urge the importance of their being interested in that aspect of the question which affected the purity of the atmosphere.

J. M. Spitzglass said that he would not hesitate to say that the relation between operating efficiency and capacity was *the* most important factor in the boiler room, also in the engine room and, in fact, in every unit of a plant.

The author had two objects to accomplish in his paper: to demonstrate that the boiler operation should be studied systematically in relation to the two fundamental variables, *efficiency* and *capacity*, and to actually study this relation. While he succeeded in accomplishing the first object, he utterly failed in the second.

He regarded the author's treatment of the furnace factors as very interesting, indeed. The combination of an air meter and draft gage, assisted by the analysis of flue gases and readings of temperatures, would answer very well if there were always some reliable person whose duty it would be to take these various readings.

When it came to the boiler, however, after demonstrating that the relation between efficiency and capacity was the most important factor in operation, the author did not suggest the direct method of indicating or determining the capacity of the boiler at all times, which was by a steam meter. He merely contented himself with saying that the factors governing furnace operation should also govern boiler operation.

It was not to be denied that some idea of the capacity could be obtained from the conditions of the furnace and measurement of air supply when six extra men, trained for the purpose as was the case in the paper, were present to observe and manipulate the readings of the various devices operated during the test. But, how many firemen would be found who were able to observe air velocities, draft-gage readings, gas analyses and flue-gas temperatures; and if they were, how many could interpret them? Many places would be found where most of these instruments were present but were seldom followed by the firemen, but Mr. Spitzglass had yet to see the place where a boiler-steam meter was installed that it was not watched by the firemen the same as the pressure gage or the time clock.

Some might object that the steam-flow meter was not 100 per cent accurate. It was not; neither were any of the attachments to the furnace, as far as he knew. The author had demonstrated that under a given set of conditions, differential pressure readings would repeat themselves for the same quantities they represented. It stood to reason that the flow meter, which was merely the index of the differential pressure corresponding to the flow, would repeat itself for the same flow, and by weighing the feedwater for only a short period, the absolute calibration might be readily obtained for each boiler or line.

But this calibration, or even the whole accuracy, was not the question of the boiler steam meter at all. The main object was having something definite and comparatively accurate striking the fireman's eye at all times—something that he could easily understand without any interpretation or calculation.

The fireman had a problem which we seldom realized. With no steam meter on the line, he did not know what the boiler was actually producing, he merely guessed at it. The demand for steam was out of his control and knowledge. Suppose he learned that by following a certain operation he kept up the pressure at a given time, how was he to know what the actual demand was at that time, or, as the author put it, what the capacity of the boiler was at that time?

We could not expect a fireman to operate efficiently from a set of charts drawn up after a boiler test. But, when he saw that by performing a certain operation he caused the steam meter hand to move to the high-capacity side, he visualized the result and would surely repeat the same operation, knowing it effected better and easier work in general.

R. C. Carpenter thought that the paper represented the first series of investigations so conducted as to determine the results produced by greatly varying the coal consumption.

It was a matter of regret that in the tests the limit of air supply rather than the heating surface proved insufficient for complete combustion at the highest limits of coal consumption. Lines 13 and 15 of Table 2 gave information as to the drop in efficiency following the increase in the combustion of coal as indicated on line 3. The determination of the weight of air employed for the combustion of the fuel afforded an opportunity for noting the effect due to the regulation of the air supply, which important matter had seldom been given consideration in boiler tests. The particular air meter employed was of interest, as were also the scientific results given as proper conclusions drawn from the investigation.

The records of the investigation would be of great value in determining the limit of capacity of steam boilers, which was now under consideration in every recent construction. Obviously as the limit of capacity for a given efficiency was increased, the overhead and operating costs were reduced.

M. Alpern, in pointing out some of the operating faults of the tests, particularly as they affected the performance of the Taylor stoker used, spoke as follows:

"Theoretically, the Taylor stoker consists of an inclined retort, throughout which the air pressure is supplied under constant pressure and through constant areas of air discharge; an auxiliary grate surface at the rear of the inclined retort for the purpose of burning out the devolatilized fuel, and a substantially imperforate dump plate on which the residue can remain for a relatively long period, for the purpose of further reducing the carbon in the refuse and discharging the refuse into an ashpit. In operation it is intended that a maximum fuel-burning effect shall take place in the space occupied by the mouth of the retort and that the feed of the fuel in the retort shall be so regulated by the adjustable feeding mechanism that the fuel will rise from the mouth of the retort uniformly throughout. Such of the fuel as remains unburned together with the refuse feeds over the auxiliary grate at the rear, which grate has a hand-regulated air supply. This air supply can be regulated from zero to a maximum opening.

"Technical operators are instructed in the operation of the Taylor stoker by observation of the fire only. When properly adjusted and properly operated, the fire will go through a regular cycle. The mixture of fuel and ash will be deposited on the dump plate until the plate is covered to a depth of possibly 12 to 15 in. While the stoker continues to operate, the material is deposited on the dump plate only as the material already there wastes away by the process of combustion and provides room for it. Accordingly, at the end of a period of 3 or 4 hours, the material on the dump plate takes on a dead and, to some extent, blackened appearance. This indicates that the time has arrived to dump. At what are normally known as low rates of combustion, that is, rates of combustion below 500 lb. per retort per hour, no air is used on the auxiliary grate, that is, the damper is closed. A

small amount of air may escape through leakage. Except just prior to the dumping period, for an interval of perhaps 15 minutes, the damper is open (sometimes wide open, sometimes only part way open). It is only at rates higher than 500 lb. per retort that there is any opening of the damper through the period of operation between dumps. If the stoker does not go through the regular cycle and produce a time, and it would also appear that the fuel bed was not properly adjusted.

"The accompanying curves will clearly indicate the trouble. In Fig. 1 are plotted first the efficiencies obtained by Mr. Phillips with light, medium and heavy fuel beds. In the same figure are shown the efficiencies obtained on the Taylor stoker of exactly similar design with the same ratio of heating

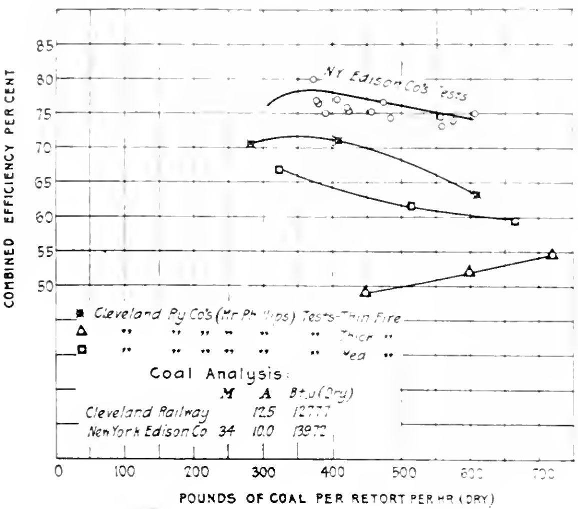


FIG. 1 COMPARISON OF AUTHOR'S AND NEW YORK EDISON COMPANY'S EFFICIENCIES FOR TAYLOR STOKERS

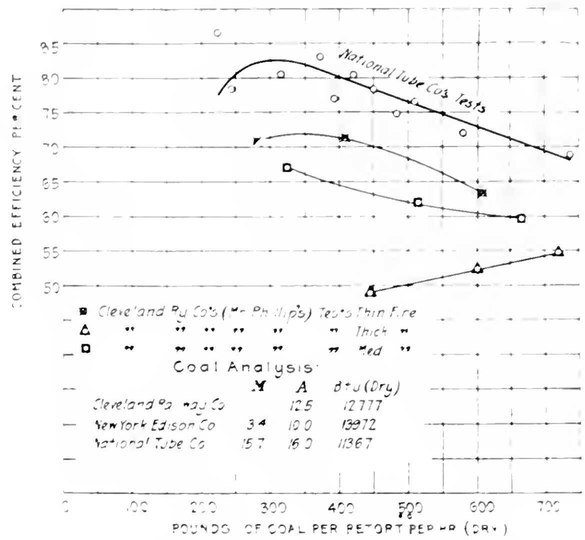


FIG. 4 COMPARISON OF AUTHOR'S AND NATIONAL TUBE COMPANY'S EFFICIENCIES FOR TAYLOR STOKERS

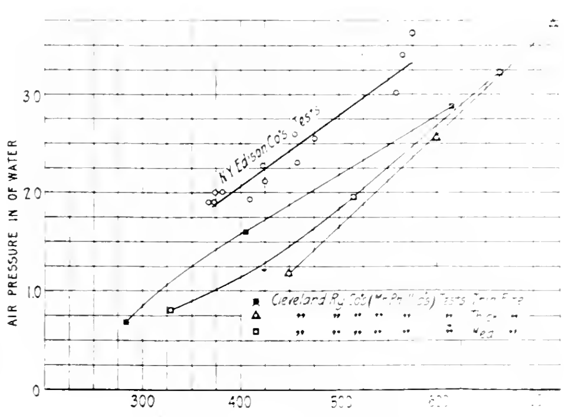


FIG. 2 COMPARISON OF AIR PRESSURES

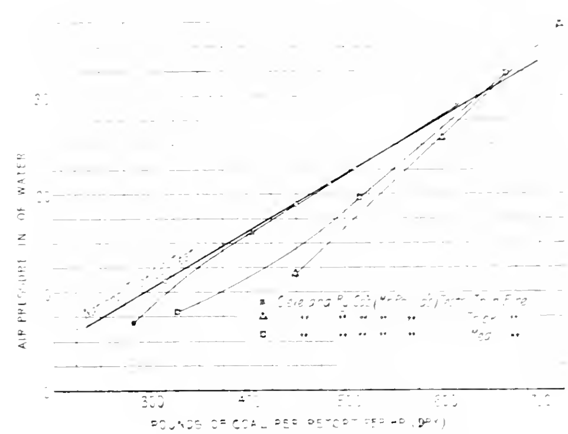


FIG. 5 COMPARISON OF AIR PRESSURES

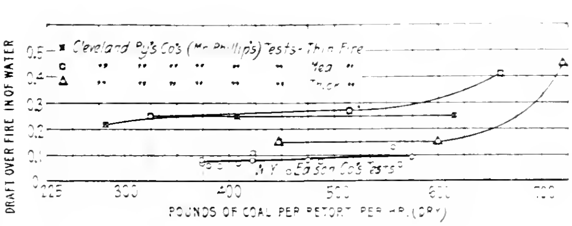


FIG. 3 COMPARISON OF DRAFT OVER FIRE

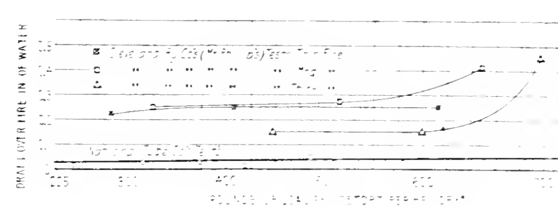


FIG. 6 COMPARISON OF DRAFT OVER FIRE

burned-out ash at the end of a 3- or 4-hr. period, no better indication need be had that one of two things is wrong. Either insufficient air is being supplied to the fuel emerging from the retort, or the feed of the lower ram is not adjusted properly. These adjustments are very simple to make. It is apparent in the tests reported by Mr. Phillips that the air supplied to the fuel over the retort was insufficient, the damper to the extension grate was wide open all the surface to grate surface, on tests run at the New York Edison Company. The coal used in the latter tests was somewhat better than the coal used during the Cleveland Railway tests.

"In Fig. 2 are indicated the air-pressure curves. The air pressure in both the New York Edison tests and the Cleveland Railway tests represent the difference in pressure between the windbox of the stoker and the furnace over the

of fuel. It will be noted that the New York Edison tests show very much higher pressure at corresponding rates of fuel burning.

"Fig. 3 shows the draft over the fire, in the case of the New York Edison tests and the Cleveland Railway tests. The draft over the fire in the latter tests was materially higher, as, of course, was the draft throughout the boiler, causing a larger loss from infiltration of air.

"Fig. 4 illustrates tests run on a Taylor stoker of similar design with a similar ratio of heating surface to grate surface at the National Tube Company, Kewanee. In this case, a much lower grade of fuel was burned than that reported in Mr. Phillips's tests.

"Fig. 5 shows the relative air pressures between the National Tube Company tests and the Cleveland Railway tests. In the case of these tests, the air-pressure curves are much closer together, owing to the fact that the actual combustible burned with Illinois coal was much less per pound of dry coal than was true of the coal burned at the Cleveland Railway tests.

"Fig. 6 illustrates the draft over the fire.

"Fig. 2 also shows the air pressures used by Mr. Phillips at corresponding rates of combustion per pound dry coal. It will be noted that with the heaviest fuel bed the lowest air pressures were employed, and with the thinnest fuel bed the highest air pressures were employed, which is just contrary to what is necessary for good operation. The heavy fuel-bed condition was an unnatural one for the Taylor stoker, and existed only because the fire was starved for lack of air."

George H. Barrus wrote that the paper stated that the "fuel bed was kept uniform and constant in thickness by very close and frequent observation on the part of three different men, all experienced firemen." From this it was evident that "the flying start and stop" was the method pursued in beginning and ending the tests. Everyone who had had experience with the operation of Taylor stokers realized that it was almost impossible for an observer, whether an experienced fireman or expert, to judge of the exact condition of the fuel bed in the regular operation of such a stoker. It was therefore well-nigh impossible to make a flying start and stop with a stoker of this kind and be assured that the condition was anywhere near the same at the beginning as at the end of a test.

Realizing this, the Power Test Committee of the Society had prescribed certain rules regarding the duration of stoker-fired tests and the method to be employed in starting and stopping them.

In regard to duration, he quoted from Par. 45 of the Power Test Report, as follows:

> In the case of a boiler using a mechanical stoker, the duration, where practicable, should be at least 24 hours. If the stoker is of a type that permits the quantity and condition of the fuel bed at beginning and end of the test to be accurately estimated, the duration may be reduced to 10 hours, or such time as may be required, to burn the above noted total of 250 lb. per sq. ft.
>
> In commercial tests where the service requires continuous operation night and day, with frequent shifts of firemen, the duration of the test, whether the boilers are hand-fired or stoker-fired, should be at least 24 hours. Likewise in commercial tests, either of a single boiler or of a plant of several boilers, which operate regularly a certain number of hours and during the balance of the day the fires are banked, the duration should not be less than 24 hours.

There was nothing in Par. 45 that permitted a test of the Taylor type of stoker to be less than 24 hours in duration, in a plant like the one in question operating for 24 hours per day.

Mr. Barrus also called attention to Par. 48 of the Power Test Code, which related to the starting and stopping of a stoker test, in order to show that there was nothing in the requirements that countenanced the flying start and stop, which appeared to have been followed in the tests reported in the paper.

Bryant Bannister[1] wrote that the author had invited discussion which should be quite beneficial to boiler-plant designers. It went without argument that the designer should attempt to provide the maximum of capacity with a given investment, without corresponding contingent losses. With the data available pertaining to heat transmission through setting walls, boiler tubes, etc., we could safely design a boiler plant for what might be termed "intensive steam production."

Since the two greatest sources of heat loss in steam production originated in the boiler furnace and through the boiler proper, we could expect the greatest interference with the design for maximum steam production either in the stoker or the boiler proper. It was possible to meet the first interference by the use of stoker equipment which improved the furnace efficiency as the rate of fuel consumption was increased. One make of stoker had this important characteristic up to a burning rate of about 1000 lb. of coal per retort per hour, and possibly further. Referring to Fig. 2 in the author's paper, it would be noted that a curve connecting the points of maximum furnace efficiency had an upward trend, rising from 68 per cent at a furnace output of 555 boiler hp. to 76 per cent at 1055 boiler hp. output. It then became the duty of the boiler unit to absorb the heat evolved without unduly high exit-gas temperatures.

The second interference pertaining to heat transfer into the boiler had been very admirably treated by Messrs. Kreisinger, Ray and Barkley in Bulletin 18, and Technical Paper 114 of the Bureau of Mines. These papers were both splendid arguments for greater capacity from a given boiler heating surface.

Presuming commercially clean tube surfaces, both inside and out, it followed that we must go further than was usually considered good practice toward providing for a long gas passage in contact with tube surface, also toward increasing the gas velocity. Just where we should stop with the boiler surface proper and introduce economizer surface must, of course, be governed by local conditions, costs, etc., but the writer believed that such economizer surface could be provided adjacent to the boiler, preferably above, with tubes of suitable size and so arranged that high gas velocity was obtained, in many cases with a single pass for gas flow.

Because large boiler units lent themselves so well to the above scheme they should be given consideration as an essential feature in the design.

If the principle of "intensive steam production" was adhered to in both design and operation, the result would be minimum investment per unit of steam produced, while the cost of operation, including fuel, labor and material for repairs and maintenance, etc., would not be increased much over similar costs for normal steam production.

The tendency toward the proposed design was apparent in central-station construction, and the writer hoped that it would be appreciated and followed for the average industrial boiler plant of the future.

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[1] National Tube Company, Pittsburgh, Pa.

N. G. Reinicker[1], while admitting that the author was correct in his statements of the importance of efficiency and capacity, considered that any conclusions regarding these items, based upon the tests reported, would be entirely out of accord with results which could be and were being obtained with similar equipment and coal throughout the country.

The fact that the runs were of only eight hours' duration was sufficient alone to discard all the tests. With any furnace having a large amount of fuel on the grate, as was the case with the underfeed stoker, it was possible in an 8-hr. test to get any efficiency desired. Twenty-four hours was the minimum time in which such runs should be made.

In every test reported there was a large deficiency of air. The furnace was apparently used as a gas producer, with secondary combustion in some of the passes, as shown by the exit gas temperatures and CO loss, and undoubtedly considerable smoke came from the stack.

The drafts for all runs showed no consistency, especially furnace draft, which was much higher than necessary. The air pressure under the tuyeres should have been from $\frac{1}{4}$ in. to 1 in. higher to supply the required air to burn the coal.

Assuming the tests were greater in number, more carefully run, and representative of the equipment and coal used, the conclusions reached from an analysis of the Combined Boiler-Unit Operation Chart would be of no value to an operating man. The experience of trying to pick from a chart the air pressure required for any rate of burning coal was like the experience gained by a number of engineers who bought tachometers for their stokers and had a second scale added showing the air pressure the fireman should carry for that stoker speed. They found the second scale of no value.

The author failed to mention the most important item controlling capacity and efficiency in an underfeed-stoker furnace, and that was the temperature at which the ash fused. With a coal causing considerable clinker, air quantity would not affect capacity unless the air could be made to distribute through the fuel bed, and not through holes in the fire. Clinker would cause holes and would limit capacity and reduce efficiency.

Less attention should be paid to convection and radiation, the losses from these items being such a small part of the total losses in a boiler-and-furnace heat balance, and much more attention paid to losses from combustible in the ash and from CO, which losses together, using the equipment and coal of these tests, should not be more than 10 per cent of the total heat supplied.

C. F. Hirschfeld wrote that there were three distinct subjects treated in the paper and they should be recognized as such and separately considered. These subjects were:

1 A discussion of the combustion of solid fuel on chain grates and on underfeed stokers, with a suggestion as to the essential variables and means for their indication and control
2 A discussion of the factors influencing the efficiency of the boiling vessel
3 A demonstration of the fact that the efficiency of the furnace as a heat liberator and the efficiency of the boiling vessel as a heat absorber were interrelated, and that there was one set of furnace conditions at each load which gave the best efficiency for the combination.

With reference to the discussion of combustion and its control, there had been a very general recognition recently of the fact that the burning of coal under steam boilers could be reduced to a fairly exact procedure if the proper indicating instruments were supplied. It had also been recognized that if the best results were to be obtained it would not be sufficient to supply only instruments by means of which the operator might measure the degree of success achieved. It was also necessary to furnish instruments which would measure for the operator the values of the various variables which combined to give the indicated result in order that he might be able to change the values of these variables wisely and methodically for the purpose of obtaining the highest possible effect.

The author proposed thickness of fuel bed and pressure drop through the fuel bed as the important controlling variables. He further proposed an inferential method of determining fuel-bed thickness, namely, the measurement of the quantity of air passing through the fuel bed in a given time and the pressure drop required to force this quantity of air through the bed.

If the operation were to be conducted by men of such mental caliber that they could not be educated beyond the point required to enable them to keep the indications of two instruments at prescribed points, it would be admitted that the author's suggested method of furnace control would probably give as satisfactory average results as could be obtained under those conditions. However, it might be pointed out that it represented little if any advance over the automatic interlock between fan speed and stoker speed, originally a characteristic part of a Taylor-stoker installation.

If the operation were to be conducted by men of such mental caliber that they could be educated to a true appreciation of the meaning of all, or most, of the variables which interacted to give a certain result in the furnace, then the proposed method would be decidedly inadequate and imperfect, particularly as applied to underfeed stokers. In this case the pressure drop through the bed, taken in conjunction with the quantity of air passing, would be a true indication of the average thickness of the fuel bed if that bed were always formed of coal of the same kind and size, if the damper settings on extension grates and other controllable points were always the same and if the character of the fire as influenced by its past history were always the same. Unfortunately, all of these variables had marked effects.

To take extreme illustrations, it might be assumed, for one case, that an operator had managed to pile up a thick fire at the top of the stoker and had burned it very thin toward the toe; and for another case, that he had forwarded the fuel more rapidly than he should have, so that he had a thin fuel bed near the top of the stoker and a thick fuel bed near the toe. In each case he would have obtained and observed some definite pressure drop which would have corresponded to perfect fires of certain definite thicknesses, and yet his fire would have been far from perfect. Or again, it might be assumed that the character of the coal and its method of combustion were such that there was serious clinkering in spots, with burning through in others. Such a condition would give a pressure drop corresponding to some definite thickness of perfect fuel bed, and yet the actual conditions would be far different.

After all was said and done, optical inspection of the fire and a good knowledge of its past history were required if the best results were to be obtained. The combination of such inspection and such knowledge with the readings of properly chosen instruments, by an operator educated to the point where he could appreciate the true significance of all facts and indications, was the most promising method of obtaining high efficiencies.

The firing methods in use in the boiler rooms of The Detroit

[1] New York Edison Company, New York.

Edison Company practically included the features which the author proposed, but others had been added and it was recognized that more must be added before the best control now in sight could be attained. At the plants of this company it was customary to maintain a certain definite draft at a chosen point above the fire and to vary the under fire pressure to suit conditions. This arrangement gave the fireman a measure of the pressure drop through the fire. The quantity of air used was not measured in conventional units but in terms of blower speed and resistance through the bed, which was just as good a combination measurement, so far as the operation was concerned.

No attempt to reduce coordinated readings to chart form had been made because the constant effort of the engineers had been devoted to the education of the men to such a point that they could reason from the known condition of their fire and the readings of their instruments, instead of going it blind on the basis of charts which at best could represent only average conditions.

In these plants it had been found advisable to supply instruments for indicating stoker speed, carbon-dioxide content of flue gases, temperature of flue gases and boiler output, as well as the values mentioned above, and it had also been found advisable to supply numerous dampers for controlling the distribution of air to the various parts of the fire. With all of these tools in the hands of thinking operators, remarkably good results were obtained and maintained.

The author of the paper had performed a real service in emphasizing, in what had been previously referred to as the second and third parts of his paper, the known fact that the best overall efficiency of the unit was really the product of the efficiencies of its two component parts and that the best combined efficiency might not correspond to the highest efficiency of furnace or of boiler. There were astoundingly few figures available by means of which one might even approximately determine values of this sort, and it would be of great value to the industry if typical units could be tested over wide ranges with respect to all essential variables in about the same way as had been the unit tested by the author of the paper.

Unfortunately for the type of control advocated, and for the worth of the data submitted, the tests recorded in the paper did not seem to represent good furnace practice. The so-called overall efficiencies were low, even for modern operating conditions under variable loads, and were correspondingly lower in comparison with what would be expected under test conditions.

Moreover, when these efficiencies were considered in conjunction with the stated thickness of fire and the under-fire pressure, one was driven to the conclusion that what the author called a thin fire must really be thick and what he called a medium fire must be very thick, or else that some other variable of great importance must have been neglected. The flue-gas temperatures and carbon in refuse also appeared to be abnormally high for the various loads and conditions to which they corresponded.

MR. KREISINGER PRESENTS PAPER BY HIMSELF AND MR. BARKLEY

With President Hollis again in the chair, a paper entitled Radiation Error in Measuring Temperature of Gases, by Henry Kreisinger and J. F. Barkley, was then presented by the former.

The purport of this paper was that in measuring a temperature of a stream of hot gases surrounded by colder or hotter surfaces, heat radiates to or from the measuring instrument, making it read high or low, and the difference between the true temperature of the gases and that indicated by the instrument is called the radiation error.

The paper enumerated the factors with which this error varies, and to show the magnitude of the effects of some of them, gave results of a series of measurements made with thermocouples placed at different points along the paths of gases flowing through water-tube boilers, citing one instance where the error under certain conditions could be as much as 320 deg. cent.

A written discussion of this paper was contributed by E. A. Fessenden and R. B. Fehr, who wrote that the paper was of decided value in calling attention to a source of error that had heretofore been almost universally neglected. It was, of course, obvious that there was no radiation error where the temperature-measuring device was completely surrounded by surfaces at the same temperature as the medium whose temperature was being measured. Many experiments concerning gas temperatures in steam boilers, however, had failed to be of material value because the conclusions had been based upon direct temperature measurements of gases surrounded by comparatively cool surfaces.

It was stated in the paper that "very likely it is the extent of the surface of the hot junction which determines the magnitude of the radiation error." It was not clear, however, just what was meant by "the surface of the hot junction." Apparently the authors had taken this to mean the surface of a cylinder whose diameter was that of the junction, which in their case was made the same as the diameter of the elements. No mention was made, however, of the length of this cylinder, and the surfaces had been assumed to be proportional to the diameters. The effects of conduction along the elements from the couple ought to be discussed along with these radiation effects. It would seem, therefore, that the length of the cylindrical surface as well as the diameter should be considered on account of the effect of the conduction of heat to or from the hot junction. Three cases might be noted:

1 Where the couple leads were surrounded by material of the same temperature as the junction (as, for example, in the authors' experiments in which the couple leads were perpendicular to the direction of flow of a large volume of gases) the temperature of the leads was the same as that of the junction and no conduction effects were produced.

2 Where the couple leads were surrounded by material cooler than at the junction, the temperature of the leads would be lower than that of the junction so that heat would be conducted away from the junction by the leads. The amount of heat carried away from the junction in this manner, and consequently the lowering of the junction temperature, would depend upon the material of the leads, their cross-section, and the temperature gradient. An example of this condition was the case where the couple was inserted in a boiler tube in which the gases were flowing parallel to the couple leads and with the hot junction pointing upstream.

3 This case was similar to the second one except that the material surrounding the leads was hotter than at the junction, as when a thermocouple in a boiler tube pointed downstream. Here heat would flow toward the junction and tend to raise its temperature.

In the second case radiation to cooler surrounding surfaces and conduction along the elements both tended to make the

reading lower than the actual temperature of the substance, while in the third case conduction tended to raise the reading and radiation to lower it.

It was to be hoped that this paper might be considered as preliminary, and that the authors would continue these investigations and at a later date give definite and quantitative information as to the effects of radiation and conduction upon thermocouples, taking into account:

a Size and material of couple elements
b Size of lead at hot junction
c Length of exposed elements
d Size and kind of protecting tubes
e Application of Stefan-Boltzmann law
f Temperature gradient in the substance surrounding the leads.

MR. KREISINGER'S REPLY TO THE DISCUSSION

Henry Kreisinger, in his written closure, replied to the suggestion of Messrs. Fessenden and Fehr that the effects of conduction along the elements of the couples should have been discussed along with radiation effects, saying that this point was simply a question of how complete a treatise on the errors in measuring the temperature of gases one wished to write. The authors had decided to treat the radiation error, and had limited themselves in the present paper to this error as far as practicable. The thermocouples they had used in their experimental work were so constructed and the experiments so planned that the conduction effect was eliminated.

In all cases the leads from the hot junctions were sufficiently long as compared to their cross-section that any lowering of the temperature of the hot junctions by heat conduction along these leads was prevented. With the smallest couples the leads were 0.008 in. diameter for a length of 1/2 in., and then 0.025 in. diameter for a length of 3/4 in. The cross-sections of these leads were too small for heat to be conducted along their lengths. Within the lengths of these leads the temperature gradient of the gases could be but very small. This construction of the couples was very well adapted to the measuring of temperature of gases within a boiler tube, as cited in the second case noted by Messrs. Fessenden and Fehr.

The large copper-constantan couples were made of copper tubing 1/2 in. in diameter, having a wall 0.052 in. thick. This tube which formed the leads was immersed in the gases for a length of about four feet. The temperature gradient for a large part of this length was very small, so that it was not necessary to consider the conduction of heat from the hot junction along the leads. The same could be said as to conduction of heat along the protecting silica tube of the large platinum thermocouples.

The surface of the hot junction of the small couples might be considered as cylinder, but in the large couple this surface was partly a sphere and partly a cylinder. Just how much of each should be considered was difficult to determine. The particular construction of the large couple was adopted because it was simple and inexpensive, and mainly because commercial thermocouples were of a similar design.

It should be added that the hot junctions of all the couples were placed in the center of the stream of gases and pulled out by steps, temperature readings being taken every two inches to determine temperature gradient of gases. The results of this part of the experiments were given in detail in the Bureau of Mines publication on Measuring the Temperature of Gases inside of Boiler Settings.

The fact that the radiation error became smaller as the diameter of the couple decreased, might be explained without going into too detailed refinements in the following manner: The couple received heat from the gases by convection and gave it off by radiation. When the temperature of the couple was constant the quantity of heat received by the couple was equal to the quantity given off by radiation. The convection did not impart the heat directly to the metal of the couple but to the outside surface of a gas film adhering to the solid. Through this gas film the heat passed by conduction. On the other hand, the heat was radiated directly from the surface of the metal through the layer of gas.

The quantity of heat that was received or given off by the couple depended on temperature difference and the extent of the surface receiving or giving off the heat. Since the thickness δ of the gas film remained practically constant no matter what the diameter of the couple was, it was apparent that as the diameter of the couple decreased the heat-radiating surface decreased faster than the heat-receiving surface of the gas film. The effect of the unequal decrease of the two surfaces was especially marked when the diameter of the couple became less than the thickness of the gas film. As the zero diameter of the couple was approached the ratio of the heat-receiving surface to the radiating surface became infinitely large, the radiation ceased and the temperature of the couple became the same as the temperature of the gases.

Following this course of reasoning, it was possible to apply the Stefan-Boltzmann radiation law and the law governing the heat transmission by convection and derive an equation expressing the relation between the diameter of a couple and the true temperature of the gases when the temperature of the surrounding surfaces and the temperature of the couple were given. The temperature of the couple was read when the quantity of heat received by convection was equal to the quantity given off by radiation; or, if Hc designated the heat received, and Hr the heat given off,

$$Hc = Hr \ldots\ldots\ldots\ldots [1]$$

Let T = the temperature of the stream of gases
T_3 = the temperature of the outside surface of the gas film adhering to the couple
T_1 = the temperature of the couple
T_2 = the average temperature of the surfaces surrounding the stream of gases, expressing all temperature in absolute units
S = the surface of the gas film receiving heat by convection
S_1 = the surface of the metal giving off heat by radiation.

Then from the law of heat transmission by convection,

$$Hc = K(T - T_3)S \ldots\ldots\ldots\ldots [2]$$

Inasmuch as with a set of any number of couples the velocity and density of gases were the same for all couples, these two factors were embodied in the constant K. And from the Stefan-Boltzmann law,

$$Hr = r(T_1^4 - T_2^4)S_1 \ldots\ldots\ldots\ldots [3]$$

From equation [1],

$$K(T - T_3)S = r(T_1^4 - T_2^4)S_1 \ldots\ldots\ldots\ldots [4]$$

The same quantity of heat that was imparted to a unit of the outside surface of the gas film by convection, passed through the film by conduction and might be expressed by the simple equation:

$$H = C\ (T_3 - T_1) \ldots\ldots\ldots\ldots [5]$$

therefore $C\ (T_3 - T_1) = K\ (T - T_3) \ldots\ldots\ldots\ldots [6]$

or $T_3 - T_1 = (K/C)\ (T - T_3)$.

But $T - T_1 = (T - T_3) + (T_3 - T_1) \ldots\ldots\ldots\ldots [7]$

or $T - T_1 = (T - T_3) + (K/C)(T - T_3) = k(T - T_3)$.

Therefore, for the whole couple,

$$H_c = c(T_1 - T_2)S \ldots\ldots\ldots\ldots [8]$$

Taking D as the diameter of the couple, then:

$$S = \pi D, \text{ and } S = \pi(D + 2\delta).$$

Equation [ ] would then become

$$C(T_1 - T_2)(D + 2\delta) = (T_2^4 - T_3^4)D \ldots\ldots\ldots [9]$$

where C embodied all the constants.

It should be remembered that the constant C' embodied the convection constant, which was affected by the velocity and the density of gases, and radiation constant, which was affected by the condition of exposure of the couple. So when any one of these factors changed the constant must be changed also. It was also probable that the thickness of the gas film changed with the velocity of gases passing the couple. However, the data availing did not justify more detailed analysis of the equation. On account of the fourth-power variable, the equation was rather cumbersome to work with. The work could be made somewhat easier by making T_2 equal to one and expressing the other temperatures as ratios of T_2, remembering what this provisional unit was and changing the final results into the standard units. Such substitution of units eliminated one fourth-power factor.

Using this method of arbitrary temperature units, and $2\delta = 0.08$ in. and $C' = 3.9$, the equation fitted the curves A and B of Fig. 6 of the paper. The readings for both of these curves were taken under the same conditions of exposure and about the same velocity of gases.

For curve R the conditions of exposure and the velocity of gases were entirely different, so the constant C' must be changed. If the constant was made equal to 12, the equation would fit the curve R. The value of $C' = 10.8$ satisfied the curve M.

SCIENTIFIC METHODS OF MANAGEMENT PRESENTED BY MR. THOMPSON

A comprehensive paper entitled Development of Scientific Methods of Management in a Manufacturing Plant, by Sanford E. Thompson and his associates, was then presented by Mr. Thompson. During the presentation of this paper and discussion, President Hollis relinquished the chair to Mr. Max Toltz, Manager of the Society. A summary of the paper follows:

The authors present in considerable detail the outline of the development of scientific methods as applied to the ordinary manufacturing plant. To make this a more concrete illustration, the discussion is centered in the plants known as the Eastern Manufacturing Company, at Bangor and Lincoln, Maine, one of the largest concerns in the country manufacturing writing paper as its final product. The development of scientific methods at these mills, however, is not, as one might assume, descriptive of a simple and comparatively localized industry. As a matter of fact, the processes involved in pulp and paper making are similar in type, so far as management methods—not in specific technique—are concerned, to a vast number of industries.

The paper was discussed orally by Frank B. Gilbreth, who illustrated his remarks with lantern slides, W. H. Carrier, Max Toltz, Calvin W. Rice and Harrington Emerson.

Frank B. Gilbreth said that he wanted to call attention to the relation of the address on the previous evening by President Hollis to the subject of Mr. Thompson's most admirable paper. He was tremendously impressed by Mr. Thompson's talk, because he had been in Europe several times since the war began, and it was no exaggeration to say that millions of our boys would be on the battlefields after the war was over. We could not help that, but we could help the waste that was going on in this country at the present time, and the waste that would continue to go on after the war. From this standpoint he wished to take great exceptions to Mr. Thompson's admirable paper in that he followed out the procedure of his predecessors in giving the impression that there were such things as elementary units in stop watch time study, and that the data obtained from such study were accurate, transferable and of permanent value.

He wanted to call attention to the fact that the Society could not go very far in utilizing data unless they were in such form that they were usable by all the members. Stop watch time study is inaccurate, through the fact that the variable of the human element is involved in pressing the stop watch. It is not transferable, in that it does not provide for recording the surrounding conditions under which the observed activity takes place. For these two reasons, among others, it lacks permanent value.

It is possible to obtain accurate records of activity that include not only the time taken by the activity, but by the elementary units of which it is composed, through methods that are inexpensive, available and adequate. Through the use of the micromotion method and the cyclegraph method, which he illustrated by lantern slides, it is possible to obtain data that are so complete and so accurate that they are usable at any time by any person. From these data may be obtained charts that enable one to transfer the facts obtained not only from one activity to another, but from one type of worker to another who has an entirely different mental, physical, or material equipment.[1]

The special importance of these facts at this time is their relation to waste elimination. If we are to do our part in the savings that are today so necessary, we must begin to collect our data in a more economical fashion, and to put them into such shape that they may be universally useful in the shortest amount of time possible. We would, therefore, urge such men as Mr. Thompson, who has both the natural ability and the training that lead to expertness in observing and recording data, to discard inaccurate devices and to insure that the results of their valuable investigations are both immediately and permanently usable.

W. H. Carrier said that it seemed rather remarkable that time study as related to efficiency as a whole from a scientific and from a manufacturing standpoint had progressed so little in the paper-making art in the last number of years as compared with other arts in this country, particularly with reference to the work in the machine room. He was not a paper-mill man, but had been connected with problems in paper mills where the lack of manufacturing efficiency in the art of paper production had been most striking.

It had been determined by several different observers for instance, that in the process of the machine room in the drawing of the paper from 30 to 50 per cent of the possible strength of the paper was lost; and that the cost of producing paper of a standard as high as writing paper was nearly double what it might be if improved methods were introduced and studies made.

Even at the present date it had been shown by actual tests to be possible either to increase the strength of the paper or decrease the cost of a given standard from 5 to 15 per cent by

[1] See Motion Study for the Crippled Soldier, Jour.Am.Soc.M.E., December, 1915.

the use of improved methods, and at the same time to increase the output 10 to 20 per cent by the use of improvements in drying, particularly the application of air and the proper handling of the rolls.

Comparatively few machine rooms were being provided with improved machinery, although their number was increasing. But there should be a thorough study made of the possibilities which would result, he was certain, in a practical revolution of the process of paper making by machinery.

Calvin W. Rice asked what proportion of the value of the product of a paper mill the cost of counting of the sheets represented. He asked whether the product had now been developed to such a uniformity that the number of sheets could be arrived at by weighing them, and if not, whether other processes had been found which would avoid the expense of counting.

Harrington Emerson said that some seven years ago he was engaged to standardize the work in a paper mill very similar in size to one described in the paper. He went through all the departments and standardized the work. There were at least 3500 different varieties of paper, and he was not certain but what there were 35,000. A great deal of work done there would have been very useful to Mr. Thompson at the beginning of his studies, and with it he would undoubtedly have extended the studies already made.

This is mentioned because Mr. Emerson feels that he also is duplicating work already more thoroughly done by Mr. Thompson and others, and he regrets that there is no available clearing house of experiences.

As an evidence of the thoroughness with which some of the work was done, he would say that the plant in question was the only place in the world that he knew of in which labor costs were immediately and accurately so distributed that in nine months they were not one mill out in the distribution of the work of 600 or 700 men, and the record was complete at 10 a. m. of the day following. The work was performed by three girls, one of whom was a substitute.

CLOSURE BY MR. THOMPSON

Sanford E. Thompson replied to Mr. Rice that sheets still had to be counted. We had not reached the point where we could accurately determine the count by the weight. The cost of counting, however, using the rubber finger tip, is small and is useful in separating small lots.

He considered that Mr. Carrier was too low in his percentages of possible cost reduction. There was a chance for an appreciable increase in production and improvement in quality by radical changes in machinery, not only in the paper machine but also in the beating engines, and these problems were now being studied in the mills referred to in the paper. They were still using in all paper mills the Hollander beating engine that was invented not less than fifty years ago.

Mr. Gilbreth was correct in his statement that time study was capable of further standardization, and we had gone only a very short way in the developing of standard methods of taking time and in getting these methods so that the results of different operators would be comparable. He was not yet quite ready to say, however, that Mr. Gilbreth had the plan that would entirely revolutionize the taking of times. At the same time, the general principle of getting with his pictures, as he did, the methods of doing the work was of considerable value in many cases; and there was no question, even in his mind, that often that might be vital interest, and should be applied.

MR. WEAVER'S PAPER PRESENTED BY TITLE

The fifth and last paper of the session, on Disk-Wheel Stress Determination, by S. H. Weaver, was presented by title only, and will be published in full in the Transactions of the Society.

JOINT SESSION WITH MACHINE TOOL BUILDERS, TUESDAY AFTERNOON

A JOINT Session of The American Society of Mechanical Engineers and the National Machine Tool Builders' Association was called to order by President Hollis of the former Society. An audience numbering 400 of the members of the two organizations was present.

The Chairman, in opening the session, expressed the high satisfaction on the part of the two societies with this joint meeting, which he hoped was only the beginning of many such meetings, since the two associations belonged very much together and could work together very effectively.

The Chairman introduced Mr. James Hartness, who presented resolutions of appreciation and condolence on the death of Mr. William Lodge, President of the Lodge and Shipley Machine Tool Company, of Cincinnati, a member of The American Society of Mechanical Engineers for 27 years, and one of the organizers of the National Machine Tool Builders' Association and its president for two years.

Dean Herman Schneider, College of Engineering, University of Cincinnati, was then introduced and delivered an interesting and forceful illustrated address upon the subject of The Trend in Engineering Training. Dean Schneider's address will be given in full in a subsequent issue; the purport of this paper is conveyed by the following paragraphs:

THE TREND IN ENGINEERING TRAINING

"It is interesting to note that prior to fifteen years ago convention programs dealt almost exclusively with materials and the natural laws governing them. About fifteen years ago, however, there began to appear some papers on organization, which was then becoming a pressing problem. More recently we have been accustomed in conventions to a new phrase, 'the human element in industry.' These three are the great divisions of production: materials, organization, and men.

"Courses of study in engineering colleges have followed the needs expressed in conventions, so that necessarily, in the early days, the courses of study for engineers dealt almost exclusively with materials and their laws, and the engineering colleges straightway attempted the solution of the problem of materials. There grew up college laboratories wherein materials could be analyzed and the laws governing them ascertained.

"A little later, when engineers began to take up the problem of production so far as organization was concerned, the colleges introduced courses in organization. None of those courses is as yet satisfactory, however, for there are no laboratories available in the universities for the study of organization, which must, therefore, be made from books.

More recently, with engineers [illegible] the pressing problem was what was called 'the human element in production,' the colleges became confronted with the problem of ascertaining some sort of relation which would give a fairly equal and just measure of interest and study in the three elements of materials, organization, and men.

"The trend of engineering training indicates that there will be three types of attempts made to solve these problems so far as engineering schools are concerned. First, there will be the attempt that has been made in some colleges not to conduct a great laboratory, but to confine a large part of the study to books. We have that kind of college in evidence in the study, for example, of organization exclusively from books. That type of American college will attempt also the study of the man problem out of books; in other words the sequestered method, the withdrawing of men from contact with industry in order to study industry, will prevail in some colleges. There will be the same trend in the study of organization and men that has prevailed in the study of materials.

"In the second place, there is a movement, inaugurated by the Massachusetts Institute of Technology, whereby arrangements are made with manufacturing concerns to have in those concerns laboratories and classrooms for the students of the Institute. In the later years of the course, according to that program, these young men are taken from the university and go, so to speak, to a secondary school—an accessory school—at some manufacturing plant where they observe the work done and after classes are instructed in the manner of doing the work.

"The Massachusetts Institute of Technology has made arrangements with a number of organizations, such as cement companies, chemical companies, and so on, for those students at the present time who are studying chemical engineering, whereby classrooms are put in the building in or near the plant, and the students go to the classes, and then go out into the shops to observe the work done in the actual commercial department of that particular concern. They spend a year in this. You can see that that scheme is possible of enlargement, and it offers a splendid opportunity for the study, at fairly close hand, of the three elements of production—materials, organization and men.

"The third attempt is one which has been inaugurated at the University of Cincinnati, and is known as 'the coöperative' system. In this system a plunge is made straight into the industry. The young men are sent out right at once upon entering their course into the work of the industries. They are not sent into classrooms there, but are sent out to do actual work and become part of the organization. They start at the very bottom. The civil engineer starts with a pick and shovel; the mechanical engineer starts in the factory or machine shop as a helper; the electrical engineer starts in the machine shop on electrical work, and so on."

Dean Schneider then exhibited a number of lantern slides exemplifying the main difference between the three types. He concluded:

"The first type is easy to operate because the whole field of operation is within the scope of the men who operate it.

"The second type is a little more difficult, because the school has to deal with different concerns, and arrangements have to be made so that there is no confusion in the work.

"The third type, the coöperative system, is extremely difficult of operation, for the problems are those that arise in the shops in addition to those in the University.

"The men operating the coöperative system are confronted daily with the same problems that the manufacturers have to meet, because their young men are working in the manufacturing concerns and become part of the problem.

"The University has had to cope with very peculiar conditions, looking at the problem from the industrial and educational point of view of the man who works and the man who employs; because the young men are working, they are working men governed by rules. At the same time the University is concerned with the major problem, the big problem of engineering and of efficient and economic production, so that the University authorities governing that course have to meet these vexing problems right along.

"The difficulty of operation is about the only thing in the way of the adoption of the coöperative plan, outside of any question that may arise as to the fundamental philosophy of the work itself. The differences that arise as to the value of this kind of work are very proper."

W. F. M. Goss said that all who had been concerned with the problems of technical education had looked with great interest upon the coöperative undertakings of Cincinnati University. These undertakings represented a procedure which was practicable only in a few communities, so that in considering their merits one was forced early to recognize this limitation. This statement emphasized the fact that the University of Cincinnati was to be congratulated not only upon the possession of Dr. Schneider, but also upon the wonderful environment which the peculiar activities of the city of Cincinnati supplied. The coöperative plan in techincal education as developed by Dr. Schneider was, he took it, a logical adaptation of means to an end. Through its adoption a great work in education had been and was being accomplished. It was to this fact that he especially wished to bear testimony. He wanted also to express to Dr. Schneider the pleasure and satisfaction he had had in listening to his masterful presentation.

Frederick W. Putnam said he had come to Cincinnati to study the coöperative system in the high schools, and found that he had also a chance to study the same system in the University. It seemed to him that the people in that city owed a tremendous debt not only to Dean Schneider, but to the Superintendent of Public Schools.

He believed that in his own city, Providence, their problem was working out and they were going to have the hearty coöperation of the manufacturers, including Mr. Luther D. Burlingame, of the Brown & Sharpe Mfg. Co., Mr. Arthur H. Annan, of the Rhode Island Tool Co., and Mr. D. M. Bartlett, of the Builders' Iron Foundry, all of whom had spent money on their undertaking. He thought that all of the success they had made was due largely to the fact that the manufacturers were interested, and that they wanted the boys to have a chance. They were trying to see that they got a fair, square deal all the way through. He believed that when those boys were through they would have gotten a good start for the active business of life because of the honest and sincere coöperation on the part of the manufacturers of the city of Providence.

James Hartness asked for information as to how many places the coöperative course under discussion had been applied in the United States. He understood it had been put into three or four hundred high schools, and he asked whether it was not an unqualified success. He knew that in Springfield, Vt., they considered it so.

If the movement were to go forward, as he thought it should, in all or in many centers, he thought we should all know about it, so that we could carry it home, where we could

bring our interest to bear to see that such things were given to the youth of our own places.

R. Poliakoff[1] described how the practical education of the students was carried on in the Technical Institute in Moscow, Russia, which had been reorganized and put on a new basis in 1870 so as to correspond with the system at that time prevailing in the engineering schools of Germany.

At the Centennial Exposition, in 1876, the school had exhibited quite a number of specimens of the work of its students, who at that time were required to spend three or four days weekly, from six to eight hours every day, in the shops attached to the school.

Very complimentary reports had been made about the students' exhibit at the Exposition, one of them appearing in the bulletins of the United States Bureau of Education. The exhibit itself would, he believed, still be found in the machine shops of the Massachusetts Institute of Technology.

As time went on the national trend had changed, and they had begun to believe that the student must know something else in addition to shopwork—he must know more about theory. For that reason they had gradually steered away from too much work in the shops.

Some twenty years ago, when he was a student himself, three days a week in the shops on filing, chipping, turning, etc., was required, also work in shops where small steam engines, compressors, lathes, shapers, etc., were made. The students had to work in those shops just the same as the ordinary workmen, and make out reports as to the progress of their work. Since about 1905, however, those in charge of the Russian schools had begun to think that different methods should be employed, and laboratories had been organized. To give an idea as to the size of some of these, he mentioned that the textile laboratory comprised a regular textile mill, a building three stories high, and the machinery installed in it probably represented an investment of $150,000. The students were afforded there an opportunity to pass from one machine to another. The school employed a number of practical men from a factory who worked with the students, and in that way he believed they turned out very good textile engineers who could go right into a factory and start to work there. In addition to that, every student that worked in that textile industry was expected to spend two or three summers in some mill in order that he might become a good practical engineer, and so that as soon as he was graduated he would be sure of finding a position.

In regard to machine-shop practice, the system at the Institute was a little different. They had still some shops which had not been abandoned, for instance, the practical machine shops in which various kinds of machinery were turned out. They had found out, however, that it did not pay a school to run such a shop on a commercial basis, and on the other hand they believed that only when it was run on a commercial basis could it be used as an educational institution for practical work; therefore, they simply rented the shop to a private concern, which concern ran the shop, and the students had the right of access to all the other shops of this concern, and worked in the shops under the guidance of the Institute's own engineers. The steam-engine laboratory supplied steam also to this private establishment, and, of course, it had to supply it at the proper time and in the proper quantities. The work was arranged in such a way that there was complete coördination of all the different sections.

[1] Assistant Professor of Mechanical Technology, Technical Institute, Moscow, Russia.

The students worked also for two summers, sometimes for six months every year, in the shops of private concerns outside the school. They were paid on an hourly-rate basis, and as many of them had not sufficient means to enable them to support themselves, they depended to a great extent upon these earnings, and so they attended to their work very regularly.

During the last three or four years some changes had been made in the courses, and less work was done in the school in the way of machine-shop practice and more in the private works. So, while this was of course not a coöperative system in the way that Dean Schneider operated it, he believed, there was not so much difference between the two systems. It was, after all, only a question of coördination; and they were trying to carry on their system in the best manner. Local conditions of course had to govern, and there were always variations that were suitable to special needs or localities. What might suit one might not suit another; but he thought the prevailing idea in all cases was to give the students some practical education outside of the school, leaving to the school the more theoretical part of their education.

Calvin W. Rice said he was hopeful that the Society and the National Machine Tool Builders' Association would some day follow the lead of the other professional societies of the world in having a committee on engineering education. The professional societies of other countries had felt it an obligation to establish a relation between the teaching of engineering and the work of the societies. He did not know of any such definite relation in America between the professional societies and the colleges, and he thought that there should be a definite relation. He was hopeful that as an aftermath of this address some members of our Society would volunteer to make a sacrifice of time and study, and develop a committee to so correlate the teaching of engineering that the students when they were graduated would be acceptable to the profession and to the industries.

E. F. Du Brul, who has taken an active part in interesting manufacturers of Cincinnati in Dean Schneider's coöperative plan, said the main difficulty encountered in conducting the coöperative course lay in procuring practical teachers of commercial experience who were willing and competent to teach engineering students at work in the industries every alternate two weeks. Not every technical college professor was willing to teach at the college eleven months a year, instead of the usual nine months. In fact, some of the men must even be content with only two weeks' vacation.

Mr. Du Brul said that it took a number of years to overcome academic inertia in Cincinnati, where conditions made that inertia less than it probably would be anywhere else. But now the manufacturers of Cincinnati who employed, paid and trained these students were getting results from them eminently more satisfactory than they ever got, or could get from the ordinary type of engineering student who comes in a factory after graduation.

There were now 500 students enrolled in the engineering college, and the only industrial difficulty was that the college had no room for more. From 3000 to 4000 applications were received every year, from which only about 200 could be accepted.

Mr. Du Brul stated that a manager of a large concern recently wrote Dean Schneider, stating that he had read a magazine article about the coöperative course and would like to try six graduates. He said that his company would pay them $60.00 per month the first year, $75.00 the second year

and $100.00 the third year, and whatever they were worth thereafter. It was fair to assume that later salaries would be $110.00 to $120.00 per month during the fourth year.

Dean Schneider replied that he could not supply any of his graduates under those conditions, because firms that were employing the students were paying them for the time they worked on an average basis of $90.00 to $100.00 per month during their last terms in college, and that such firms found these men so valuable that their salaries at the end of the third year after graduation averaged about $3000.00 per year. "Is the average graduate of the average technical college," he asked, "worth $3000.00 a year at the end of his third year after graduation?"

Some educators to whom this question had been put very bitterly charged that this was putting education on a sordid commercial basis, saying that a money standard should not be applied to measure the value of an engineering education. To this the speaker said he had replied that a laborer was worthy of his hire, and that since most engineers ultimately earn their living in commercial establishments, the salary an engineer could draw was a fair measure of his worth to his employer. If therefore, the average graduate of the coöperative course appeared to be worth more to the users of trained men than was the average graduate of the traditional course, the commercial standard proved the coöperative course to be the better course, both commercially and educationally.

It had been stated that at Providence, the manufacturers did not want to make money out of the coöperative-high-school students. In Cincinnati it was understood that, far from having any tinge of charity or tolerance, the coöperative course in the University did return a direct and immediate profit to all concerned. The Cincinnati manufacturers were not unfairly exploiting the students, but were making money by employing them, just as they did by employing any other employees.

Mr. Du Brul concluded with the statement that the plan was truly coöperative. The employers made a direct profit on the regular output of the students and they made a larger though intangible profit by training those students to be the sort of engineers that they required in the industries. The students profited directly because a great majority of them could not procure an engineering education, due to the lack of funds, without some plan that helped them to pay a large part of their expenses. They had a further profit in the opportunity to secure an engineering education of a kind that fitted them to hold a better job than they could otherwise get after graduation. The University profited directly in that, being very limited in its funds, the Schneider plan enabled it to educate more and better engineers for the amount available, at a lower cost per head than any other institution could show under the traditional plan. The University's indirect gain was the great reputation that this plan had made for the College and its educational product in a very short time.

Dean Schneider, in his closure, answered all the points brought up by the several discussers, enumerating the institutions which were using the coöperative plan and reciting their experiences. His closure will be published with his full address.

Dr. Otto P. Geier then delivered an address on The Human Potential in Industry, which is published in full below.

THE HUMAN POTENTIAL IN INDUSTRY

By DR. OTTO P. GEIER,[1] CINCINNATI, O.

FOR the past three years history has been writing the terrible story of the human potential in modern war. As a result of a long period of peace, we Americans had looked upon war as a most remote possibility, attested to most strikingly by our present state of utter unpreparedness. As we reflect, it appears now we were not measuring nations by their fighting strength, but rather by their social, industrial and commercial strength. Nations were tabulated for their rate of production and consumption. This differential had its social as well as its economic effect. It produced state and private wealth. It produced leisure, the arts, extended educational and health measures, and raised the standard of living. In brief, the world was in keen competition not only in business life, but in social life. Nations were striving to outdo each other in promoting financial success, health and happiness for their people. Individualism had reached its zenith and the philosophy of collectivism was just appearing above the horizon.

It was rather our subconscious minds that recognized the great sea power of England and the militaristic spirit of Germany. Our real attention was focused, not on the plans and intrigues of governments, but rather on the national characteristics of their peoples. We thought of London as the financial center of the world, of the Englishman as the world traveler, a lover of outdoor life and sports, an educated gentleman and judge of the fine arts.

When we traveled in Germany we admired her order and cleanliness, her *Gemüthlichkeit*. The world paid homage to her philosophers, revered her musicians, studied and copied her educational systems and longed for her thoroughness and scientific capacity.

POTENTIAL OF WAR

But the bloody struggle of the past two years has changed our viewpoint of these nations. War, with all its horrors, its terrors, has changed these peoples. The human potential of nations is no longer directed at the creation of comforts, contentment and health, but the backs are bending low under the struggle of destruction of property and life. National efficiency is now expressed in new terms.

Shortly after the program for the Spring Meeting of this Society began to take form, our country entered the war. There were those who doubted the advisability of holding the meeting. Our fearful unpreparedness produced a public state of mind akin to hysteria. We have scarcely had our sober, serious second thought. Democracy is being subjected to the acid test. There are few so daring as to prophesy what failures and what successes we shall find. Of one thing we see signs. Our nation is finding itself. We are trying to forget and forgive ourselves for our "spread eagle" and forget our jingoism. Even in the early stages of preparedness we are intensively appreciating, as never before, the stuff that other nations are made of. Their capacity to produce, their silent ability to suffer, sets us to wonder.

[1] Cincinnati Milling Machine Company.

AMERICA REBORN

Perhaps, for the first time since the Civil War, we are thinking together. Our national consciousness has been reborn. The pettiness in us is disappearing and true Americanism is coming to the foreground. Our faces are turned to the common enemy. We have turned our backs on the paltry bickerings of the past. We are witnessing the first truce in the century-old strife between labor and capital.

This is a day that calls for statesmen as well as soldiers, for calmness as well as courage, for patience and patriotism, for virtue and vigor, for faith and faithfulness, for health as well as willingness to die. This day calls for social reconstruction as well as enemy destruction. Huge is the task in which *all* should find a place to do with all their hearts.

POTENTIAL OF INDUSTRY THE POTENTIAL OF THE NATIONS

And what tasks has our entering the war brought to industry? Huge production? Yes! But is that all? Have not old truths as to the value of the conservation of labor taken new form, new emphasis? Has not The Human Potential in Industry in the nations abroad finally been the measure of their potential on the battlefield? Has the interdependence of man ever been more fully demonstrated? Has the mutual dependence of labor and capital ever been so strikingly proved? Have we ever witnessed such limitless industrial energy and output? Has it occurred to all of us Americans, that Europe's industrial experience of the past three years holds not only a lesson but a warning? Militant and efficiently industrial England of war times will be succeeded by industrially militant England of peace times. Labor and capital in England, Germany and in France, having learned the mutual advantage of coöperation in war, are not likely to give up this advantage and return to the destructive internal warfare of former days.

OUR NEW COMPETITION

The question that presents itself is this: Can we keep pace with them in war, and will we keep pace industrially after the war? Can we stand this new type of competition unless we likewise enter upon the program of the new social order? Will not the programs of our National Association of Employers, chiefly defensive in the past, necessarily become socially constructive? Will not labor now have to seek leadership capable of best adjusting itself to these forward-looking steps.

FORWARD-LOOKING INDUSTRY

War has lifted the discussion of "the human potential in industry" out of the realms of philosophy and has used it as the foundation stone of a national economic policy. The Council of National Defense has appointed a committee on the conservation of the health and welfare of the worker, and in the interest of the health and productiveness of labor proposes to establish definite standards of plant operation. The human potential of the nation is needed at its maximum, for the country cannot afford the usual labor losses due to accident, disease or fatigue, and industrial poisoning.

A right-minded, forward-looking man does not wait for compulsory legislation to develop his business organization to the highest degree of efficiency. This type of man, for years, has developed not only the administrative and technical divisions of his plant, but, when most successful, has given a great deal of thought to the human equation; the giving of happiness and meting out of justice to his employees. It has been a great satisfaction to him to find an economic method of lessening the human waste due to preventable accidents and occupational diseases. He noted that a healthy, contented employee was a more productive employee, who, in turn, was a higher type of citizen, demanding a better standard of living for himself and family, better protection for his children against disease, delinquency, and crime, and higher forms of community recreation. He recognized that right in his plant he could make his best contribution to the health and well-being of the worker, and that he had found, perhaps, the most tangible basis for coöperation between himself and his employees. To him it was apparent that by intensively studying the health of his workers he was establishing some splendid new points of contact between himself and his men.

MASTER AND MAN, THEN AND NOW

Industry must find a substitute for the valuable relationship of master and man which passed with the coming of greater industrial concentration. Then the master was teacher as well as craftsman and to a large degree a substitute for our modern continuation school, manual training and coöperative university engineering course. Master and man worked elbow to elbow. The master largely molded the thought and living of the man. Then they had real personality for each other. Now, in too many instances, the pay envelope expresses the only bond between the two. The man was graduated from his apprenticeship, frequently to set up a business of his own; now, industrial concentration practically hinders the establishment of the new small unit. Then, labor took part in the making of the mechanism and conceived the full purpose of the machine which he assisted the master in building; now, his work is more repetitive and limited to single parts of a machine, whose mechanism he may not understand.

TENEMENT STRIKES, LOCKOUTS

It was but natural that in this evolutionary process of industry, capital and labor should become more estranged. They not only worked farther apart, but lived farther apart, for with industrial concentration, community life changed, and the tenement district developed. The difference in their scale of living was more evident. Industrial discontent was more readily bred. Labor and capital organized themselves to meet strife, and strikes and lockouts were the natural outgrowth.

Neither master nor man can be held accountable for these unfortunate conditions, which were but the natural consequence of industrial evolution and the consequent crowding of population in cities. So engrossed were both labor and capital in adjusting themselves to the new conditions that the estrangement of these former partners in work came on quite unnoticed.

DISTRUST OF EARLY WELFARE WORK

Some years ago industry began to recognize its social obligation. It saw the economic advantage of substituting fine, light, well-ventilated buildings for the dark, unsanitary workshops of the good old days. It was at about the same period that many abortive attempts at so-called welfare work were started, which in most instances failed to make any real contribution to the better understanding of labor and capital. This sort of welfare work was established on purely paternal-

[illegible] was imposed upon the group of workers without their desire or consent, and all too frequently furnished that for which they had no real need. The type of welfare contributed to the social and superficial requirements of the man, and overlooked the fundamental. It did not take into account the basic principle that the workman is very human, and that to get the best results out of any socializing effort you must first engage his coöperation. You must put him to work, so that he too may use his creative instincts, and enjoy with the employer the fruits of intelligent coöperative work. Welfare work of the former kind deserved failure and did fail. It was "built upon the sands" and was all too frequently washed away by the least wave of discontent among the workers. After the first strike, the returning man found the doors of the dining rooms, libraries, and club rooms closed upon him. The whole structure was weak and crumbled at the mere sign of a storm. Is it any wonder then that welfare work came into such disrepute with the worker and was so continuously and effectively used by the labor agitator?

BUILDERS OF MEN

It would indeed be a foolhardy individual who should attempt to interest the members of these organizations in that kind of welfare work. I am equally sure that most of the plants represented by this conference are already engaged in some effort to solve the great problem of human potential in industry. We are all groping our way toward finding the right method. If we can evolve a sound economic scheme for the establishment of a human-service department in industry, which day by day will pay dividends, which will reduce lost time for illness and accidents, reduce labor turnover, and quicken loyalty, we will not build up a "blockhouse" which will fall to pieces at the first sign of industrial strife. It will each day have served its purpose, secured a result worth while for itself, and will automatically, along with all other departments, be again set in motion the moment that the wheels of industry begin to turn.

I have faith in big industry. I believe that when builders of big enterprises sense their social opportunities they will also prove themselves to be builders of men. In time their widened perspective will include an active interest in national and local health problems, they will, for the sake of the men, use their good offices for better housing and transportation facilities. They will apply themselves to the great human problem of taking much of the drudgery out of work. With this new purpose in life will come a recompense which cannot be valued in mere dollars.

They will be instituting the first intelligent effort toward the alleviation of poverty and the establishment of social justice. Philanthropy and legislative effort to correct conditions have failed lamentably.

BUILD UPON HEALTH

The activities of the human-service department should be founded on intensive health work. Health is our most vital possession. The mere act of conserving the health is ennobling. Healthy bodies promote right thinking, right living, good habits, and it is upon such factors that intelligence, stability and loyalty are engendered. Unless we have these things, our employment departments, struggling with the labor turnover, our mutual-benefit societies and loan associations, our restaurants, our coöperative buying, our sanitary measures, will meet with but half of the deserved success.

ALL-DAY DISPENSARY

The point of approach to the human potential had best, therefore, be through the industrial dispensary. Under a high-grade physician it will be the great melting pot of the human experiences of men. Here the virtues and the weaknesses of the men will be most apparent. The physician will also be confessor, adviser, priest. Through him the employee may learn that it pays to be healthy, steady, and of good habits. He does not hesitate to preach the "Sober First" campaign.

An industrial dispensary, with a dental clinic as its adjunct, will advertise itself. It will come in daily contact with five per cent of the force, the equivalent of the whole force each month. To respond to all the possible services that grow out of these frequent contacts, it will require one full-time physician to every 750 employees.

The men will first use this department for their slight cuts and accidents; next they will begin to call the doctor's attention to some surgical defect with which they have been suffering.

DOUBLING WAGES

I recall the case of an Italian watchmaker with five children, whose complexion was pale and pasty. He seemed anxious to please his foreman, but his work, like his skin, remained rather pale. He had a bad record for absence and lateness. His average earnings amounted to $13.00 per week. Investigation showed that he had been suffering with hemorrhoids for twenty years and had been repeatedly advised against an operation. He had enough confidence in the plant physician to undergo the operation. As a result, his physical efficiency was raised, so that now his premium earnings are nearly as great as his weekly wages formerly were. In other words, the operation had practically doubled his wages. An inefficient man, an active candidate for the human scrap heap, one whose family had been on the poverty line for years, has been converted into a happy, productive citizen.

In an industrial all-day dispensary men will frequently learn that while they have been treated for rheumatism on the outside, they are actually suffering from broken arches. Again and again men will be found who are continually taking headache dope for headaches due either to gastric conditions or eye strain. Untold numbers of men will be found whose working capacity has been below normal; whom employers have always felt more or less sorry for and therefore did not discharge because they seemed anxious to make good, but they never quite "reached." Quite a lot of these will be found suffering with chronic intestinal toxaemia, while fully as many will be discovered whose lowered vitality has been induced by years of bad mouth hygiene, abscessed roots and pyorrhea. I am thinking just now of such a man who had been treated for rheumatism for years and who never was able to get out of the subnormal class of workers. A careful checking up showed pyorrhea of the teeth to be responsible. With six months' supervision and care, that man increased his earning capacity by nearly 100 per cent.

While speaking of mouth conditions, let me recall the case of a man who for three weeks suffered excruciating neuralgia of the face and head. He was the type of man that puts off going to a physician until the last moment. Examination showed that he had a very dirty mouth, a number of snags and some pyorrhea. X-ray showed an unerupted cuspid tooth lying horizontally, the pressure therefrom causing the pain. Twenty-four hours after the removal of this tooth, and the old snags, all pain disappeared. If the plant dentist

had been an average dentist no X-ray would have been called for and the man would, for weeks, have lost sleep and time from work, and have considerably reduced his vitality and working capacity.

In passing, we might mention one other case where the man was losing a day or two each week as a result of nausea, sleepy, draggy feeling, practically no ambition for work, and gradual loss of weight. Physical examination showed nothing unusual, except that the teeth were bad. Cleaning up the mouth and pulling out the old snags was followed by immediate improvement. The stomach trouble disappeared. In six weeks he gained seven pounds and had a new bite for work.

DIAGNOSIS NECESSARY

The plant dispensary, with the economic pressure back of it to get results, will go farther to establish a diagnosis than the family physician. It sees the financial advantage to the patient and to the company, to spend a few dollars for consultation or for X-ray. If the employee cannot pay for the consultation, the plant physician can always place his hands upon some consultant on the outside who will do the work for nothing. There is a drive behind the plant physician to get a quick result.

Too much cannot be said for physical examinations of employees. No one knows how many cases of incipient tuberculosis are present in his shop force. There are any number of men whose appetites are variable, who tire easily, but who have no cough or symptoms that would make them consult a physician; are perhaps merely irritable, and have a draggy feeling and no "pep." They attribute their weariness to the job. In so many cases of an early diagnosis of incipient tuberculosis, an enforced rest of a month or two will put these men on their feet again.

INDUSTRIAL CROSSED EYES

The development of the human potential with all of its mutual and economic advantages will not be introduced in industry where the employer does not possess some social vision. I am thinking just now of one narrow-visioned employer who was recently interviewed by someone who was anxious to gain a consensus of opinion as to the value of employees service departments. The total human equation in this particular industry, employing some 1100 men, was represented by a mutual aid to which the company contributed annually the large sum of $100 (less than nine cents per man). It was necessary for that association at their annual picnics, given for the purpose of raising money, to invite employees of a number of other smaller concerns. In other words, for the sake of a few dollars raised by inviting outsiders, this company blindly encouraged the undermining of any good feelings of fellowship that might have been encouraged among its employees by this one annual getting-together. The same employer boasted that the efficiency plan of wages greatly reduced the cost of production, returning ten dollars for each dollar put into that system.

A LOW-BROW HIGH TURNOVER

In discussing his men he spoke only of their lack of loyalty and the lack of loyalty on the part of the foremen. With an injured air he told that petitions for the unionizing of the employees had been in circulation in his shop for two weeks with the full knowledge of the foremen before he discovered that fact. The result is, he says, that the shop is fully organized and the union has his company under its thumb. It seems that it had been the custom of this company to entertain the foremen once a month with a dinner and smoker, and that one of these entertainments was held the night before the discovery of the petitions. With stupid satisfaction he said that thereafter foremen's meetings ceased. It is not surprising to note in passing that the labor turnover in this plant is 305 per month. This man who gives the whole sum of $100 toward the sole coöperative effort on the part of the men to care for themselves in times of illness loses $100,000 per year in excessive labor turnover.

If I were called upon to make a diagnosis of that employer, I would venture to say that he had an aggravated case of mental strabismus or was mentally cross-eyed. He does not realize that the sound-minded industrial procession is passing him. He does not know that the movement for the conservation of the industrial worker marks the greatest change in the attitude of society of the twentieth century, that next to the municipality the industrial corporation is the largest social unit, that as such it partakes of many of the characteristics and functions of a governmental subdivision. He does not realize that his industry is an example of one selfishly administered, and as such is a menace to the peace, prosperity and happiness not only of the members of his industrial unit, but a menace to the rest of the community members. A coldly calculating, selfish enterprise, no matter how big, engenders selfishness, distrust, envy and hate in individuals in and about it. As a by-product it manufactures class feeling, which other social agencies vainly try to counteract. Conversely, a socially organized, profitable, and farsighted business enterprise, by its very existence, continuously creating more work for more people, is not only a great financial asset to the community, but is of definite social value as well. The first grows at the expense of society which gave it life. The second is one of the taproots of society. The first produces the malcontents, the industrial hobo, the I. W. W. The second creates intelligent, contented citizenship, the only hope of a democracy.

THE PHYSICIAN IN INDUSTRY

To men who are attempting to fit their enterprises to this latter classification, to men who are seriously at work solving the problem of the human potential in industry, permit me to say, that most of them are overlooking the possibilities for service that the socially minded physician may render employers and employees. The proper place has not yet been accorded him. He has not been given an opportunity to make one for himself. It doesn't count for much if surgeons are employed in a plant to care for the injured. The surgeon is in just the same relation to a business and the employees as is the electrical repair man who replaces the fuse and looks after short-circuits. What is needed is a doctor, a combination general repair and safety engineer, to look after the human machinery, to study stresses and strains on it, to give warning of a probable breakdown, to advise easing up on the load until the human mechanism has been readjusted, to do the hundred and one things that make for comfort of mind and body.

COST OF ILLNESS TO CAPITAL AND LABOR

When we are told by investigators that only one industrial worker in five in need of a physician calls one, we may know what this shortsightedness in them is costing in lost time. We may also know what great service the industrial dispensary may render.

The loss of wages to the worker on account of preventable illness runs annually to the billion dollar mark. To the employer the loss must surely be twice that amount when we remember what a large part bad health plays in inefficiency, in irregularity of attendance, with its consequent poverty and low standard of living, in its frequent shifting from job to job, in its undermining of character and stability, in inducing alcoholism and other vices. The man struggling against a physical defect uses up every ounce of energy and loyalty to support his family. Can he have any loyalty left? Is it human to expect it?

Are we going to meet this great medical and economic question by the general introduction of the physician in industry or are we going to sit idly by and permit the propagandists to persuade our legislators that compulsory sickness insurance alone will assure every worker adequate medical service. I personally disbelieve that compulsory sickness insurance will produce that result, but this legislation is inevitable, unless industry grasps its opportunity and shows society that it is willing to undertake a method of health insurance through its own dispensaries, whose costs will be negligible compared to compulsory sickness insurance and whose results for national health will be infinitely greater. If business isn't big enough to see the social and economic advantage of some system of self-imposed compulsory medical supervision of employees, then some of the most staunch opponents of compulsory sickness insurance will have to become its active proponents.

The industrial dispensary will lessen disease, increase the number of working days as well as working capacity and thereby increase the purchasing power for adequate medical service for the families of the workers. Medical care in industry is not a charity. It pays the best dividends of any department in business. It secures a new arm to the health department and makes possible preventive medicine on a scale yet undreamed of. Witness the reduction of 75 per cent of the lost time on account of illness in the employees of the Norton Company who use the medical department. In attacking directly such problems as personal hygiene, bad housing and living conditions, alcoholism and venereal disease, it will make a real contribution to national health and social welfare. It will immediately help cure the legislative mania with which the American people are cursed.

DISCUSSION

R. G. Williams emphasized Dr. Geier's statements, citing The Norton Grinding Company, which for a number of years had been practising a good many of the things Dr. Geier advocated. This company had an industrial health department, and it was just as indispensable as the telephone. They could prove to anyone interested that it was a dollars and cents proposition. As an example, soon after the department was installed and the men were just getting confidence in the work, an epidemic of grip broke out in the town. About half of the men who developed symptoms immediately got in touch with the plant physician; the other half did not, but held off as long as they could, and eventually lost considerable time. The men that used the hospital lost on an average 19.2 less hours per man per month than the men who did not.

Frank B. Gilbreth said that he wanted to emphasize one statement in this remarkable paper, not with the idea that it was the most important, but that that one thought would warrant the paper even without the rest of its contents. He referred to the conservation of industrial workers.

"We are very much interested in the work of conservation of industrial workers who have been crippled both in the war and in the industries," said Mr. Gilbreth. "It will probably surprise you to know that in Canada the number of cripples who return from the war is not as great as the number of industrial cripples for the same length of time in Canada. Statistics showing this may be obtained from those in charge of the re-education of the soldiers in Canada. Statistics from our own country are published in a remarkable book to be obtained from the Commissioner of Vital Statistics of the State of California.

"In the work that we have been doing with the coöperation of people in foreign countries, we have found a tremendous number of jobs for crippled soldiers as a result of which they can practically date the beginning of their financial prosperity from the time that they were injured. The work undertaken in finding occupation for these industrial cripples has been successful to an extent that has been perfectly astounding, and the same thing will apply to placement of re-educated industrial workers, if they are given proper attention.

"The great need is for adequate teaching, and this need can best be met now, when the subject of the cripple holds worldwide interest. Immediately after the war began I went to Washington to try to get a bureau started somewhere that would take up the question of providing teachers for crippled soldiers, with the idea of training them so that we could properly handle the cripples that will come back to us. It takes two years to teach anyone to handle the best methods of teaching cripples and it is absolutely necessary to make preparations *now*.

"Mistakes have been made in other countries in the matter of teaching crippled soldiers, where they have often been taught to make baskets, because the vocation of basket making might have been the only one that the teacher could teach.

"The cripple must be taught *not* primarily what the untrained teacher wants to teach, but *what he needs to learn.* He must be provided with an occupation that develops him mentally and physically, and that satisfies his desire to do "a man's job."

"It is the duty of this Society to see that the training for efficient teachers is provided not only in the schools and colleges, but also in the industries. The teachers must know how to prepare the cripples to go back into our shops and offices—must be able to furnish practical as well as theoretical knowledge.

"Then, when the need for re-educating war cripples is over, they can turn their energies to the cripples of the industries, to whom Dr. Geier has so eloquently called our attention."

F. A. Geier closed the session with a word of appreciation. He said it was the Local Committee that decided on what the program should be for the session, and he was very happy to feel from the applause that the subjects were well chosen. It was the Committee's purpose to impress upon the members of the two associations at this particular meeting the great value and their very great obligation in the matter of considering the worker in the shop.

They had had papers in both societies on the construction of buildings, on the construction of intricate mechanism, and on increased production. But the main thought among the Cincinnati Section was that they would like to impress those present that there was now the greatest opportunity put before them, namely, the earnest and sincere study and investigation of the human element.

FIRST MUNITIONS SESSION, ALL DAY WEDNESDAY

THE feature of the Spring Meeting which proved of great interest from the professional standpoint was the topical discussion arranged by the Committee on Meetings on the Fundamental Problems Involved in the Manufacture of Munitions. It was planned to have two sessions for this discussion, on Wednesday and Thursday mornings, May 23 and 24. The subject was considered so important, however, and the interest was so sustained that the Wednesday morning session was continued throughout the afternoon of that day, in spite of the fact that a boat ride on the Ohio River had been arranged by the local Committee for Wednesday afternoon.

The attendance at all of the sessions was large, numbering at times as many as 300. President Hollis, who presided at the beginning of each session, called to his assistance as chairmen L. P. Alford of the Committee on Meetings and John H. Barr, Manager, and William B. Jackson, Vice-President, Am.Soc.M.E. Representatives of the Government in attendance were Lieutenant-Commander R. R. Adams and Major P. S. Bond.

The initial discussions, or papers, published in THE JOURNAL for May, touched upon some of the vital problems which manufacturers of munitions have to meet, such as munitions contracts and their financing, organization and procuring of special machines, designing for quantity manufacture, procuring materials, limits and tolerances, gages and small tools and inspection.

There was a strong sentiment at the meeting in favor of some action by the Society of a constructive nature which would be helpful alike to the Government and to those who might be called upon to manufacture munitions.

A deep impression was made by representatives from Canadian manufacturing plants, who emphasized the importance of coöperation among manufacturers, and the pooling of information by manufacturers for the benefit of all concerned,—in other words, coöperative manufacturing as carried on in Canada, as opposed to competitive manufacturing which has prevailed to so large an extent in this country.

Naturally, there was much interest in the relations of the small manufacturer who might be a sub-contractor for the large manufacturer. There was considerable discussion also, as to the possibility of the Society becoming a clearing house for information, even to the extent of undertaking the collection and publication of data upon the manufacture of munitions in the form of a handbook or otherwise.

In order that the discussion might be without restriction and of the utmost benefit to those in attendance, it was agreed that where requested the remarks would not be reported. In several instances this desire was carried out.

At this session the following papers were presented, the first three in the morning, and the last three in the afternoon:

MUNITIONS CONTRACTS AND THEIR FINANCING, Frederick A. Waldron.

ORGANIZING FOR MUNITIONS MANUFACTURE, Arthur L. Humphrey.

ORGANIZATION FOR MUNITIONS MANUFACTURE, Harry L. Coe.

PROCURING SPECIAL MACHINES FOR MUNITIONS MANUFACTURE, H. V. Haight

PRACTICAL WARTIME SHELL MAKING, Lucien I. Yeomans

THE DESIGN OF MUNITIONS FOR QUANTITY MANUFACTURE, J. E. Otterson.

GENERAL DISCUSSION: REMARKS BY LIEUT.-COMMANDER R. R. ADAMS, U. S. N.[1]

Lieut.-Commander R. R. Adams, U. S. N., who attended the meeting as the official representative of the Bureau of Ordnance, said the policy of the Bureau had been to direct its representatives "to coöperate with the various manufacturing firms to which they are accredited in every consistent and proper manner." It had also given directions that the inspector facilitate the manufacture and expedite deliveries wherever possible, provided that satisfactory and acceptable material was procured by the Government. To accomplish this in every instance was impossible, but by the exercise of tact and patience in the case of firms unacquainted with Government methods and requirements, it was believed that many of the difficulties which would ordinarily crop up could be eliminated.

The Bureau desired its representatives to advise the firms in their district as fully as possible, and where possible to make decisions within the scope of their professional knowledge as to the suitability of the materials to be used.

Even with these instructions, cases would arise which had to be referred to the Bureau of Ordnance, but by the use of telegrams and long-distance telephones for important decisions serious delays in manufacture could be eliminated. The Bureau had requested its representatives to make suggestions to the manufacturers, where it was thought that such suggestions would be of assistance, or to give any general information which would help in the manufacture of material required by the Government. Information was volunteered if it would aid manufacturing processes and at the same time did not violate confidential matters disclosed by other firms. But matters of a confidential nature which had been confided to the Inspector were not to be divulged under any conditions.

The Government representative or his inspector was directed to assist in the manufacture of material as far as practicable in addition to inspecting it for acceptance, where such assistance was requested. Our country desired to prevent trouble with regard to new munitions plants such as was experienced in Canada for some months after the outbreak of the war. Many munitions plants in Canada failed to turn out satisfactory products because of lack of coöperation among the plants. This had finally led all plants to pool their experience, and the success of one plant was followed by others until all had the necessary experience. This should be done in this country in the near future, and all information and experience required for the manufacture of munitions should be pooled by the different plants so as to assist other plants, especially the new ones.

Reuben Hill commented on present conditions as they existed in this country with respect to the war, and gave sound advice to those who earnestly desired to serve the Government. He spoke from his experience in munitions manufacture in Canada, and had the closest attention of the audience.

The speaker deplored the apparent apathy in relation to the organization of our industrial forces to support those men that we must necessarily and immediately send forward to the front. He also took the view that the general public were not taking the situation seriously enough and that they would not realize the gravity of the situation until the men that we had sent to the front had been killed. This was based on the fact that the people in Canada were living very close to the war;

[1] Inspector of Ordnance, Munhall, Pa.

[illegible] words, they had been "burying their dead." Therefore they realized how essential it was to back up the men at the front with sufficient material and munitions in order that a great deal more might be accomplished. He also referred to the sad conditions of the past, which was general history now, in relation to the bad start that Great Britain and France made by allowing the best men to push to the front at the beginning, and thereby crippling the maintenance of the industrial support.

He further emphasized the necessity of prompt and immediate attention to the organization of the industrial forces which was necessary now, suggesting that the Government take a more coöperative and guiding activity in relation to the manufacturer, thereby departing from the peace-time methods of arbitrarily giving a contract, and then at a certain time sending some one forward to inspect the work, and either arbitrarily accepting it or rejecting it.

He also advocated that the Society, by reason of its membership in practical engineering, should be of great assistance to the Government in formulating an ideal coöperative industrial scheme, similar to that prevailing in Canada, with the Imperial Munitions Board.

Frank B. Gilbreth emphasized the importance of recording all details, including the time element, with respect to industrial operations, and referred to the use of the micromotion film for this purpose. He said in part:

"We hear much of the loss of information to the world when the great library at Alexandria was destroyed, but we hear little or nothing about the wonderful amount of information in the heads of our workingmen, who have not been properly trained to pass on that information in literary form so that the public can get the benefit of it.

"The best method of doing any kind of work does not lie in the consecutive acts of any one worker, but is synthesized from records of methods of many expert workers. When these skilled but uneducated experts referred to die off without passing on their information in any way, the best elements of the methods that should be recorded and passed on are lost to us forever.

"There has been some confusion between the ordinary motion picture film and the film used in making micromotion study. The micromotion film is the result of placing a timepiece that records the *time* element, and a cross-sectioned screen that records the *space* element in the field of the method to be photographed. The pictures are taken at varying rates of speed, and are then projected at the speed at which they are taken, at slower speeds and at more rapid speeds, in order to get different views of the operation being studied. The pictures are studied one at a time, the film being run forward and backward, and a cycle of motion being reviewed as many times as is desired. The two aims are, first to get all possible detailed information on the film, and second to get this information off the film and into the simultaneous motion-cycle charts, or such other form as will aid in transferring the information most easily and most efficiently to the learner. The stop watch can make no such adequate records as this. I would urge that all observations should be made once for all by the most scientific methods possible."

Harry E. Harris told something of the industrial mobilization carried out in Fairfield County, Conn., the county in which Bridgeport is located and which has been called the "Essen of America." He said in part:

"On April 4 the manufacturers in the county held a meeting with the members of the chambers of commerce, boards of trade, philanthropic societies, granges, and the Farm Bureau and organized a patriotic association which expects to raise in the neighborhood of one hundred thousand dollars from the people of the county and to have a membership which will embrace every man, woman and child.

"The object of this association is coöperation and there are six chief departments: Manufacturing, Transportation, Industrial, Relief, Welfare and Agricultural. The Industrial Department, which we are interested in as engineers, has ten divisions of work, one of which is the establishment of an interchange of measurements. The different manufacturers who have facilities for measuring have offered them to the association and experts in measuring who reside in the county have offered their services. Committees have been appointed which are already working in conjunction with Dr. Louis Fischer of the Bureau of Standards. The Association has offered its assistance to the Bureau of Standards and to the different manufacturers with a view to securing accurate local standards and means of measurement. It will be the aim to work in conjunction with the different Government inspectors.

"There is a committee for securing the coöperation of labor, one on industrial efficiency, and one on the training of employees."

Lieutenant-Commander Adams in response to an inquiry as to what could be done to facilitate delivery of material, said that the steel-manufacturing firms in this country had authorized the Government to call on them for certain amounts of steel at a fixed price: but at the present moment most of those firms have been filled up with Government material. He said that there were a number of steel firms throughout the country that were not doing their part. That question was being considered in Washington, and would probably be taken up in the near future. If any firm in his district had difficulty in getting steel, he took it up direct with the steel corporation in the district and had so far succeeded in getting steel within 90 days, sometimes in two weeks. The question was being considered at Washington of giving more power to some Government official who would have power to assign certain deliveries of steel to certain plants at a fixed price.

President Hollis urged that some constructive action be taken by the meeting as the most obvious thing to do, inasmuch as the men in attendance represented the productive industries of the country. He suggested that a committee be appointed to draw up resolutions for consideration at the next session, offering helpful suggestions to the Government and possibly suggesting the establishment of an effective central bureau on the whole subject of gages. He believed it was most important that some such action be taken by the Society to help accomplish the thing that Canada and England have required a long time to bring about, so that there would be fewer mistakes to start with.

W. H. Carrier expressed his approval of the suggestion by President Hollis and said that he himself was about to suggest a coöperative board to determine what mechanical manufacturing problems could best be handled by the engineers and manufacturers of the Society. Such a board should take a census of the membership to determine what the individual members were capable of doing, to find out which of them were specialists in different lines that would be useful to the Government—in short, what the problems were and who were the men to solve them.

As a result of a motion by Harry L. Coe, it was voted to ask that a committee be appointed to draw up resolutions.

DISCUSSION ON MR. WALDRON'S PAPER ON FINANCING

In presenting his paper Mr. Waldron spoke of the financial protection required by a manufacturer in taking a contract from a foreign government. If it were simply a business firm with no tangible assets in this country, the usual practice would be to have an advance payment to cover the expense of preparation and to insure against financial loss. In turn, the government advancing the money must have suitable security, which might be in the form of a bond. In many cases the hugeness of the contracts had not been fully appreciated and they had been undertaken with a smaller advance than would have been demanded under similar conditions in the conduct of the regular business of the firm. In particular was one contract of \$84,000,000 taken with an advance of \$10,000,000, which, while it seemed like a large amount, was only 12½ per cent of the total. Later the advance had been increased to \$12,000,000.

R. Poliakoff[1] said that Mr. Waldron had mentioned the fact during the presentation of his paper on financing of munitions contracts that a concern had taken a contract for \$84,000,000 with an advance payment of only 12½ per cent of the total value. He did not know what concern Mr. Waldron had in mind; but he knew of a similar case of a contract of \$84,000,000 and with the same advance payment of 12½ per cent, or \$10,000,000.

It was assumed that a contractor who entered into a munitions contract took also upon himself a certain moral obligation, because the equipment of the army depended every day on that contract, and any delay in the execution of the contract became a serious matter. Could a foreign government be blamed, then, when it gave a contract of \$84,000,000 and did not advance to the contractor, say, \$30,000,000 for which he might ask, especially if the contractor before the war had been rated as a concern with a capital of from one to three million dollars?

Of course, a guarantee for that advance payment could be secured, but how? Well, by surety bonds. But according to the last information of the Treasury, up to August 15, 1916, there were in this country only twenty-six surety companies, with a stock capital of about \$27,000,000 and a surplus capital of \$20,000,000, making a total of about \$47,000,000; moreover, according to the law of this country, none of these companies was allowed to issue surety bonds pertaining to one contract to the aggregate amount of more than ten per cent of its capital and surplus. This meant that even if all the surety companies in the country should pool surety bonds to the largest amount possible, in order to protect one contract, the sum would not exceed \$5,000,000. He certainly hoped that in the new contracts some other method of financing and some other method of advance payment would be devised. For it was no easy task to get back money from a contractor who did not live up to his contract.

Again, Mr. Waldron had stated that some contractors had been trying to get contracts even with very small advances, and that these small advance payments must be considered perhaps as one of the reasons why the contractors could not go on. But this was because the contractor could not ask for financial assistance from his bank unless he had the contract in hand. The bank would not give him money unless he had a contract which could be used as a guarantee to protect the bank. Thus the contractor would try to get a contract even with a small advance payment. Therefore small advance payments were by no means the reason of failure of some of the contractors, and the true cause of such failures had to be attributed to different reasons.

Professor Poliakoff, speaking at a later session on Mr. Walsh's paper on The Inspection of Munitions, referred to the points he had made in his discussion of Mr. Waldron's paper for the reason that both writers spoke of the same contract. The Professor said he was authorized by the Russian Government to state that a printed statement concerning Mr. Walsh's remarks was in preparation, which, with the consent of the Publication Committee, would be contributed later to THE JOURNAL.

[1] 111 Broadway, New York. (Assistant Professor of Mechanical Technology, Technical Institute, Moscow, Russia.)

DISCUSSION ON ORGANIZATION, BEARING PARTICULARLY ON THE PAPERS BY MESSRS. COE AND YEOMANS

James Hartness spoke in commendation of all the papers, and particularly of Mr. Coe's contribution on the subject of Organization. He spoke from personal knowledge of the energy, persistence and practicability which Mr. Coe had displayed in reorganizing work for the company with which he was connected, and said that the principles outlined in the paper were worthy of the widest publicity at this time.

H. B. Coho[2] (written), who was in charge of the business organization of the United States Cartridge Company's plant at Lowell, Mass., explained the system of coöperation which they had instituted. Their working force had been increased from 300 to 8400 in considerably less than a year, and their output from 100,000 a day to 2,000,000. They were fortunate in procuring the coöperation of the machine builders, and in having a man in their mechanical department who was not only familiar with cartridge manufacture, but also had a big enough vision to see what would be required so that orders for supplies could be placed ahead.

The company was favored by having available for its work an intelligent class of operatives, who realized that success or failure rested almost solely upon them. In appreciation of their special efforts the company introduced many factory betterments, such as free medical attendance and examination, restaurant facilities, rest rooms for the women workers, first-aid and safety-first. Great attention was paid to a welfare committee, which was organized from among the workers themselves. The labor department, through which all of the 7700 odd people were procured, took the trouble to show the prospective employees the advantages they would derive in this plant over those to be derived from manufacturing plants in other locations.

The services were secured of a great many young men who had been educated as efficiency engineers at the Massachusetts Institute of Technology. The firm had found the difficulty with efficiency men to be that they had cure-alls for everything which they discovered to be wrong, but comparatively little original experience on which to base their experiments. They were, therefore, told that it was not a case of providing medicine for a sick institution, but rather an opportunity to take one department and organize it so it would be synchronous with all the other departments and form a useful cog in the wheel. Results spoke for themselves, as it was now one of the best organized small-arms-manufacturing plants in the United States.

One thing that contributed to the success of the organization was a system of conferences of the various shop committees.

[2] United Lead Company, 111 Broadway, N. Y.

The meetings were conducted along parliamentary lines and a competent stenographer was always present.

A. B. Reynders[1] sent a communication endorsing the statements in Mr. Coe's paper and outlining briefly a method used by his company in the manufacture of high-explosive shells, which secured a large and continuous production after the equipment and operating force had been organized. The method embodied the following features:

1 Piece-work system of wage payment to machine-tool operations. This contained a differential factor; that is, the price per piece increased with an increased output.

2 A liberal bonus system to the supervisory force based upon the following:

a Quantity output

b Expense

c Man efficiency, that is, the ratio of the workmen's earnings to their day rate.

3 A load or bogey set at the beginning of each month for

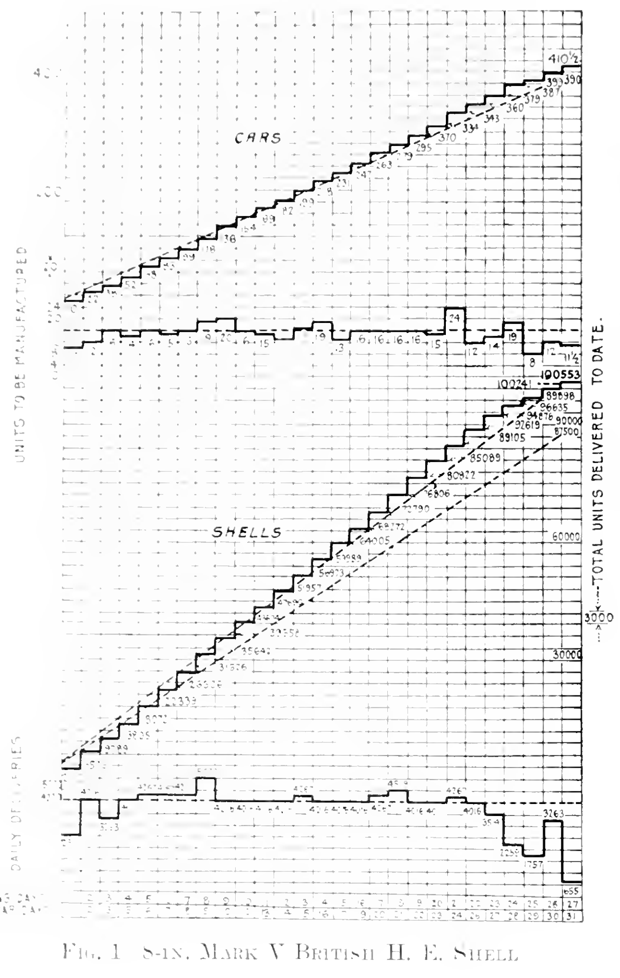

FIG. 1 8-IN. MARK V BRITISH H. E. SHELL

the desired output for that month. This bogey was shown as a diagonal line, as drawn on the accompanying chart, Fig. 1. Each day's output was charted in a step curve.

If the corner of the step touched the diagonal line, production was up to requirements. These charts were fastened to boards and distributed throughout the factory where they could be seen by all of the supervisory force. When the output was satisfactory, the common expression was that they were "hitting the line."

[1] Director of Production, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

4 In addition to the visible charts for keeping a record of production, a tabular record by operations was maintained. This was reviewed each morning by the manager or superintendent. Any abnormally low output of any operations was immediately checked to see if it was temporary, and if permanent, corrective measures were applied. It was found that this check has to be kept up continuously, as a failure to do so usually settled into a chronic lack of results.

5 An adequate supply of material had to be maintained for continuous production. This meant a large storage space, careful checking with the suppliers of materials, transportation companies, and frequently manufacturing the material by the company itself.

H. G. Bertram wrote giving an account of the organization of the plant with which he is connected (the John Bertram & Sons Company, Ltd., Dundas, Ont.) for the manufacture of 8-in. British howitzer shells. Their regular line of work is machine tools, but the organization for the manufacture of shells is entirely separate.

Upon receipt of their order, the major operations were outlined and the production expected per machine at each stage. Orders were then placed for the necessary machinery and the dimensions of machines secured to which it was expected to fit attachments. As the lathes were purchased without special equipment, great perseverance and close application to the smallest details were required so that the lathes would be ready to run when put under the belt.

Their working gages were made in their own shop from blueprints supplied by the Imperial Munitions Board. When these were ready and the equipment was fitted to one machine in each operation, a shell was carried through at once to see that everything was satisfactory and the finished shell produced was up to standard. Minor changes were made, and half a dozen forgings carried along to see that no failure was likely to crop out. During this time other machines were being installed, and by the time the fixtures had proved satisfactory a start was made on a larger scale.

Following then Mr. Coe's paper, the organization, wrote Mr. Bertram, is made up as follows:

1 GENERAL SERVICE DEPARTMENT:

a Records and Accounting. This is a bookkeeper's work. The shop is charged with components received and credited when shipments are made. In addition, a record is kept of the disposition of all the shells in each heat. The necessary records are sent in from the various departments, such as receiving, shipping, inspecting, etc. The value of these records should not be underestimated, and all information regarding the shells should be carefully filed.

b Purchasing and Stores. The former is handled by the regular shop staff, while the latter is under a special clerk, who checks all shipments coming in and going out and sends a report to the Accounting Department.

c Designing and Drafting is still looked after by the department that got out the tools and fixtures, but with a much reduced staff.

2 DIPLOMATIC STAFF:

This is a very necessary department and is handled in our works by the sales engineer. Quite often the members of the production or engineering staffs are so worried by a breakdown or other troubles that they have not the time to give visiting officials or manufacturers the proper attention. Our sales engineer actively coöperates with the Engineering Department in outlining the machining operations and equipment, and is in a position to give all the necessary explana-

tions. In this way visitors are entertained without interfering with production.

3 PRODUCTION DEPARTMENT:

a Maintenance of Equipment. Orders for repairs are handled by the original Engineering Department, as they are directly in touch with the various designs, and know whether or not a broken part should be strengthened. They also have the necessary tracings or drawings.

b Operation of Equipment and Training of Workmen. The operations were subdivided into seven small sections (this has later been reduced to six), and placed at the head of each section is a mechanic drawn from the regular shop force. These men are paid a good salary and bonus on shipments, and it is their duty to teach the new operators, many of whom never ran a machine before, to keep the heats running through in order, to watch their machines for failures and check them frequently with indicators to insure perfect work. They are also encouraged to keep a notebook and jot down anything unusual about any of the work going through their department.

c Establishment and Operation of Wage Payments and Penalties Systems. The piece-work system is introduced as soon as records could be figured on. The prices set are fixed for the first order only. Each man is handed a slip daily showing what he earns, so that all errors can be immediately corrected.

Penalties are established, and, while the price is a small part of the cost, it tends to make the workmen more careful.

4 INSPECTION DEPARTMENT:

The Chief Inspector is chief inspector in the machine-tool department. He looks after the Operation Inspectors, checks all gages frequently, sees that the sub-foremen correct promptly any errors in workmanship which might develop, and, being a first-class mechanic, he keeps generally in touch with all branches of the work.

Operation Inspectors receive the shell after each operation, and, after gaging, stamp their mark after the operator's letter or number. Their report at the end of a run is used to check the operator's production cards. They are instructed to insist upon "quality" before "quantity."

On the 8-in. shell the rough turners have no limit allowed—the inside boring bars are set in the tool room and are between the mean and the high—while no limit is allowed for finish turning. In this way all the shells are cut to the same length over all, instead of weighing each and then cutting to suit.

In many other cases the limits allowed the workmen are reduced.

An inspector goes over the shells before the Government preliminary inspection, and also before the final Government inspection. The final shop inspector has the only shop scales used on the 8-in. shells, and it is a rare thing to find a shell over or under weight.

A special inspector, called the Steel Inspector, watches the forgings, especially after rough turning, for seams or cracks. In this way defective forgings are cut out immediately. The Steel Inspector sends a "defective" record to the shop stores clerk, who checks the shells into the yard and sends the records on to the Accounting Department, where the number of defectives is charged against the various heats appearing on the record.

Discussing Mr. Yeoman's paper, Mr. Bertram said that the greatest difficulties to be encountered by the prospective shell manufacturer were lack of appreciation of the magnitude of the work and lack of organization. The average manufacturer could not hope to equip and bring a large plant up to capacity in less than five or six months. In his own plant, after having practice on two smaller sizes of shells, they prepared machines, tools and gages for 8-in. shells, and thought they did very well to make shipments in about four months after receipt of order. Continuing, he said:

"The statement that an entire plant can be erected, fitted up and operated to capacity in sixty days is most unusual, and would call for explicit information regarding deliveries of material which, unfortunately, is lacking. The feat might be accomplished if one were able to command all avenues of supplies; but being dependent, as one is, upon so many different concerns, each one of which is being held up in turn for want of raw material, strikes and other troubles, one might well cry that it is impossible.

"However, the present war should not require the establishment of such mushroom factories as outlined by the author. There are already many shops fitted for the manufacture of shells, and thousands of others with their organizations, money and machinery, ready to place all at the disposal of the Government; and I truly believe that these shops, with their loyal following, will be able to handle the munition work more economically than shops held together by mercenary officials.

"The type of plant suggested is open to criticism. It presupposes the use of machine tools with a single-pulley drive, with the pulley conveniently located for belting horizontally. This brings up the question whether it is easier to erect a building suitable for all machinery or build machinery suitable for all buildings, or none at all. In starting up a shell plant, engineers without previous experience at their command on the particular size of shell under consideration often prefer cone-driven machinery, owing to the greater range of speeds and feeds obtainable (especially by the use of a two-speed countershaft)." As to leaving the machines exposed, Mr. Bertram said "this would be quite satisfactory in summer if it were not too hot or did not rain, but I suppose sunshades could be supplied at a reasonable cost and operators could be requested to bring their own umbrellas."

Ralph E. Flanders offered some information with reference to 15- and 18-lb. shells, which he believed to be authentic. He said: "We have more than enough shop capacity for their manufacture: at least for our own use. The capacity that has been developed for the English and Russian contracts far surpasses the largest possible consumption that our 15- and 18-lb. guns can take care of. For this reason our attention will probably be directed toward the increase of the gun output on the one hand, and, on the other, toward making larger sizes of shells from 4 in. in diameter up."

In reference to the point mentioned by Mr. Bertram in the discussion of Mr. Yeomans's paper that the most valuable single asset of any firm starting or contemplating the manufacture of anything was its organization, Mr. Flanders said this should be strongly emphasized as a general principle. "This does not mean the paper organization or certain forms and methods of doing business, but the vital organization of a group of men who are used to working together, who know each other, and have a fair degree of knowledge about their jobs. They do not all have to be wonders. They do not all have to be 'top-notchers.' But if they are ordinarily earnest, intelligent men, who have been working together for a number of years, and know each other, they will eventually accomplish more than can be effected by an organization of the greatest group of experts in the country who have never seen each other before."

He was sure that in contemplating work for the Government in this crisis, we must all count on our organizations as being

[illegible] things we could offer to the Government. We would [illegible] from patriotic grounds of anything that would tend to [illegible] up these organizations in their vital [illegible].

DISCUSSION ON COÖPERATION AMONG MANUFACTURERS AND THE POOLING OF INFORMATION

The reference by Lieut.-Commander Adams, in his remarks before the meeting, to the coöperation which now existed among Canadian munitions plants, and to their practice of pooling information, led to a general discussion of this subject.

Secretary Rice believed that the point brought out by Lieutenant-Commander Adams in respect to the free interchange of data among Canadian manufacturers was the most important that had developed during the convention. In Canada every citizen not only had a right to go into the plant of every manufacturer of munitions to witness the processes of manufacture, but was cordially invited to do so and if he could improve upon the processes, he was privileged to proceed with the manufacture of munitions on his own account, through the information which he has secured, for the common good of the Dominion.

As President Hollis had emphasized in every way possible, and in doing so he has been an inspiration to the Society and to the profession, the supreme effort at this juncture should be for the engineering profession as citizens of the United States to work for the common good of mankind.

William Kent asked if the Government had a bureau to which a manufacturer could apply for information as to the best way of doing a particular machine operation. The case in point was that of a manufacturer doing Government work, who had been experimenting to find out the best way of accomplishing it, but who did not know if the same work had been done before, or if done, by whom it was done.

Lieut.-Commander Adams replied that the proper way to handle such a question would be to take it up with the officer inspecting the material, who would write to the Bureau for the information. If available, the Bureau would inform the company through the inspector where the work was being done, and whether the process could be seen or whether simply a written description of the method would be all that could be sent to the Government.

Reuben Hill, in further answer to Mr. Kent's inquiry, explained the way in which such matters are handled in Canada. He said:

"The Imperial Munitions Board of Canada is organized to create a spirit of 'help one another' among the munitions manufacturers of Canada. Very frequently we have received letters from the office of the Imperial Munitions Board asking us to permit other manufacturers to visit our works and investigate our methods of manufacture. This has been freely permitted, since the Board has explained that the output of a certain number of firms would in any case be required in order to secure the necessary production, and that information given out would in no way affect the amount of work which firms would do individually.

"Prices which the Government pays are known to each of the manufacturers, which still further removes any doubt as to competition. For instance, we have devised a certain tool which has been very useful in obtaining great precision in time-fuse making. Concerns hearing of this, write us asking whether we will send them blueprints of such tool. We make no fuss over it, but immediately mail them the blueprints, at the same time asking them if they require any further information.

"A few weeks ago I had a little doubt as to one of the processes in the manufacture of time fuses. A concern in Toronto very willingly permitted me to send a representative to its plant to inspect the manner in which it performed this particular operation. Shortly afterwards we received a letter from this concern stating that it appreciated the visit of our man and that it would be pleased to do anything for us, and invited us to pay an additional visit. This is the correct spirit to maintain among manufacturers, and, as I stated, this Society should be the main factor in inculcating this spirit in the United States.

"I distinctly remember that at the commencement of our fuse making I paid visits to several concerns. One of the things I was most interested in was the correct formula for the mixing of brass, in order to obtain the necessary tensile strength. It was impossible for me to get any manufacturer to explain his formula, as he considered it a shop secret. Today there are no secrets at all in relation to this, inasmuch as everybody in Canada knows the exact formula and the way to work the metal. Unquestionably, should this Society start a coöperative spirit of this kind with the Government it would prevent many delays, and, individually, I would willingly undertake to assist the Society in any way with regard to types of machines or designs of tools that would aid in the manufacture of fuses."

Frank O. Wells was in sympathy with the idea of this organization helping the Government and of getting together to supply it with proper information. As he understood it, before war was declared no Government official could add to his force in any way, but the minute war was declared they could not find room enough for the officers in Washington. Thus the Government should have all the help possible from this organization and others similar to it.

Mr. Wells was informed recently by a naval officer in Washington that they had four times the capacity necessary to make shells up to and including 6 in.—four times the capacity of their needs. Whether that was correct or not he did not know, but the officer was in a position to know. Regarding the pooling of information, he was sure that many did not know that the Government had had officers in the different factories gathering data for the use of manufacturers.

Mr. Wells believed that all should coöperate, and that he himself would be only too glad to welcome everybody to his factories; in fact, cards had been issued asking all to come. Instead of each manufacturer experimenting individually, why should not the Government organize a clearing house to serve all manufacturers?

Chester B. Hamilton, Jr., contributed from his experience with the system of coöperation in vogue in Canada. He said in part:

"We were lucky in not having started on the competition basis at all. The shops began by sharing ideas when the orders first began to come through. I think there is not a single shop which refuses information that would tend to increase the capacity of the whole. Any of you who will come to any of our shops in the Dominion will get a thorough welcome.

"I do not know how it is proposed to handle the general contractor question in this country. The larger shops experience many difficulties in doing the work required on fuses, cartridge cases, primers, and the various components of the shells themselves. It is a man's job to look after a shop doing

any one of those things; and the shop where the boss knows the individual will get out delivery ten times faster than a large corporation. In Canada, the Imperial Munitions Board is the general contractor, and buys all the material and turns it over to the component contractors. They make their components and account for the material under inspectors employed by the Imperial Munitions Board. The component parts go, according to the directions of the Imperial Munitions Board, to the various machining and assembling plants, where they are to be worked upon and again inspected and counted, and then shipped on to the loading station, where the fuses and explosives are added. At the loading stations they also receive cartridge cases, primers and propelling charge, and there the completed round is turned out. In short, it amounts to a system of subcontractors, with the Imperial Munitions Board as a general contractor. The plan works out well, because nobody tries to do up somebody else or steal his profit. We are all knit together; it is all in the family.

"As for gages, there are not tool makers enough to make them. We have a few, and the rest are good machinists that are willing to take instructions and be as accurate as the requirements call for. It is the same way in the production department on the munitions themselves. We are running with about two mechanics to a gang, a foreman and a deputy foreman, or instructor; the rest are anything or anybody that we pick up. A good many of them are returned soldiers, wounded men who have recovered from their wounds but are not fit for further service at the front. We see the boys that we worked with last year coming back in pieces. Some of them are able to work at a new trade. We are trying to work them in as well as we can for single operations or repetitional work. Men that are maimed in one member or another can usually be fitted into something within their capacity.

"The first question that Mr. Waldron brought up with regard to the advance payment is not as severe under our method of organization where the Government owns all of the material. We touched the low-water mark, financially, at about sixteen per cent of the value on our first contracts. Size of contracts is unimportant. I do not know how many contracts we have had. It is a continuous system flowing straight through. Anybody figuring otherwise is working on a wrong supposition.

"There is a whole lot more I would like to tell you, but I do not want to go on too long. But wake up, wake up! You are up against a far bigger thing than you have any idea of now: Get the coöperation idea into your head, the idea of working together, not as units or individuals, but all working together."

Ralph E. Carpenter said he personally knew that the Army was working in conjunction with the Bureau of Standards to establish just such a Central Inspection Bureau as had been suggested; and also that the Bureau of Standards was waiting for legislation that would give it increased appropriations. Now it was absolutely tied hand and foot for funds. If this Society should draft a resolution to the proper authorities at Washington that would lead to the appropriation of funds, something would be accomplished which would be modeled after the scheme used in Canada. There would be a bureau for the inspection of gages and the establishment of standards which would assist everybody engaged in the manufacture of munitions.

Mr. Carpenter voiced the sentiment of the manufacturers of this country by saying that they were all willing to coöperate to the fullest extent with every facility that they had at their command, but that the extent to which they would coöperate depended upon the attitude of the Government. At the present time the attitude appeared to be one of competitive bids, which naturally produced competition, but eventually he believed the authorities at Washington who were interested in the manufacture of munitions would work out a comprehensive scheme which would largely eliminate competition.

During the past year the various engineering societies had made every effort to canvass the whole country as to the facilities that were available in the various plants. At the Frankford Arsenal, Mr. Carpenter gathered the impression that they already had a tabulation of all the available facilities and what they could be used for. They were also disposing of some big contracts for the smaller sizes of artillery ammunition. These contracts were being placed with manufacturers who had facilities for doing that work, and eventually they would require the aid of almost every shop in the country.

DISCUSSION ON THE OPPORTUNITIES AND DIFFICULTIES OF THE SMALL MANUFACTURER

E. F. Du Brul said that he had considered the discussion from the point of view of the small manufacturer. In reading different articles dealing with the munitions supply in Europe, he had gathered the idea that practically every machine shop in Germany, Canada, England and France, no matter what its size, had been engaged in making munitions or some war supplies for their respective governments. He had read that many establishments that previously had had no metal-working departments had lathes fitted up in some corner and were turning out shells.

Mr. Du Brul further continued, "It seems from what our Canadian friends said this morning that the smaller shops can produce munitions more quickly than a big organization. In the papers we have had from American manufacturers the contrary seems to be true. The small shop is warned to keep off; but that does not seem to tally at all with the experience in Canada. There the small shops have been turning out large quantities of munitions through coöperation with their manufacturers' association and their shell committees. I think that we ought generally to recognize that in order to help our Government the most, we have first to functionize any activity of this Society along these lines.

"The smaller establishments together employ a great number of machinists and mechanical labor. I remember well that fifteen years ago, when I was criss-crossing the country as Commissioner of the National Metal Trades Association, the man who was quickest to get things done was the man who owned his own business, knew his own business and ran his own business. We always had more trouble with the big organization whose boss was a board of directors than we had in dealing with men who themselves could take prompt action when necessary.

"I take it from talking with others that we smaller manufacturers all want to do our bit, but we cannot find out either what to do or how to do it. It seems to me that we must have talent enough in this Society to work out schemes that would organize these small plants and get their coöperation for national defense. We will never get such schemes from our Government. We must do for ourselves some of the things that the Canadians and British have done.

"Those who heard Mr. Hard talk before the Machine Tool Builders will realize that the British had a tremendous task only to get ready; that they had to eliminate civilian control of purely military matters and eliminate military control of matters of production. The same thing will have to be done here. It is aggravating to think of our Congress wasting time

in providing the lump-sum appropriations which it is the business of Congress to supply. Yet a senator, mechanically ignorant, strikes out an appropriation for gages with the remark that 'gages have nothing to do with the production of munitions.' We, above all others, should do everything possible to eliminate lost motion, waste of time, waste of money and waste of American lives consequent on such stupidity in high places."

Reuben Hill, referring to the previous discussion of the situation of the small manufacturer, said: "I will refer again to the Imperial Munitions Board, which takes a keen interest in the manufacturer, and his progress, and, if necessary, obtains for him any materials or parts, etc., which he is unable to secure promptly. The Board brought over from Great Britain expert ballastic engineers, who are available at any time the manufacturer does not understand certain things in relation to requirements. Should the manufacturer, for instance, in making fuses make a certain hole half a thousandth too large, these engineers are called upon to give their decision as to whether such work is acceptable. Oftentimes, if this deviation does not concern a vital functioning of the fuse, such work may be acceptable, thereby saving the manufacturer considerable expense. Should the manufacturer be temporarily delinquent in deliveries, due to conditions beyond his control, efforts should be made to advance certain payments on his contract, therefore preventing a 'tie-up.' This in turn produces a greater coöperative feeling between the manufacturer and the Government, and at times when the manufacturer would have been forced to quit, he gets sufficient confidence from the relationship between himself and the Government to allow him to overcome what might have been an insurmountable obstacle from his viewpoint.

"Realizing that this spirit of 'give and take' or practical coöperation should exist, it is high time that such methods should be instituted, and, acknowledging that this war is a serious proposition, it is time that all practical information such as described previously should be collated for the benefit of the manufacturer. Broad-minded action, as described above, will oftentimes prevent imperfect work surreptitiously passed through, unknown to the manufacturer, by his own men when percentage inspection is resorted to.

"Any further details in relation to this coöperative action on the part of the British Government I will be glad to furnish if necessary."

M. W. Sherwood, who had been shop manager for a subcontractor of one of the larger concerns making 18-lb. shrapnel, said that the shop had only 250 men, who simply finished the forgings that later were processed by the larger concern. Coöperation between the larger and smaller plants was very satisfactory, although the compensation was not entirely satisfactory. Owing to the poor conditions of business existing at the time, he felt that if some arrangement could be made whereby a standard price could be established and paid; or if the work was taken at a price which subsequent developments proved was lower than the average price paid, if an adjustment could be made to conform to this average, he felt that the small shop would be safe in taking contracts from the large concern, or such portions of the work as they were equipped to do.

F. O. Wells felt sure that the Frankford Arsenal would be glad to give the smaller shops information as to the time required to do the work. He had been there several times and had been very courteously treated.

DISCUSSION OF STANDARDIZATION OF GAGES

Lieutenant Commander Adams replied to an inquiry as to what provision was being made by the Government for the inspection of different parts required in the manufacture of shells, so that all these would conform to given standards. The Bureau of Ordnance would issue an order on the Naval Gun Factory to manufacture master gages, maximum and minimum go and no-go gages for the shells under manufacture. These master gages would be in charge of the inspector and would be sent to the sub-inspector at the works and be there used by the company having the contract as a model for their gages to be used in the inspection of this material. He said that the Naval Gun Factory had master gages showing the required tolerances, and these gages were furnished to any company manufacturing shells for the Bureau. The company would make their gages from the Government gages, and would have access to the master gages in order to check up their own gages.

Reuben Hill through an endeavor should be made to adopt a scheme similar to that used by the Imperial Munitions Board of Canada, which involves a central gage-checking department. This department should undertake the checking of all new gages which were supplied to their inspectors at the various plants. After checking these gages they were recorded in the Government checking department's office with a serial number and issued to their individual inspectors. They were then checked by a traveling gage inspector, who, in turn, was followed by a checker who checked the references and tested the pieces used by the gage checker. This department should also be able to check any working gages of the manufacturers should they tend to create a dispute as to the accuracy between the manufacturer and the inspector.

Chauncey H. Crawford said the idea of a handbook appealed to him strongly. It should include a list of the necessary tools with description, and information as to where they could be procured, their cost, etc. Similar information should be given upon gages required in munitions manufacture.

Mr. Crawford, who is engaged in railroad work, said that his road had thought of taking up the manufacture of munitions, but after investigation found that their shops did not have a single tool that was fit for making shells of any size. He felt that the question of making guns was a still bigger one and that they were even further away from being equipped for the manufacture of guns than they were for the manufacture of shells. He believed that a committee of the Society should arrange a clearing house of some kind, with an officer in charge, and raise money to pay him. He would personally see that the railroad with which he was connected would join in the undertaking, and would urge other railroads to do the same. To obtain an idea of the strong organization which America now has to contend with, he recommended that engineers read Roberts' Monarchial Socialism in Germany.

H. Wade Hibbard said the question had been raised among the professors of engineering in attendance at the meeting as to whether it would be desirable for the Bureau of Standards to establish subsidiary testing stations at the various engineering schools throughout the country, so that the manufacturer who wanted to have his gages tested would not have to send them such great distances. The professors of the universities, while not expert in testing gages, were expert manipulators, so that they could very easily acquire the touch necessary for the inspection of gages. A large gage manufacturer had told him that he would be glad to have several professors detailed

at his plant to be put under the instruction of a professional gage-tester for the purpose of entering into gage testing.

Reuben Hill, in answer to the above suggestion with respect to the establishment of testing stations for gages, believed that a scheme would be necessary similar to that of the Imperial Munitions Board in Canada. He said it would be readily understood that considerable delay would ensue if the Government inspectors' gages had to be sent to a central point to be checked. If the manufacturer should be remote from the central gage station, it was obvious that the delay would be considerable. Furthermore, the Government inspector, not being in a position to check his test pieces, would not know if his gages were wearing. This referred, of course, to these gages which were being used by the inspector and not to new gages. The latter should be sent to the central checking station for initial inspection and registration under serial numbers for future reference.

COLLECTION OF DATA PROPOSED FOR BENEFIT OF MANUFACTURERS OF MUNITIONS

Ralph E. Flanders referred to the discussion at the Machine Shop Session held in the morning, looking toward a collection of data on the manufacture of field artillery. That was regarded as an open question of great importance, and it was suggested that papers be secured at the earliest possible moment for publication in The Journal.

H. S. Bergen, speaking along the same line, suggested the idea of a handbook which should contain a classified list of munitions and of the various methods adopted by different factories making such munitions. If this information were available in convenient form, it would greatly remove the necessity for visiting factories, in cases where there might be objections raised to visitors coming in from another plant.

F. A. Waldron felt that, if possible, we should get the wheels in motion whereby information which manufacturers seem to demand could be tabulated either in handbook form or in a card index. He thought there might be a clearing house of the college students willing to go into munitions work; of people who are making special types of gages; those who had been manufacturing artillery—or 3-in. shells and down, or 3-in. shells and up. Such information also would be available for the Government.

L. P. Alford said that the work of gathering information on the manufacture of munitions had been done by the technical journals of the country up to the present time. He considered the complete accumulation of data by this means to be beyond the bounds of possibility, but that it might be feasible to organize a bureau with a sufficient staff to accumulate information so that it might be printed in a rather rapid fashion, because a great deal of the information is already in documentary form in the shops which are producing munitions. He believed that the only way to secure the information would be by having a sufficient number of men to canvass the field personally.

H. S. Bergen spoke of the excellent material on the subject of munitions which had appeared in the *American Machinist*, *Machinery*, and the *Iron Age* and other technical journals. He believed it could be more quickly procured through means of these journals than in any other way. He thought that some working arrangement might be had between the different publications and the Government, not in a competitive way, but with each journal working in its own field.

F. E. Rogers suggested that it might be well to get some idea as to what such a work as had been proposed would cost. He, himself, thought that $25,000 would not be sufficient.

Lieutenant-Commander Adams explained the present method of handling the question under debate. While not as satisfactory as the method proposed, manufacturers on several occasions had written to the Inspectors of the Navy in their district requesting additional information, so that they could turn out the material desired; and if the Inspector lacked this information he would request it from the Bureau of Ordnance, and the Bureau of Ordnance would request it from some other district. The information could not always be furnished; sometimes it was not on hand; sometimes it was confidential; but if the inspector of the district did not have it, he would write to the office and they would write direct to some other manufacturer, and thus, under the Government authority, the first manufacturer could quite often get the desired information much more quickly than it could be obtained by waiting for a handbook to come out. There are inspectors at Midvale, Baltimore, Pittsburgh, Bethlehem, Brooklyn, and in Connecticut. The Pittsburgh district covers Buffalo, Cleveland, Toledo, Detroit, Cincinnati and Louisville, and as far west as Alton, Ill. While the Western districts are rather extensive, they have not got the intensive manufacture of munitions in these districts that they have in the East.

In response to the inquiry by John H. Barr as to whether information which the Government had would be given out to the editors of the handbook, in the event of such being prepared, Lieutenant-Commander Adams said that he usually was permitted to give out information. Ordinarily he would have to write to some manufacturer of munitions, or some inspector or bureau for the information, but the Department, at least, would know where to find it and could direct the editor to the proper authority.

F. A. Waldron called attention to the specifications which are sent out by the War Department, to be attached to the pamphlet, giving suggestions as to what materials are employed and their physical characteristics. He had found this very useful in estimating on work, and it would be valuable to almost anybody who should send for specifications and blueprints.

SECOND MUNITIONS SESSION, THURSDAY MORNING

As a result of the discussion at the first session on munitions, a committee was appointed to draft resolutions upon the questions of gages and standards; coöperation among manufacturers in supplying information and the status of men who are serving the country in the industries instead of at the front. These three sets of resolutions were reported at the third session by the committee consisting of: Luther D. Burlingame, *Chairman;* John H. Barr, J. B. Doan, A. J. Baker, Reuben Hill, H. L. Coe, Harry E. Harris and C. B. Hamilton, Jr.

The larger part of the third session was occupied in the discussion of these resolutions, each set being considered

[illegible] and were finally approved [illegible] below.

RESOLUTIONS RELATING TO [illegible] STANDARDS

WHEREAS: [illegible] experienced in other countries [illegible] the production of munition work and [illegible] manufacturer, and its consequent shortage of labor and material due to lack of control of [illegible] standard gages of measurement; and

WHEREAS: Great Britain, Canada and France have found standardization [illegible] essential for both Army and Navy [illegible] uniform and reliable results, and have [illegible] established an efficient organization which has proved [illegible] in overcoming these difficulties; and

WHEREAS: Increased efficiency of our manufacturers would be promoted by the establishment of proper standards of measurement;

BE IT RESOLVED: That the Congress be urged to appropriate sufficient funds for expenditure through a suitable agency, to provide standards and adequate means of calibration, distribution and supervision of such standards, including means for calibration of working and inspection standards in the different centers of munitions manufacture.

Also that provision be made in this appropriation for the establishment of a central office for the collection and dissemination of information on the methods of manufacturing munitions and other supplies.

RESOLVED: That this Society endorses any efforts tending to promote the ends outlined above, and in view of the imperative needs of the present situation, most strongly urges immediate action.

RESOLUTIONS RELATING TO COÖPERATION BETWEEN MANUFACTURERS

WHEREAS: It is the patriotic duty of every manufacturer to facilitate and expedite the manufacture of munitions and other supplies for the Army and Navy;

BE IT RESOLVED: That an appeal be addressed to all manufacturers and engineers to coöperate in the dissemination of information and the interchange of data pertaining to methods of manufacture, systems of organization, design of tools, operation layouts and time studies, including what is generally known under the term "shop secrets" so far as they pertain to munitions manufacture.

RESOLUTIONS RELATING TO STATUS OF MEN IN THE INDUSTRY

WHEREAS: It is necessary to obtain the entire patriotic coöperation of every man who can contribute to the furnishing of military and naval supplies;

BE IT RESOLVED: That we urge upon the Government the necessity of indicating in some way the value and loyalty of men in service in the industries whose occupation is essential to the production of war supplies.

DISCUSSION OF RESOLUTIONS

In introducing the subject of the resolutions President Hollis said that many other people in this country were passing resolutions to be presented at Washington, as a result of which there were so many lines crossing one another that it would be necessary and desirable before transmitting them to determine whether they would interfere with any action on the part of our Government or by agents representing the Government. The intention would be to discuss them at Washington with the officials there and the Munitions Board, in order to find how effective they would be in bringing about the end which all were hoping would be achieved.

The first set of resolutions, as originally presented, contained a reference to the serious delays which had been experienced in Great Britian and Canada in the production of munitions work, and to the desirability of increased efficiency of American manufacturers "in competition with foreign manufacturers."

Calvin W. Rice, Secretary, suggested that instead of speaking of England and Canada by name, the resolutions should not specifically state what countries it was desired by inference to improve upon, but that the general expression "other countries" be used.

John H. Barr said that in referring to England and Canada we were not reflecting upon them but instead were complimenting them upon the successful handling of a difficult situation. He felt that the resolutions were a great deal stronger with the names of these countries mentioned.

John Platt objected to phrasing the resolutions in a way to indicate that this country was in competition with other countries in munitions work.

Secretary Rice agreed with Mr. Platt, saying that a large number of people in this and other countries thought our entrance into the war indicated the prosecution of a dollar war, which it was not. The President of the United States emphasized in his proclamation that we sought no benefit, direct or indirect, and he felt that the strength of the resolution would be increased by the omission of any term indicating competition, even though we failed to get immediately the results we were after.

Fred H. Colvin said that in presenting resolutions such as was contemplated, the Committee should be appreciative of the condition which existed at the present time with respect to the Bureau of Standards, because of the difficulty which the Bureau was having in securing the appropriation needed for their work. With regard to the gaging of munitions, for example, they were going at it in a thoroughly practical way. Only last week their appropriation for gaging was struck out of the Committee's bill in the Senate, because our learned senators said that gaging had nothing to do with war!

There was some further discussion of phraseology, and a sharp difference of opinion was expressed by several as to whether, when speaking of manufacturers of this country, they should be designated as "*American* manufacturers," or as "manufacturers of the *United States*."

The first set of resolutions was finally approved as printed above.

With respect to the second set of resolutions, there was some discussion as to whether they were sufficiently specific in their phraseology, but they were finally approved as originally presented by the Committee.

The third set of resolutions, relating to recognition of those who sought to serve the country through work in the industries rather than in a military way, led to a discussion of the best way to accomplish such recognition.

President Hollis thought it very essential that recognition be given to those engaged in the industries useful to the country in time of war. For instance, this might be by an exemption board appointed in every state which would issue to persons in the industries exemption cards indicating that the persons holding them were exempt from service in the army by authority of a board duly appointed by the President of the United States.

Frank B. Gilbreth said the day had gone by when the only man to be recognized was one who was dodging bullets. While it might be rather revolutionary from our standpoint, he believed in the method adopted in Germany of a recognized industrial army which wore a designating uniform by which a man's status was determined, rather than by a certificate or by something in his buttonhole.

Reuben Hill declared that American workmen would not wear a uniform, even if they could get it for nothing. The practice in other countries was to give them a button. In Canada girls wear badges with a silver bar for six months' service, for which, after the close of the war, a more permanent decoration would be substituted. The man who returned from the trenches wore a button to show that he had been there, until such time as he received a medal for his service. It was not found possible even to prevail upon returned soldiers to wear their uniforms when they went into the industries.

Mr. Hill further stated that if certificates were issued, they should be endorsed by the concern by which the man was employed, showing his rating and pay. He instanced cases where men had left one firm and passed themselves as experts in seeking employment elsewhere, when, as a matter of fact, they were greatly exceeding their abilities in the claims which they made.

In concluding the discussion previous to the approval of the third set of resolutions, President Hollis said that he had had a hand in drafting them and that they were for the purpose of answering questions such as had been asked him very many times and upon which he had received letters beyond number, to the effect that a man wanted to know if he went into the industries how he could make it plain that he was not a "slacker." He asked who was to indicate to him the relative value of military service and of service in the industries. He had told many young men to stay where they were, doing useful work, but of course that was unofficial and he had no authority for giving such advice. It was his opinion that if there were some Government agency to give such advice officially, it would reconcile those of our citizens who felt uneasy about the matter in cases where they were for any reason exempted from military duty.

F. A. Waldron at the conclusion of the discussion of the resolutions said that because the engineer did not take sufficient interest in political matters, as a general thing he did not figure in public affairs as he should, and often got "the small end of the stick." He thought it would be desirable to outline a plan by which through united effort his services would be sought and his work recognized. With this end in view, he submitted resolutions calling for the establishment of a clearance bureau for information on the manufacture of munitions, which it was voted to refer to the Council of the Society with power.

ADDRESS BY MAJOR P. S. BOND, U. S. A.

Major P. S. Bond,[1] who attended the meeting as a representative of the United States Army, said that he was a civil engineer and not an expert on the subject of the manufacture of munitions, and that he would not attempt to speak upon topics with which his hearers were more conversant than he, but that instead he would refer to certain broad subjects in connection with our entry into the present war.

He said there was a tendency on the part of people entering upon something that they had never done before to go to extremes, to lack a due sense of proportion, to fail to separate the things that counted from those that did not count. He had been in the military service long enough to realize the fact, which he emphasized as the keynote of his remarks, that the spirit which actuated man, the spirit of pride in his efficiency, the spirit of wanting to do things, counted for a great deal more than mere knowledge of details.

During the previous discussion reference had been made to the subject of "slackers," and the status of the engineer who sought service in industrial work rather than in military duties at the front. Commenting on this, Major Bond said that under the voluntary system which had been characteristic of our military policy, or lack of policy, since the early days of our history, service to our country had been voluntary and in consequence inefficient. Now we had done away with the voluntary system and recognized the principle of the universal obligation of the citizens to serve their country—the principle of universal service, which was the only intelligent and efficient plan.

Under the system of universal service there was no such thing as the slacker; he became extinct with the ending of that system. The Government would call the men and select those best suited for military service and the men who were not thus selected certainly were not to be called slackers. They would render service of a different kind. The term slacker, he said, was concomitant with the voluntary system.

Continuing, Major Bond took up the main theme of his address to the effect that his mission was to help his country a little bit by attempting to instill into his hearers the need for the spirit of accomplishment, and the following extracts are taken from his remarks. He said in part:

"I have every confidence in the knowledge of details possessed by the engineers present in respect to the tolerances of the munitions business, the heat treatment of steel, and all such matters. If a man were selected for service in this work, as a matter of course the Government would be interested in the extent of his knowledge of details, but it would be much more interested in knowing whether he had the spirit of doing things or whether he was the kind of man who did not do things.

"To illustrate, there are two kinds of quartermasters in the army. First is the man who is very familiar with all the duties of a quartermaster, the man who knows all the rules and regulations governing just what the quartermaster is supposed to do and what he is not supposed to do; and second, the man who knows comparatively little of the regulations but who goes ahead and does things, because he does not know that he cannot.

"Therefore, unless you as engineers have this spirit of coöperation, or this willingness to do things, your detailed and intimate knowledge of your affairs may be an actual stumbling block to the country. What we ask and need of you is disciplined conduct in the German sense. When a German is asked to do something, he almost automatically does what he is called upon to do, because Germans have been disciplined for generations. The American, on the other hand, has a great deal of individualism; and now is the time when we want to ask him to control that individualism to some extent. When an American is asked to do anything—and this is true of mechanical engineers as well as of all other classes of Americans—he will very often start off by showing that what he is asked to do is absolutely unnecessary; but that if it must be done it better be done in a different way from that in which he was asked to do it. He will then remind one that the business should have been started two or three years ago, anyhow.

"Now we know that we should have started to prepare for war three years ago at the outbreak of hostilities; in fact, that we should have prepared ourselves 30 years ago—but we did not do it! And it is just as much your fault as ours! We

[1] Corps of Engineers, U. S. A., Cleveland, O.

know we have been wrong, but let us get busy and see what can be accomplished to make up for the time that has already been wasted."

Speaking more directly of the war, Major Bond expressed the belief, which he said was common with all military men, that Germany has drawn us into this war with a purpose. He believed that that purpose was to make a separate peace with the Allies at any terms they might ask, provided she were permitted to pursue her conflict with the United States and make us pay every cent that the war had cost her. Continuing, he said:

"The first thing that America must realize is that the country is at war. This may sound foolish, yet what indications is there that we are at war? We see something about war in the newspapers, but we do not realize what the war means because we have faced nothing comparable with it in all our existence.

"Ancient war was fought by a small handful of men trained for that particular purpose. A group of knights from one nation met a group from another nation, and on the outcome of their conflict depended the fate of one or the other nation, all the common people accepting the issue of the conflict because they were not able to oppose the knights.

"How different is the situation of the present day! Instead of a handful of men to do the fighting, war is now a whole nation's game; the entire strength of the nation goes into the conflict, she puts forth every ounce of effort, moral, physical and intellectual. This is well expressed by the title of a recent book, The Nation in Arms. That is what modern war means.

"The science of war is the most complex of all sciences, because it represents the sum of all sciences. There is no science known to mankind, from astronomy to bacteriology, that has not found its application in modern warfare. We are used to big business, but we do not realize that modern war is the biggest of all business.

"The romance, the glittering panoply of the knight and the crusader have been taken out of war and it now has become a matter of cold-blooded business conducted on a strictly business basis and governed by the same laws of cause and effect that rule in all business enterprises.

"In the Civil War some of our greatest battles covered a frontage of five or six miles; today the frontages extend from the North Sea to Switzerland, and from the Gulf of Riga to the Mediterranean Sea. Battles were fought in the Civil War by armies of 100,000 men; today there are millions of men engaged. The modern French '75' can fire 30 shots a minute—as rapidly as the modern rifle; the modern machine gun can fire 1000 shots a minute.

"In the Boer War the British fired about a million shells. Today the Allies on the western front are firing a million shells in a single day. The Frankford Arsenal, working three shifts of eight hours each, can turn out 16,000 shells a day. A single regiment of field artillery (24 guns) could fire this number in one day. A million shells means the product of sixty Frankford arsenals, which indicates the problem that we have before us!

"The dearest hope in the hearts of Americans is the hope of getting something for nothing. We have always sought to evade the issue, and our unearned success has lulled us into a sense of false security. We have hoped that the war could be won by some brilliant invention and without sustained and unwearying effort. All of us have hoped that some one would invent a machine that would save the country from having to send its men to war; but it is my opinion that the way to evade the issue successfully is to be fully prepared to meet it; and it is up to the nation today to put itself in that position.

"The men who have been called from civil life to assist in the mobilization of our industries are hard-headed, practical, common-sense engineers and business men. Their accomplishments, training and standing in the profession entitle them to unqualified support. Mr. Frank Scott, chairman of our Munitions Board, says that the Departments of our Army and Navy are too serviceable to be thrown over and entirely replaced by new civilian bodies. He regards it as the duty of civilians to coördinate the efforts of the Army and Navy and the great industrial forces of the nation.

"Our Ordnance Department has labored long and earnestly, in spite of discouragements, lack of money and popular support. It has labored incessantly, with insufficient funds and insufficient facilities, and yet has kept abreast, and a little more than abreast, of the progress of the art of war. Some of the notable contributions to the science of war have been made by our own ordnance experts, both civil and military. Among these are the disappearing gun, machine and automatic guns, the highest-powered guns in the world, automatic pistols, many devices for range finding, etc., etc.

"There have been no new effective machines introduced into this war. The 42-centimeter guns of Germany were in existence before this war. All the weapons of this war, including the aeroplane, were in use in previous wars, although of course they have been developed and brought to a higher stage of perfection in this war." (A voice: "What about the tank?") "There have been a number of devices, including the 'tank,' which I think is an adaptation of the motor vehicle, and the 'flammenwerfer.' These devices can hardly be dignified by the term 'new arms of warfare.' One does not hear very much now about the 'flammenwerfer' and the 'tank'; but he does hear a great deal about the fire of the '75,' which was invented before this war. We need not look for any sudden developments or new machines to save us. If we attempt to discard all the painstaking study of our Ordnance Department and pin our faith on new and untried devices we will assuredly come to grief.

"Our own Ordnance Department has been conducted on a comparatively small scale heretofore; but we must not hesitate to enlarge upon this; reduction of first cost in war times is no economy. A shortening of this war by even a few days means saving many millions of dollars and many valuable lives, including those of our own countrymen; therefore, let us not count the cost if only we can secure results. It is the function of the engineer to take up the military work of our ordnance experts which has been carried on over years of patient study and research, and to put their military methods on a commercial basis.

"I ask the engineer to get out of his head the idea that the ordnance experts of our army are narrow-minded pedants, that we are hidebound, or out of date, that we do not have commercial sense or commercial spirit. We want the engineer to work with us and bring his knowledge, not to confound or to supersede, but to aid ours, and together we will get results.

"A typical instance that will throw some light on this is that of a contract let for the construction of some wheels for artillery gun carriages. The man who secured the contract was an old wheel maker, who had been at the work all his life and thoroughly understood the business of wheel making from the manufacturer's viewpoint. He complained about the specifications, terming them 'foolish.' The specifications

demanded that the tires should be of a certain grade of higher quality steel than he had been using for tires; and he said to himself: 'Those fools up there in the Ordnance Department, fellows that sit at their desks and design these things, know nothing about commercial affairs or about the construction of wheels, and that is why they have made up these foolish specifications, and I am expected to stick to them.' So he came up to the Ordnance Department to complain about it. He said, 'Why cannot you accept such and such a grade of steel for the tire, milder steel than you have specified here? Why cannot I use good commercial standard steel such as I have always used, instead of that high-speed steel that some foolish ordnance expert has put in there?' And the ordnance expert at once pulled out a record of tests extending over a period of five years, to show the contractor that the durability of the steel that the specifications called for was about three times that of the grade of steel which he proposed to furnish, and that the weight called for was much less. And he explained the importance of weight. The contractor was convinced, and he went off and made the wheels according to the specifications.

"Another example Mr. Scott told me of himself. He had noticed that the specifications of the Ordnance Department called for a certain amount of nickel alloy in the rotating bands of certain projectiles in which the English use pure copper. Now the nickel was somewhat expensive, relatively speaking, but the greatest trouble was the time and the difficulty of obtaining the alloy. Mr. Scott went to the ordnance people and asked why they wanted the nickel alloy instead of the pure copper band? He did not take the attitude of the wheel manufacturer, because he had confidence in the Department, but he asked to know the reason why they could not use the copper band. It was explained to him that it would be contrary to the genius of our Ordnance Department, which is as progressive as any in the world; that their ingenuity and skill had been directed toward the development of very high pressures and very high muzzle velocities, so that our guns of any given size were more powerful than the guns of other nations; and that a copper band was not strong enough to stand up under the resulting stresses. 'And now,' said the ordnance experts, 'If we used the copper band it would prevent our following out our plans, and we either must have the alloyed band or else devise a different and inferior type of ordnance.'"

In conclusion, Major Bond said that modern war meant the application of engineering science to armed conflict. It was primarily an engineer's undertaking and was more that of a mechanical engineer than of a civil engineer. He hoped his hearers would get into their souls the spirit of service and prepare to do what they would be called upon to do without argument, without cavil, without hesitation, criticism or fault finding. "You are called upon to help," he said, "to help with all your hearts and souls and to remember how much it means to our country in the matter of saving the lives of our own citizens. The furnishing of an ample supply of munitions means saving the lives of those you love, therefore for your country's sake turn to and do all that you can. Do not count the cost, do not hesitate."

PRESENTATION OF PAPERS ON TOLERANCES, GAGES, ETC.

Following the address by Major Bond, the last four papers of the meeting were presented. These were given either in brief abstract or by title, owing to the short time available, and were as follows:

Procuring Materials for Munitions, C. B. Nolte.

Limits and Tolerances for the Manufacture of Munitions, A. W. Erdman.

Gages and Small Tools, Frank O. Wells.

The Importance of Intelligent Inspection in Munitions Manufacture, E. T. Walsh.

CONCLUDING DISCUSSION

Major P. S. Bond in discussing the paper on Inspection in Munitions Manufacture by E. T. Walsh emphasized the importance of closeness and accuracy in shell manufacture. He said this was essential, particularly since the adoption of the moving barrage, which had been the secret of the success of the Allies on the Western Front. This method of firing was first successfully employed by General Nivelle and was the occasion of his being elevated to the supreme command of the French armies. The idea of the barrage was to advance the range by certain intervals by the clock, so many yards per minute. The infantry followed immediately behind the barrage, so that as soon as the barrage had passed over the space immediately in front of the trenches, the advancing force was ready to jump in at once before the enemy could come out. Formerly they had to traverse a considerable distance after the barrage was lifted, which gave the enemy an opportunity to come out and oppose them by bringing his machine guns into action.

In the use of the barrage it was found that if there was an error in the bursting point of the shrapnel of even as much as 25 yards, it would result in the killing of great numbers of the attacking force; in fact, it was looked upon as inevitable that a certain number of the men would be killed by the barrage, and a sergeant in the English Army describing to an American such a situation remarked that, "Shorts are very annoying, sir, very annoying, indeed!"

Major Bond said that there had been a great deal of complaint on the part of the Allies about shorts in the shrapnel fire and in high-explosive shell fire. He also called attention to recent occurrences of premature or faulty explosions on our armed ships. There had been a number of instances in the Navy, and a great deal of complaint about the imperfect manufacture of shells. Too much importance could not be placed upon the necessity for accuracy in the manufacture of shells.

Major Bond concluded the technical discussion of the session by urging that we be lenient with our War Department, just as we expected the War Department to be lenient with those, in the membership of the Society for example, who might hold preconceived ideas with respect to the production of munitions. It should be remembered that Germany's system of defense had been under way ever since the Battle of Jena in 1806, at which time Napoleon imposed upon Germany the restrictions that caused her to develop her present scheme of national defense, which has proved thus far to be of great effectiveness.

Now we had this war dumped on us overnight, as it were. We had, comparatively speaking, "a tiny little War Department" which simply was not adequate to the situation. It was literally swamped with duties suddenly thrown upon it. Major Bond urged the engineers present to be patient and said that "the one certainty is that we are all going to be called on for service. Whenever the department wants experts along certain lines this Society, or some other society such as this, will be asked to designate the men who can do the work."

GAS POWER SESSION, THURSDAY MORNING

At the Gas Power Session, held under the auspices of the Society's Sub-Committee on Gas Power, four papers were presented and discussed. Prof. William T. Magruder and Mr. [illegible], both members of the committee, acted as chairman and secretary, respectively.

PROFESSOR JUDD PRESENTS PAPER ON FIRE-ENGINE TESTS

The first paper presented was by Prof. Horace Judd, entitled Test of a Motor Fire Engine, and contained the results of a test of a Seagrave motor fire engine having a 4-cycle, water-cooled, six-cylinder motor, 5¾ in. cylinder bore by 6½-in. stroke, 79.3 hp. by A.L.A.M. rating. The motor operated a two-stage centrifugal pump with balanced end thrust.

The maximum capacity was found to be 745 gal. per min. at 122 lb. pressure at discharge of pump, with 2-in. smooth nozzle and 250 ft. hose line with Siamese union. Gasoline used per hour, 0.218 gal. per hp. at rated load.

With coal at $2 per ton (2000 lb.) and gasoline at 25 cents per gal., the cost of producing a fire stream with the motor fire engine is four times that with a steamer. As compared with the horse-drawn engine, the motor engine can reach a fire in half the time, is readily converted from locomobile to pumping engine, is more easily and economically operated, and eliminates entirely the expense of maintaining horses for transportation. Its duty is nearly six times that of a steam fire engine.

A written discussion of this paper was contributed by Claude M. Garland, and it was discussed orally by E. W. Roberts, and the author replied. The discussion follows:

Claude M. Garland stated, in a written discussion, that the motor fire engine, like many other pieces of apparatus, does not depend for its success upon thermal efficiency or fuel economy. The results in the paper indicate, however, a combined thermal efficiency from engine to water horsepower of approximately 10 per cent, which would doubtless indicate a thermal efficiency of engine of something like 20 per cent. This is a very satisfactory performance.

The differences in fuel costs, as shown in the paper, between the steam- and the motor-driven engine are, however, hardly representative of actual conditions. It is seldom necessary to pay 25 cents a gallon for gasoline; eighteen cents is probably an average figure. It is hardly probable that coal suitable for use under the boiler of a fire engine can be obtained for $2 a ton; $4 would probably be more nearly an average figure.

As the fire engine is seldom in operation for more than a few hours a day, the item of fuel cost is undoubtedly negligible when considered with the advantages of high speed in travel, the saving of time in starting, and the elimination of feed and upkeep on horses.

E. W. Roberts[1] pointed out, as a matter of interest, that no horse-drawn fire apparatus is being built today, and none has been for several years. A few steamers are being built, but they are all drawn by gasoline tractors, and these are gradually being replaced. As rapidly as possible, all the cities in the country are installing motors. The motor-power apparatus is rapidly succeeding the horse everywhere throughout the country.

The chairman thought the paper might be considered as a foundation paper, from which to judge future performances of motor-driven fire engines.

Professor Judd, in closing, said it might be well to point out that the unit was operated entirely by the fire department and fireman operators. Those who conducted the tests had nothing to do with the adjustment of the motors or anything else pertaining to the engines. All they did was to look after the accurate measurement of the fuel and the water pumped. The results presented may therefore be regarded as average results for the type of engine tested.

[1] Consulting Engineer, Cincinnati, O.

MOTOR-TRUCK ENGINES FOR LONG LIFE

The second paper, entitled The Design of Motor-Truck Engines for Long Life, by John Younger, was presented by the Secretary in the absence of the author. A brief synopsis of the paper follows:

The problem of long life of a motor-truck engine is not a simple one, on account of the widely varying conditions under which the engine operates.

Long life depends on three factors: Design, manufacturing excellence, and operating conditions.

Design: Under this head the paper summarizes present practice, giving particulars of recommended materials, dimensions of parts, and factors of safety for the several parts of the engine.

Manufacturing Excellence: Workmanship, tolerances, and running tests are considered. For long life the best workmanship is essential.

Operating Conditions: Recommendations for maintaining the engine in first-class condition are given. For long life particular attention should be paid to lubrication, cleaning, inspection and regulation.

Contributed discussions of this paper were received from H. S. Whitten and H. E. Morton, and the paper was discussed orally by E. W. Roberts and Kaufman T. Keller.

F. A. Whitten[1] wrote that he believed that operating conditions had more effect upon long life of truck engines than design and manufacturing excellence combined. The motor-truck manufacturer, unfortunately, had practically no control over the operating conditions. He had applied governors, screens, and other devices in an endeavor to protect his machine from abuse, but drivers did not like them.

Generally speaking, owners had no workable system to determine whether the manufacturer's devices were being used or his instructions carried out. Any investigation along this line was usually of the sort which resulted in locking the barn door after the horse was stolen. A tremendous amount of education of the owner was required in order to attain proper results. The first trucks a man used were frequently condemned as unfit for the service because of the way in which they were operated. We had very little difficulty with trucks in the hands of those who had had previous experience in operating, as such owners had usually already learned their lesson from the results of neglect and careless handling.

As the author stated, "oil and lots of it" was one of the principal features of successful operation. Actual breakages were rare, and lubrication troubles were responsible for most operating troubles and delays.

The carburetor was not usually considered a part of the

[1] General Motors Truck Co., Pontiac, Mich.

engine, but Mr. Whitten believed it should be so considered, as the success or failure of the engine depended upon the carburetor in more ways than was generally recognized. Investigation would show that present-day lubrication troubles were usually intimately related to the carburetor and fuel. That the low-grade fuel generally used today was responsible for many troubles was a fact not generally recognized by operators.

The driver should not be given control over the carburetor adjustment except to a very limited degree. Choking the air supply to produce a rich mixture for starting might be necessary, but forcing the engine to pull its load before it was warmed up might be a very expensive procedure if persisted in. This rich mixture, with present grades of fuel, was almost certain to carry into the cylinders a certain amount of fluid fuel which destroyed the oil and resulted in piston-ring and cylinder wear. This liquid fuel also worked down past the pistons and destroyed the lubricating oil in the crankcase. Not only was the oil spoiled in this way, but the liquid fuel loosened small particles of carbon dust and carried this down into the cylinders and the crankcase, from whence it would be distributed into the bearings in spite of any screens which might be provided. By the use of a rich mixture, either in starting of the truck or by bad all-around carburetor adjustment, it was possible to wear out a motor in a very short time.

The danger of this sort of operation was self-evident to any engineer, but it seemed very difficult to get the user to appreciate the necessity for care of this sort or to believe he was in any way responsible for troubles caused by such operation.

H. E. Morton discussed the lubrication of an internal-combustion engine of the multi-cylinder so-called high-speed class, which, he stated, involves a variety of problems. The conditions were severe, and in most cases the engines received little attention, so that the real successful system had to be reliable, self-contained, efficient and fitted with indicating devices to give early warning of an exhausted oil supply or irregularity in operation.

The three systems most used were full splash, full-forced and a combination of the two. The individual pump and distributor system was seldom employed on modern engines. There seemed to be no special merit in the full-splash system except low cost. The full-forced and combination systems were both good, but the former, properly designed and applied, would give excellent results, and had the great advantage of making possible the highest unit bearing pressures all through the engine. The belief had existed in the minds of some that this higher loading was made possible by a sort of counterbalance equal to the oil pressure, but there was little to substantiate this theory. "Forced volume system" might be a more significant name for the system, as tests indicated that it was the volume of oil forced through the bearings which was most important. The volume of oil rapidly carried away the heat generated, immediately replaced a break in the oil film, due to momentary heavy loading, and thus allowed the use of very high unit bearing pressures. All the above-mentioned systems made use of what might be loosely termed splash for cylinder-wall lubrication.

To make any one of these systems practical it was necessary to use the oil over and over, passing it through suitable filters each time, of course. Also for ordinary-duty engines all the oil was carried in the lower part of the crankcase. These conditions meant that a great deal of loose carbon was washed into the oil, and as it was so fine that the ordinary wire gauze would not remove it, the pump continued to pass it through the system. This particular point should not be lost sight of, for the carbon particles were quite effective as a lubricant and tended to hold up the viscosity of the oil. A good mineral oil under such conditions appeared to lose very little in lubricating value after long use, especially if occasionally well filtered.

For exceedingly-high-duty engines, such as those designed for aeroplane service, the practice of carrying all the oil in the crankcase was questionable. Oil temperature needed to be kept down, and with a secondary external circulating system and supply reservoir it could be fully controlled. Actual service tests covering many months showed that good oil could be used almost indefinitely, employing an external circulating system and carrying very little oil in the crankcase.

E. W. Roberts[1] said one or two points in the paper were rather astonishing to him, and quite against his experience. A clearance of cylinder and piston of 0.002 in. was generally considered by manufacturers far too large. He believed that such large tolerances were a mistake, because the workmen were apt to get careless. He had never heard of a tolerance for a cylinder or piston of over 0.001 in. He thought that while larger tolerances could be allowed, but tolerances of 0.0005 in. made the men more careful.

He disagreed with the author's contention that spiral oil grooves would be found preferable for bearings. He said that one of the greatest mistakes made by manufacturers of engines of all kinds was in the shape of the oil grooves in the bearings. Experiments made at Cornell by Bierbaum nearly twenty years ago, showed that the proper form of oil groove was the H-groove and not the spiral groove or the X-groove. In engines having lubrication troubles, or hot bearings, if the change were made from the spiral to the H-groove the trouble would generally disappear.

Referring to the general idea that carbon was produced by the lubricating oil, this speaker said that it was not generally recognized that an over-rich mixture was quite a prolific source of carbon, because in such a mixture there was a tendency for the hydrogen to combine with the oxygen: that was now proved experimentally in a number of ways. But the general idea prevailed that all carbon was due to lubricating oil, which is not altogether true.

E. E. Keller discussed the author's statement that "When the oil gets dirty, say, every three hundred miles or so, it ought to be thrown out and replaced with clean oil." In his experience in the testing of engines, he had found that the oil could be used over and over again. It was not necessary to filter it, but by running it through a cream separator the heavier particles of matter that had accumulated in it could be taken out, and the finer carbon or graphite was very beneficial to the engine. He had found, however, that oil used over and over contained considerable muck or gummy substance, which collected in the bottom of the oil can, and which was sometimes due to water getting down and breaking up the oil, or particles of dirt getting in.

Regarding tolerances for cylinder and piston, he differed with the author, and thought that pistons on the high limit should be put into cylinders on the high limit, and pistons on the low limit into cylinders on the low limit.

MR. YOUNGER REPLIES

Mr. Younger, in his closure, said that Mr. Roberts had stated that the clearance of 0.002 in. was generally considered by manufacturers far too large. He did not understand where he got this impression, as in dealing with motor-truck engines of 4 to 5 in. bore, a *maximum* variation in clearance

[1] Consulting Engineer, Cincinnati, O.

of 0.002 in. could be allowed, and it was certainly inadvisable to come below a clearance of at least 0.003 in. on the skirt of the piston, preferably, in accordance with his experience, 0.001 in. per inch diameter of piston.

He thought that in Par. 12 he should have been a little more careful in explaining exactly what was meant by a process of selection. It simply meant, however, that while cylinders could be ground to a maximum tolerance of 0.002 in. and the pistons finished to a similar tolerance, a total tolerance of 0.004 in. should not be allowed in the engine, but that, as stated, pistons on the high limits should be put into cylinders on the low limits. This held for the rest of the engine as regarded connecting rod bearings, etc.

If Mr. Roberts would refer to the paper, he would see that on connecting rod bearings the bearings should be grooved with a slightly spiraling oil grove, to prevent ridges wearing on the crankshaft. This was not at all the figure 8 oil groove that probably Mr. Roberts was thinking of, but was simply a one revolution spiral of a pitch very slightly in excess of the width of the groove. This had been found in combination with labyrinth checks to be exceedingly satisfactory. The H-groove was, as far as he knew, obsolete in automobile-engine practice. Quite a number of firms were using successfully no grooves at all.

He feared that he would have to disagree with Mr. Keller entirely. Oil at the rate of one gallon every two or three hundred miles was so cheap that it should be thrown away, and filtering or separating need not be resorted to.

It must be remembered that the great majority of motor trucks were running in places where mechanical separators could not be easily obtained, and it was very questionable if the labor and cost involved in separating a gallon a week would be worth the trouble. Experience had distinctly shown, beyond all question, that the safest, most reliable way was to throw away oil every two or three hundred miles and replace entirely with clean oil.

Mr. Keller gave away his case entirely when he stated that he noticed considerable muck or gummy substance accumulating in the bottom of the oil pan. This was due to water getting into the oil and products of combustion; also, in cold weather the rich mixture that was used in the carburetor, to get the engine warmed up, would cause an excess of gasoline to drain past the pistons into the oil, and accordingly waste the oil.

Mr. Whitten rightly emphasized the point that operating conditions had a great deal of effect on the long life of truck engines. Designers and manufacturers had still to go a long way in order to make their machines fool-proof against even the most stupid operators. However, in all fairness to truck drivers, it must be stated that the last two or three years had seen very considerable improvement, and the average truck driver today was a reasonably intelligent operator.

DESIGN OF GAS ENGINES DISCUSSED BY MR. DUPRIEST

A paper entitled The Relation of Port Area to the Power of Gas Engines and Its Influence on Regulation, by J. R. DuPriest, was then presented.

In this paper it is stated that any system of connecting up the governor of a gas engine to the throttle valve which gives equal changes in port area for equal changes in the governor speed, will make the regulation of the engine very sensitive at light loads and too slow at heavy loads.

The object of this paper is to present a method of determining the port area required for any fractional load on a throttling gas engine operating on the four-stroke cycle, and to suggest a means of admitting the fuel so as to get the same degree of speed regulation throughout the full range of load.

The author has made an extended study of the working of a $16\frac{1}{2} \times 24$-in. horizontal double-acting tandem throttling engine, running on natural gas at 180 r.p.m., and from a consideration of the data obtained in tests and the characteristic curve of the governor used has devised a method by means of which the relation between the travel of the governor collar and port area for a given power can be determined. A governing mechanism may then be designed which will give equal changes of load for equal movements of the collar, or the ports may be so shaped that equal changes in governor-collar travel will give equal movements of the valve, but at the same time give the proper port area for equal changes in power delivered.

THE PROBLEM OF AEROPLANE-ENGINE DESIGN

The fourth and last paper of the session was that by Charles E. Lucke, entitled The Problem of Aeroplane-Engine Design.

The paper resolved the engine into a light, high-tensioned steel structure, consisting of seamless tubing and forged or welded steel parts, possibly formed in drop-forge dies. To this steel stress structure are added certain members, such as the piston, exhaust valve and guide, designed primarily for heat-flow conditions and not for stresses; and certain closing members, such as the ports for the intake and exhaust, which can be very properly cast in aluminum; and the oil crankcase closure, which can be made of any material desired.

This paper was presented by the chairman, who called attention to its salient points in the following words:

"Professor Lucke prepared this paper from an analytical point of view, and discusses the things which have been done and the outlook for the future whereby to reduce the stresses and decrease the weight per horsepower of aeroplane engines. He states that the air-cooled motor has entirely failed in comparison with the water-cooled motor, which will impress everyone. He considers the mixture quality of very great importance, and also the dryness and the homogeneity of the mixture. He brings out a point about the position of the spark plug, to the effect that the moving of the spark plug from a side wall to a center point will improve the power of the engine. He emphasizes the desirability of using the air meter for measuring the quantity of air supplied and regulating the horsepower. He advocates large diameters and short strokes for aeroplane motors. He states that cast iron is well enough to use, but we now have several methods of making aeroplane-engine cylinders in aluminum or sheet steel or of steel forgings, with cast-iron liners. He discusses the question of the arrangement of cylinders and valves. He takes up the construction of valves, discounts Grashof's formula, goes into the thermal capacity of valves and pistons, particularly, and advocates that the piston head should be made increasing in depth towards the wall of the cylinder to furnish a better means for the heat to pass off."

Written discussions of this paper were contributed by R. C. Carpenter, O. C. Berry, Claude M. Garland, H. L. Hornung, H. E. Morton, E. W. Roberts and H. M. Crane. Mr. Roberts presented his discussion in person.

R. C. Carpenter said that Dr. Lucke's paper should be read in connection with a paper by Neil MacCoull, Jr., presented before the Society of Automobile Engineers in June 1915. The two papers were in remarkable harmony on the principles

of design which applied, and the possible results which might be obtained, in the selection of materials.

The particular problems which had made the production of the aeroplane engine more difficult than internal-combustion engines for marine and stationary purposes were, without doubt, due to the important requisites of reliability, lightness, and efficiency, which requirements were conflicting to a greater or less degree, making it essential that the designer decide which requisite was to be considered the most important.

The question of reliability involved lubrication, carburetion, and all the problems relating to continuous operation. So far as Professor Carpenter could recall, there was no other class of engine in which the question of reliability was so vital for results. In the marine or stationary engine, failure of the engine to operate merely required repairs or adjustments which, although possibly inconvenient, could be made without endangering the entire supporting structure; this was obviously not the case should for any reason the aeroplane engine fail to run.

The use of a compression rod for valve openings was undoubtedly not theoretically correct, but it was giving good satisfaction in practice. The use of a tension rod or steel wire as suggested did not prove so attractive after the necessary mechanism was laid out.

Regarding valve timing, for high-speed engines he had closed the inlet valve as late as 45 deg. past the outer dead center. The best test of the inlet valve was the "flow back." A good plan was to set the valve closing so late that a slight "flow back" from the carburetor would be manifest and then reduce the lap just a few degrees.

In the matter of valve lifts, an increase in the number of valves permitted reduction of lift and reduced both the pounding and the inertia of the mechanism.

In his thermal analysis of the valve, the author had undoubtedly overlooked the flow of heat from the valve head to the seat. The exhaust valve was on its seat about two-thirds of the time, and experience had shown that if the seat was not cooled, valve trouble was experienced.

A misconception had existed among designers regarding the two functions of the piston. Professor Lucke pointed out the heat conduction. Another thing was the wearing surface. Short pistons and shuttle-shaped pistons—pistons with the bearing only on the ends—had insufficient bearing surface, which resulted in rapid wear and a piston slap early in the life of the engine.

A heavy piston was a very bad feature in a high-speed engine. We must keep our piston weights down to reduce the inertia effect. This was very essential.

Regarding the bolts for the cylinders, in his first aeroplane-engine design, made in 1910, he used long cylinder bolts passing through and beyond the crankshaft bearings.

In both papers steel was recommended as a substitute for cast iron, which was obviously a desirable change so far as the substitution might be practicable. In this connection, it would also seem to be of advantage to employ aluminum alloys as far as they proved themselves to be serviceable and reliable both because of the light weight and of the higher heat-transmission coefficient which such alloys had as compared with cast iron.

It was Professor Carpenter's opinion that the aeroplane engine was now passing very rapidly through a development period, and that a short time only would be required to fully disclose the essential requirements as to types, materials, and details of workmanship. These, he believed, would in a general way agree with those stated by Dr. Lucke.

O. C. Berry, in a written discussion, supported the author's point of the importance of motor efficiency and the part which quality of the mixture played in determining this efficiency, by giving the results of tests carried out in the laboratories of Purdue University for the specific purpose of showing the effect on the performance of a motor of changing the character of the mixture.

These tests showed that the most efficient mixture coincided almost exactly with the theoretically perfect mixture when the engine was running under load, and was considerably leaner than the most powerful mixture. For low-load conditions, the richer, more powerful mixture seemed to be more efficient as well, probably due to the fact that it fired more regularly at low pressures.

The tests also showed how very important it was that the mixture be correct if high efficiency was to be obtained. In this connection it was important to note that any change in the temperature of the air or the fuel flowing through the carburetor, or a change in the altitude, would change the character of the mixture furnished by a carburetor having a fixed setting. For this reason the carburetor should be furnished with an adjusting device which could be operated from the driver's seat. By such a means the mixture might be kept correct while the machine was in the air. The rule for the operator to follow was to make the mixture leaner until the engine lost power, and then make it richer, a little at a time, until the power was restored. The leanest mixture with which the engine would pull satisfactorily was the most efficient.

Professor Berry did not agree with Professor Lucke that drying the mixture was a sure cure for carbon in the cylinders. A dry mixture might be too rich and cause a heavy carbon deposit.

The aeroplane motor, like the racing motor, was designed to do most of its running at a speed and torque which were nearly constant. The best way to speed up the rate of combustion in such a motor was to increase the compression. The racing motors developed their best torque at about the speed at which the aeroplane motor was required to run, and gave their best power at nearly twice this speed. The rate of combustion and piston speed were therefore scarcely controlling factors in aeroplane-motor design.

The factor which limited the speed at which an engine could run continuously at full torque was the ability of the bearing at the lower end of the connecting rod to keep cool enough to permit proper lubrication. This was borne out by the experience of automobile-race drivers. An examination of the experience of several hundred cars entered in various races showed that many more engines failed due to crankshaft and connecting-rod trouble than due to piston trouble, and that valves did not cause half as many failures as crankshafts. To Professor Lucke's list of pistons and valves he would therefore add that the connecting-rod and main bearings on the crankshaft must be designed primarily for heat dissipation. The best way to accomplish this was to supply them with a copious supply of oil under pressure, and thus oil-cool them.

Claude M. Garland wrote that there were two points in the paper which his experience would indicate to be of first importance, not only in the design of aeroplane engines, but also in the design of all internal-combustion engines of the single-acting type. These were the design of the exhaust valve and the piston from the standpoint of thermal conductivity for the purpose of maintaining the temperature of these parts at such a degree as to prevent preignition of the charge.

The piston was the more difficult member to handle, and in most instances was the principal offender in premature-ignition

conditions. This was clearly illustrated in the testing of a single-cylinder engine which had given considerable trouble from preignition. On removing the plate which carried the spark plug immediately after a test, the piston was found to be at a low red heat. Some experiments were made on this engine for the purpose of determining to what extent the temperature of the piston affected on the premature ignition.

A small nozzle was located in the end of the cylinder, and an injector device provided whereby a very fine stream of water was discharged on the piston head on the opening of the exhaust valve. This not only cooled the piston head, but also the exhaust valve and the cylinder walls. In fact, sufficient water was injected to lower the temperature of the exhaust gases to about 500 deg. fahr. Under these conditions, illuminating gas, which normally could not be compressed to over 70 lb. without premature ignition, could be compressed to 250 lb. without any trouble whatever from this cause. The maximum pressure of the cycle approached 900 lb. per sq. in. Under these conditions the engine indicated a thermal efficiency approaching that of the Diesel.

While it was not possible to provide water injection for the cooling of an aeroplane engine, yet it was possible, as Professor Lucke suggested, to minimize greatly the troubles through proper design of piston and valves for the rapid conduction of heat.

H. L. Hornung wrote that Professor Lucke's analyses of the mixture question were fundamental with any fuel, but became particularly apropos with fuel having end points 400 deg. fahr. and above.

His conception of the straight portion of the m.e.p. curve was no doubt borne out by the inaccuracies of our testing methods, wherein small variables made it impossible to read slight changes in ordinates which must exist, producing a peak in the curve at some maximum point. It did not appear to be a mathematical probability that we should actually have a straight portion to the curve, which was the resultant of variables of a higher than first degree. Of course, for all practical purposes it might do no harm to consider a portion flat, but for the sake of future deductions, it appeared more satisfactory to think of the curve as seldom being straight at any point or series of points.

The author's discussion of arrangement of cylinders and jackets suggested a thermoanalysis of the motor by dividing it horizontally into layers $\frac{1}{2}$ in. in thickness, and laying out a curve with the layers as abscissæ and as temperatures ordinates in different horizontal-vertical planes. Such an analysis would open the eyes of most of us to a new realm of design, and would show why valves do not seat and pistons seize with apparently no reason. It would also show how far the crankcase might be brought up on the cylinder, which might be made with separate heads. Block cylinders failed through our lack of knowledge such as this analysis would give.

Later in the paper there was further evidence of designing from the thermal-stress standpoint. Without desiring to take issue with the author, laboratory investigations showed that heat flow was from the center of the valve to the seat and up through the stem, if the area was sufficient. Here came the question of stem diameter from the standpoint of heat conductivity and not wear. In valves running under high output there was a dark annulus on the outside corresponding to the conducting ability of the seat. The wider the seat, if it seated well, the cooler the valve and the wider the annulus; but the wider the seat the greater chance to catch carbon and the lower the effective area for a given lift. These were shop observations which did not seem to check the analysis of the text. A valve head did not always receive the same amount of heat on the outer edge, nor was the water cooling of the seat always uniform, all of which caused unusual distortions.

The author's thermal-stress analysis of the piston was a masterpiece. Attention should be called to the fact that the center of the piston head usually gave the trouble and controlled largely the cylinder bore for high outputs.

Thermal analysis of the cylinder illustrated the necessity of neglecting the lower regions of the flame-swept bore while giving unusual attention to the regions of the exhaust valve and spark plug. The tendency of this treatment was to bring about a more uniform temperature throughout the cylinder structure.

Sections on the design of the crankcase were certainly worthy of the attention of all engine designers, both from the thermal and dynamic standpoints. Most crankcases were deplorably weak, even in otherwise well-designed engines.

In closing, it seemed proper to accent the tendency so aptly crystallized in this paper of reverting to the fundamental conception of the fact that the internal-combustion engine was a heat engine and must be designed with this primarily in mind before the dynamic designing was done. This course had seldom, if ever, been followed in the past, but was the direction toward which real progress must be made.

H. E. Morton wrote that the paper stated that the ordinary aeronautical-engine piston today was a failure, and was, with the possible exception of the exhaust valve, a source of greatest trouble. While this might be true of some engines, he had for several years been having absolutely no trouble with pistons, and especially those of the aluminum variety. The problem of heat conduction through the piston was unquestionably of great importance, but he found that it was a comparatively simple matter to design a strong, light and also cool-running piston for even comparatively high-speed engines.

It was interesting to note the reference to the use of wire for actuating the valves. He supposed that was one of the first suggestions that came to the mind of a designer, but his experience had been that to incorporate neatly such a member was not a simple matter.

It seemed that Professor Lucke, for some reason or other, had omitted to mention the detachable-head design which was apparently growing in favor in aeronautical work. This design was certainly most convenient both in manufacture and field work, and was especially applicable in connection with aluminum cylinder jackets. The method mentioned in the paper of screwing steel sleeves into the aluminum was more or less expensive and troublesome, and a much simpler method could be resorted to where a detachable head was used. Aluminum heads with cast-iron valve seats were proving very satisfactory, and with a light steel sleeve shrunk into an aluminum casting this detachable-head design became extremely lightweight and accessible.

E. W. Roberts[1] wrote that the air-cooled motor was still a considerable factor in the aeroplane, and for certain classes of machines, like the fast scout, was still in considerable favor. So far as the 2-cycle engine giving way to the 4-cycle type was concerned, this would warrant the assumption that the 2-cycle was the original engine. The majority of the 2-cycles that have been offered for aeroplanes have been poorly constructed and poorly designed. The trouble with this type of engine was not so much with the type itself, but with the builders. It offered a solution of one of the most annoying problems of the aeroplane engine, the trouble with the valves. From 24

[1] Consulting Engineer, Cincinnati, O.

to 25 hours of cumulative flying was about all that could be depended upon from the 4-cycle aeroplane engine, and then it had to be overhauled, the valves reground and all adjustments remade. This phase of the problem had been prominent since the beginning of aviation. Lubrication had been fairly well solved, but in a rather complicated manner, in the 4-cycle type. Valve trouble in the 2-cycle was eliminated because there were no valves. Lubrication of the 2-cycle was simplicity itself because the oil was mixed with the gasoline. In actual flying, the 2-cycle had proved itself fully equal to the 4-cycle in all points but one, and that was fuel economy. This was a very important point, but if the same attention were given to the 2-cycle development as had been given to the 4-cycle, this part of the problem would be solved. As it was, the 2-cycle water-cooled motor did not use quite as much fuel as the air-cooled four-cycle for the same amount of power.

In the matter of carburetion, two conflicting phases of this problem were encountered. One was, we must heat the mixture to get perfect proportions, especially with modern fuels, and heating the mixture reduced volumetric efficiency. Internal-combustion engineers did not altogether agree with the statement that the explosion line on the indicator card must be maintained vertically for a maximum efficiency. Some engineers seemed to think that if the explosion line did not bend toward the expansion line, a certain amount of back pressure would be obtained that would cut down the efficiency. Personally, Mr. Roberts had never seen any data to prove this.

In the statement that curvature of the horsepower-speed line was due to a corresponding variation of volumetric efficiency, and also that at some high speed the horsepower-speed line fell before the volumetric efficiency, he would point out that the two factors of inertia effect of reciprocating parts and vibration in mass had considerable bearing on high-speed efficiency.

Regarding connecting-rod length, he had found the limit in practice was 1.8 times the stroke. While this would undoubtedly appear quite short to some engineers, it apparently gave good results.

He had used quite a number of cast-iron cylinders for aeroplane motors 1/8 in. thick, and had never had any trouble with them. There were several references in the paper to the use of aluminum for water jackets, and apparently for the combustion space. As a matter of interest, he might say that he had built something like 100 aeroplane engines with aluminum-alloy cylinders, and found that when making very extended flights with inadequate radiators these cylinders would break through in the combustion space. In all other respects they gave very satisfactory results.

Regarding valves, and particularly valves in the head, quite a number of engines had been made with a single valve opening into the cylinder which would admit of a very large area. There were several ways in which a single valve opening could be employed.

In conclusion, a feature of aeroplane-engine design that appeared to be overlooked by quite a number of designers was the crankshaft. There were two factors in this connection of great importance and yet quite frequently neglected. One was the length of the crankpin bearing and the other was the securing of lightness by using a hollow shaft. To replace a solid shaft 1 5/8 in. in diameter, he used a shaft 2 1/2 in. in diameter with a 2 1/4-in. hole. This not only decreased the weight to such an extent that a four-cylinder shaft 40 1/2 in. long weighed only 17 1/2 lb. when finished, but the large diameter of bearing reduced the oil-film pressure and practically eliminated overheating these bearings.

W. H. M. Crane, in a written discussion which will be published in full later, outlined the relative characteristics of motors for aviation service and for motor car service respectively. Regarding the aeroplane motor, he wrote that the one supreme requirement was that it should have the lowest possible weight per horsepower of continuous duty. The weight must include not only the motor and its ordinary accessories, but also the fuel and oil required for the length of flight desired. The limit of power that could be successfully used in aeroplanes had not yet been nearly reached, but already even the lower-powered machines had motors more powerful than all but a few motor cars, while the other military types of aeroplanes employed motors of a power entirely unnecessary in any motor-car service. The bulk of aeroplane motors would have piston displacements of 500 cu. in., or over, while there were very few car motors as large as 500, the average being from 300 to 400.

Not only must it be able to operate continuously at full load without distress due to overheating or other troubles, but it must also have as nearly as possible 100 per cent of reliability. This latter requirement was always present, due to the danger involved in a forced landing at some place unfavorable to landing.

It did not have to be particularly quiet, in view of the very considerable propeller noise. A very moderate amount of muffling of the exhaust and practically no attention to mechanical quietness would meet all the requirements.

Extremely long life in hours of operation, without repair, had not yet been required of aeroplane motors, although the time would undoubtedly come when this feature must be given more serious consideration.

Flexibility, as we knew it in the motor car, was not required in an aeroplane power plant.

Absence of vibration was of importance in aeroplane motors, but as only one full-load speed had to be provided for, the problem was considerably simpler than it was in motor-car engines.

In the aeroplane motor, the lightest possible materials were used, aluminum alloys and the higher grades of alloy steel being very largely employed; cast iron, which had given such valuable service in the gas-engine field, was out of the question on account of its weight. The design, as a whole, should be compact, and the number of parts as small as possible. Only in this way could light weight be obtained with the necessary strength and stiffness. Therefore many motors of the V-type or of the radial type were seen, such as the rotating air-cooled motors and the stationary Salmson motor. Block casting of the cylinders where possible was also a great help toward stiffness with light weight.

Efficiency in gasoline economy being so important, as well as power with light weight, the highest possible compression was employed, while valve-in-head motors were almost universally used. Valve timing, inlet pipes and carburetors were laid out with a view to the best possible operation at the full-load speed desired. Ignition systems of only the highest quality were required to furnish the necessary reliability, in view of the high speeds and continued high temperatures. Magnetos were subject to continuous heavy vibration, and must be built accordingly, while spark plugs had to meet conditions of high temperature and oil that were rarely present in automobile work. Complete oil circulation under high pressure, with special means for cooling the oil, was required to take care of the lubrication under the severe conditions imposed. At the present time, reliability of operation required complete duplicate ignition systems.

Mr. Crane concluded with a consideration of the question of aviation motors driving propellers direct and those driving them through gears. The fundamental basis of power in a gasoline motor was, of course, piston displacement. There was, therefore, always the incentive to increase the number of revolutions, with the idea of getting the greatest possible amount of power out of a given size of cylinder. We were, however, considerably limited in the possibilities of power increase by increased speed, due to the fact that the power could only be expected to increase in proportion to the speed, while the stresses in many of the parts increased as the square of the speed. Furthermore, as the life of many parts subject to repeated stresses limited the reliable life of the motor, increased speed imposed other difficulties of design.

The principal reason for gear-driven propellers was, of course, the well-known limitation of propeller design, based on the speed of the aeroplane. This limitation in aviation work was exactly similar to the limitation in motor-boat work, which had resulted in many high-speed hydroplanes having propellers geared to run at greater speeds than the driving motors. In aeroplane work, the improvement in motor design had tended to outstrip the possibilities of the propeller to such an extent that aviation-propeller speeds were uniformly lower than aviation-motor speeds, except in very-high-speed machines or in certain types of motor. This was especially true because of the military development of aviation, which naturally placed efficiency of operation ahead of long life.

The great advantage of the direct-drive machine, from the point of view of design, lay in the use of the crankshaft as a propeller shaft also, a manifest economy in material, both in the shafts themselves and in the bearings required.

All the studies that Mr. Crane had made indicated that a geared motor must weigh from 15 to 25 per cent more than a lower-speed ungeared motor of the same piston displacement. The question was whether we could get a corresponding increase in horsepower to offset the increased weight. Personally, he thought the question was still a very open one, so open, in fact, that he expected to see both types of motor continued in use for some years to come.

E. W. Roberts pointed out an error in one of the discussions, namely, that the motor should be run at the weakest mixture at which it could operate. That would result in heating the motor and blowing off the radiator.

PROFESSOR LUCKE'S REPLY

Professor Lucke, to whom the discussion was later submitted, wrote that there was practically nothing for him to say in reply except that he was pleased at the acceptance of the ideas set forth in his paper.

INDUSTRIAL SAFETY SESSION, THURSDAY MORNING

At a professional session held under the auspices of the Sub-Committee on Protection of Industrial Workers, tentative drafts of two safety codes were presented and discussed. Howard P. Fairfield acted as chairman of the meeting.

The first code, entitled Tentative Draft of a Code of Safety Standards for Industrial Ladders, included sections on definitions of ladders, general requirements for ladders, fixed ladders, portable straight ladders, extension ladders, fire ladders, portable step ladders, scaffold ladders, trolley ladders, sectional ladders, and safe practices for ladders.

This code was presented by William A. Viall and was discussed orally by Hollis P. Porter and J. G. Hatman. Written discussions were contributed by H. W. Mowery, H. M. Elder, M. W. Alexander and W. F. Wettling.

J. G. Hatman asked whether, when the Code was prepared, the Committee had consulted the work of the National Safety Council on Ladders, which had been approved by the Board of Underwriters in Chicago. Practically all the industrial plants, he said, were using that code as a standard now, and were having it approved by the Board of Underwriters.

Mr. Viall replied that all the codes he knew of followed the National Safety Council idea. In some cases it might be modified somewhat, but not to any extent.

W. F. Wettling,[1] in a written discussion, described a patented form of ladder designed to be stiff and strong enough at the weak points to overcome the danger hazard, and at the same time to be of minimum weight. This ladder was constructed with semi-tubular wrought-steel braces inserted in the recesses on the inner side of the ladder, and bent at right angles at each end and riveted to the top and bottom of each step or rung. The ladder has been approved by The Industrial Board of Pennsylvania Department of Labor and Industry.

M. W. Alexander thought that a paragraph could well be added in Section 8 under the heading Trolley Ladders, to recommend the use of a suitable locking device which would prevent a ladder from inadvertently moving under a man if, for example, he should be reaching around the side and handling a fairly heavy object. Such a locking device could be readily made and would, he believed, be an added feature in the safeguarding of such ladders.

H. W. Mowery[1] wrote that the question of safety-ladder shoes for portable ladders was one upon which there was considerable difference of opinion among those who should know. His experience had led him to the conclusion that spikes or long, sharp points on the foot of such a ladder were dangerous. The hazard of the spike was regarded as more dangerous than the hazard it was designed to eliminate.

The various types of self-adjusting shoes were, too, not entirely satisfactory. In many plants they were considered as excellent safety devices, while in other plants, equal in number and prestige, they were condemned as causing accidents.

An adjustable shoe must be kept clean, in good condition and not allowed to gum up with grease, etc., so that the abrasive, cork or other anti-slip element would be effective. That was a matter of good housekeeping, proper inspection, etc.

Decided objections were raised against such shoes on the ground that workmen seeing a ladder equipped with them would place it at any angle with the horizontal and expect the shoe to hold, thereby increasing the hazard of a fall and defeating the purpose for which the shoes were intended.

[1] The Bent Rung Ladder and Manufacturing Company, Indiana, Pa.

[1] Safety Engineer, American Abrasive Metals Co., New York.

The objection was also raised against adjustable shoes on account of increasing the weight of ladders already too heavy; but as the weight was increased 2 per cent to 5 per cent, this did not seem valid.

Until a portable ladder was so constructed that it automatically could not be used at an unsafe angle, the statistics of ladder casualties would remain about the same, with only slight reductions on account of better construction and inspection.

H. M. Elder contributed a table giving the specifications for standard ladders employed by the American Locomotive Company. He said that although their standard rung was 1¼ in. in diameter, whereas the Code specified a minimum diameter of 1½ in., they had not yet had any failure caused by weakness of the rungs. The spread at the bottom of the ladders which they employed was greater than that given in the Code.

On their work ladders got the most and severest service possible, as men were continually handling heavy material up and down them and frequently standing on them working for long periods. The safety devices used at the top and bottom of these ladders were as shown in Fig. 1.

SAFETY STANDARDS FOR POWER-TRANSMISSION MACHINERY

The second code, entitled Safety Standards for Power Transmission Machinery, contained rules and requirements for the protection of industrial workers from hazards commonly presented by mechanical equipment used for transmitting and distributing the power from the prime movers to the various power-utilizing machines, tools and devices.

This code was presented by Rufus W. Hicks and was discussed orally by Hollis P. Porter and William A. Viall. Written discussions were contributed by W. G. Ashton, C. A. Tatum and H. A. Hale, Jr. The discussion follows:

Hollis P. Porter said that he had always found the dimensions of handrails specified as being of the strength and size of 1¼-in. standard-weight pipe. A standard-weight 1¼-in. pipe had an outside diameter of 1.31 in., and he would like to know whether that was the size meant in the Code and elsewhere.

He also asked whether the specification "If constructed of structural metal the rails imposed shall be at least equal in strength to 2 x 2 x 1¼-in. angles," related to just the handrail or to the screen guards which were to protect moving parts of a machine.

In regard to belt guards, he asked what size of angle iron should be used and what relation the size of the angle iron should bear to the span which it covered between its supports.

William A. Viall replied to Mr. Porter that 1¼-in. pipe meant 1¼ in. inside diameter—ordinary commercial pipe. Replying to Mr. Porter's second question, the clause quoted was under Par. 4; everything in that paragraph applied to handrails.

Rufus W. Hicks replied to Mr. Porter's third question that it seemed to be the general practice throughout the East and in Illinois to use 1 x 1 x ⅛-in. angles for erecting guards and that these might be used in practically all cases; but owing to the fact that specifying the strength of the different structural materials was more properly the function of the laboratory, the Committee felt it was not their place to take up some special-sized angle and say that it should be adopted as the standard.

W. G. Ashton,[1] in a written discussion, drew attention to Par. 6, which calls for the construction of guards of structural metal from not less than 2 x 2 x ¼-in. angle iron. He agreed that this weight of material was necessary in a great many instances, but had found that 1¼ x 1¼ x 3-16-in. angles were sufficiently heavy in most cases. It seemed to him that the medium strength could be reduced materially, with recommendations for heavier construction where necessary. That was the policy pursued by his department, and he had found it worked out successfully, especially, at this time, when the price of structural metal had increased so much.

In Par. 7 a center rail of 1 x 4 in. was called for, and he was not thoroughly convinced that this was a practical proposition. He had been using 2 x 4-in. construction throughout, and found it more satisfactory, because 1 x 4-in., unless carefully selected, was liable to warp and did not possess the strength it should. Likewise, they had found some objection to the 4 x 4-in. post. There were places, of course, where they

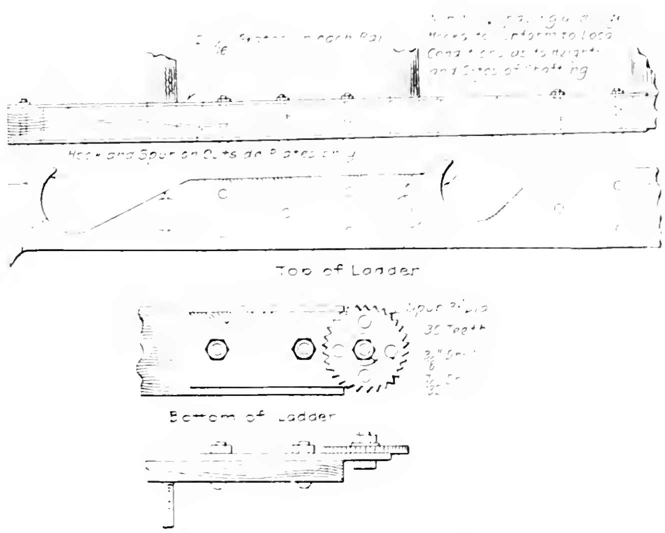

Fig. 1 Safety Devices Used on Ladders by American Locomotive Company

used it, but they applied largely the doctrine applied to the angle iron, using 2 x 4-in. construction entirely in many cases. In this connection, he suggested that the cast socket, where wood construction was used, was desirable, especially where it was necessary to remove the guard frequently. Another thing, they had found they should go more into detail, explaining that this type of construction should either be bolted together or fastened together with wooden screws. It made the guards easily removable, and when it came to durability they noticed the effect was very great.

They had found a recommendation as to the construction of angle-iron frames for guards absolutely necessary. So much of this work was squared up at the corners, oftentimes leaving a rough edge, which could be removed either by using a hack saw or an acetylene torch—the latter preferably, because the joint could then be welded, making it very substantial and doing away with the possibility of any rough edges.

In the matter of guarding the exposed sides and bottom, more especially the bottom, of high belts, particularly over passageways, many belts more than 7 ft. from the passageway were especially hazardous unless properly protected, and the notation in the Code on belts over driveways would not be

[1] Commissioner of Labor, Oklahoma City, Okla.

applicable in this case. As an illustration, a belt might be 8 ft above a runway and yet, should it break, would not only endanger life, but would endanger property as well. No hard and fast rule could be fixed on this proposition, of course, but the matter must be left largely to the judgment of an inspector. It did seem that some specific mention should be made of this particular condition, however.

The application of a guard between the belt and the pulley where the pulley was less than 30 in. from the bearing, he also regarded as inconsistent. The rule was very good where ladders were used for oiling and other work on the shaft, but he did think it could be reduced to approximately 20 in. in cases where runways were used.

In the matter of clutches, he believed that all clutches, wherever located, should be completely enclosed. The same rule should apply to them that was applied to set screws, and this same doctrine applied, in his judgment, to a majority of couplings.

The one problem that they had to contend with was the matter of protecting horizontal shafting. A condition in

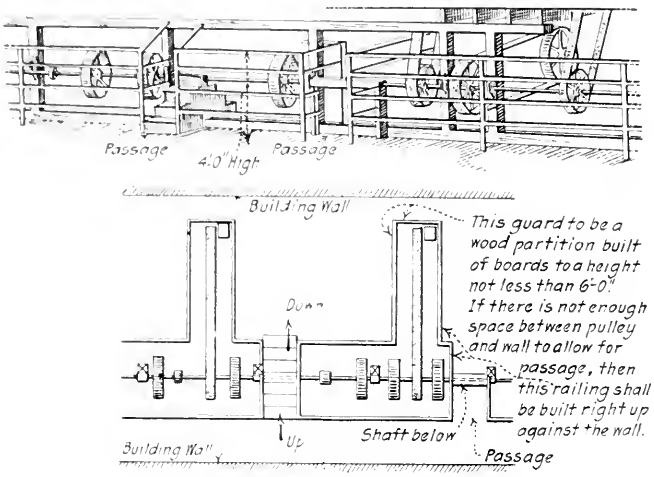

FIG. 1 GUARDS FOR GIN LINESHAFT

cotton oil mills and gins made it almost impossible to apply standard guards as specified under Classes A and B, and handrails must be relied upon to eliminate the hazard. In a cotton gin, for instance, the lineshaft would be in the basement and approximately 40 ft. long, with some 12 or 14 pulleys, averaging about 30 in. in size. The pulleys would all be equipped with idlers, and to place a handrail with a standard clearance of 5 in. from points of contact would make it impossible for the oiler to get to the bearings from the outside of the fence; likewise, belting one of the pulleys through a fence of 15 in. would be a very cumbersome job.

The common thing had been to put a gate at the edge of the fence or handrail, and the oiler, and others who had some operation to perform along the shafting, went down between the handrail and the moving parts. In fact, the belting was done from there and in many cases there was a tendency to crawl through the handrail and go under or over the shaft as the case might be.

Experiment with this proposition had shown that the belting and the oiling could be done from outside the guard, provided it was placed about 8 in. from the points of contact of the pulley. In fact, the gin men and the oil-mill men said that they belted with more ease following this method. To overcome the feature of crawling through the fence, it had been constructed 48 in. high, and made with four rails instead of two. Through this operation, all the serious accidents that had been occurring in the State in years past had been eliminated.

Argument had been advanced that this guard could be built around the pulleys, but too much care could not be taken about constructing as little of this mechanism around the shafting as possible. For this reason, they did not like the idea of building around each individual pulley; then, too, this reason did not apply in the case of overhead runways, and it seemed inconsistent to require it on ground-floor shafting. Fig. 1 showed their method of guarding a gin lineshaft. At the passageways the guard had to be closed up where the pulley was closer than 15 in.

He thought it would be beneficial to specify the weights and grade of filler to be used. Employers invariably allowed their economy ideas to prevail, with the result that galvanized wire mesh and things of that kind of very little weight were used. This has had a disastrous effect, because of lack of durability, damaged parts causing raw edges. They were now specifying 18 gage steelcrete with ½-in. mesh, or 13 gage with ¾-in. mesh, or diamond wire mesh of these weights and sizes, with very good results.

Specifications along construction lines should be incorporated in the specifications in Class A and B guards. Employers should be cautioned to construct the guards so as to leave the bearings outside the guard, and where this was impossible, the bearings should be tapped and equipped with extension oilers, extending outside the guard. Again, special caution should be given that where these close guards were made, doors full length of the guard, allowing the employees access when necessary to make repairs, should be provided. To further carry out this idea of repairs, where it was necessary floor sockets should be provided so as to make the guards easily removable. These sockets should be not less than 16 in. deep, with ¼-in. walls and a 3½-in. base ⅜ in. thick. On this point, in dealing with food-producing establishments, stress should be laid upon the necessity of leaving one side of this socket open so as to afford cleanliness. Also it should be specified that the filler, where used on 1¼-in. standard pipe should be constructed on an independent frame of not less than 1-in. channel iron secured to the iron pipe in a substantial manner.

A thing that seemed to have been overlooked in the specifications was a standard upright guard in front of high-speed belts at passageways, and this applied particularly at floor passageways. They had used two types of guard for protecting this, one type being iron pipe of various dimensions, setting it in concrete in the floor and extending it to the ceiling or supporting it from the wall back of the guard. Another was to use angle-iron frames filled in with very heavy sheet metal or boiler iron. In one plant the generator belts were protected with 4-in. iron pipe set in 3 ft. of concrete, using five pipes in front of each belt. These belts broke frequently, and the guard served as a perfect protection. In other places of lighter belts of less speed, they were using the angle-iron frames.

C. A. Tatum[1] wrote that it was important that standards be defined on conditions effecting the safety of machine operation, and also for the purpose of arriving at a fixed basis or practice for insurance purposes as well.

The matter of friction drives had also been overlooked in the Code. They were using a complete enclosure for this

[1] Manager, Safety Department, Texas Employers' Insurance Association.

type of drive, made on a frame of $1\frac{1}{4}$ x $1\frac{1}{4}$ x 3-16-in. angle filled in with 18-gage ½-in.-mesh expanded metal, or 20-gage sheet metal. This was the general type of guard. In other cases they were using a band guard of cast iron extending clear around the friction and flanged down on both sides beyond the points of contact. They were using 16-gage metal in most cases, reinforced with ½-in. strap iron.

Another thing they had found almost imperative was that solid enclosures for couplings, dead-shaft ends and things of that kind should be independently supported so as not to revolve with the moving parts. Where these guards were so constructed that they revolved with the moving parts, they created a hazard in themselves.

Referring to Par. 11, the insurance rating schedule took no consideration of the speed of the belts, charging for a 2-in. hack-saw drive the same as a 42-in. counter at 7000 ft. per min. and making the same requirement in each case. Belts over a certain weight and speed could not be protected by the ordinary guard from the dangers incident to breaking, but this danger would rather be increased in the event of a break by the presence of either woodwork or fabricated steel used as a guard; and it was his opinion in cases of this nature that the standard handrails, properly located, should be employed instead of trough guards or housings. A condition prevailed in the South in cottonseed-oil mills, of which there were a large number, where the drive of the attrition mill using two 8-in. belts to disks moving opposite it, required 8-in. belts at about 7000 ft. speed, and in which the most practical method of protection would be to use the hand rails shown in Fig. 44, of the proposed Code. The trough guards or a solid enclosure would increase the hazard on account of the necessity of a number of employees always being engaged in the vicinity of the machine.

With regard to Par. 29, set screws employed to secure pulleys could not be of the safety type, and it was necessary that exceptions be made in cases of this kind; but it should be required that a cover be used, which might be either of a turned wooden block properly secured, or a leather strip wound around the hub to the height of the screw, and made secure.

Referring to Par. 39, an effective signal system should be required in all plants where machinery was in group drive, and fixed rules should be established for the use of these signals. Negligence on this point had caused a large percentage of the serious accidents in the industries. The compensation rating schedule took no cognizance of a signal system, but it was his opinion that in many plants the importance of a well-laid-out signal system, with defined rules of operation, was such that it would be entitled to a substantial credit on the plant. It should carry about the same value as the stop-and-start device or ten-machine limit on group drives. Par. 34, should be a companion charge or credit, with a stop-and-start device on machinery.

Par. 40 dealt with an important feature in any plant, and it should be made requisite that the same record of inspection of improvements be kept on transmissions as on the individual machines.

Henry A. Hale, Jr.,[1] recommended the following changes in the Code to make it harmonious with the safety standards now recognized by practically all companies writing workmen's compensation and liability insurance throughout the United States:

Par. 2, Line 2, to read: "Guarded part is less than 4 in., etc.," the assumption being that a person's finger cannot project more than 4 in. and become injured, through a substantial guard that will not admit objects larger than 2 in.

Par. 3, Line 2, to read: "Guarded part is 4 in. or more, etc.," this change being explained as above.

Par. 4, Line 3, to read: "Extreme parts within 6 ft. of floor, a handrail 36 in. in height," this standard being recognized by the insurance companies as affording adequate protection.

Par. 4, Line 5, to read: "Supported at least every 8 ft., of substantial and rigid construction, with no sharp points or edges." With this definition it appeared that Pars. 5, 6 and 7 were entirely superfluous. The dimensions mentioned in these paragraphs did not contribute to the effectiveness of the guard unless the work of construction and erection was properly executed. The dimensions of materials used should therefore be left to the discretion of the one who designed or erected the railing.

Pars. 9, 11, 12, 13, 14 and 15 to be supplemented by the following:

"Belts (chain, rope) shall be completely enclosed or effectively guarded. Guards shall be of substantial construction, securely fastened in place and of such size and arrangement that a hand or other part of the body cannot project through, over, around or underneath guard, and be caught at point of contact of belt and pulley, or between spokes and pulley and adjacent framework or other fixed part.

"If the point of contact of belt and pulley is within 6 ft. of floor or platform level, a guard shall be provided, the top edge of which, if higher than the point of contact, shall not be less than 15 in. from such point of contact,[2] but in no case need the guard be higher than 6 ft. from floor or platform, nor shall it be less than 36 in. in height.

"If the top edge of guard is lower than the point of contact of belt and pulley located within 6 ft. of floor or platform shall be considered as standard if consisting of a double railing 36 in. in height.

"If the point of contact of a vertical and inclined belt and pulley is more than 6 ft. above the floor or platform, guard shall be 36 in. in height with the top edge not less than 3 in. nor more than 15 in. (measured horizontally) from the vertical projection of all portions of the belt and pulley within 6 ft. of floor or platform level.

"Where pulleys are of such dimensions and so located as to permit passage between upper and lower part of belt, standard railing shall be provided and a substantial passageway, guarded on sides and top, shall be constructed, or space, traversed by belt, shall be completely barred against passage.

"Overhead belts, with lower part 7 ft. or less from floor or platform level, shall be guarded on sides and bottom, or space underneath belts to be railed off to avoid use for passageway or storage."

It was inadvisable to use a railing for a guard in connection with rope transmission, except in some cases along the sides of a horizontal drive, as in many instances a broken rope had become entangled in a railing guard, causing considerable havoc.

In Par. 11 an exception was provided to the effect that guards were not required on belts "transmitting so little power that accidental contact therewith could cause no accident." This vague expression was very misleading, for he could not conceive of any equipment that would come under

[1] America Mutual Liability Insurance Co., Boston, Mass.

[2] It is undesirable to locate a guard more than 15 in. (measured horizontally) from a moving part and thereby permit persons to get between the guard and danger point.

this category. For example, a 5/8-in. diameter belt on a sewing machine had caused an injury to a female employee costing the insurance carrier $9,000 to settle. While he would not recommend that all 5/8-in. belts should be guarded, yet some definite width or diameter of belt should be expressly mentioned as a minimum where guarding was required.

In Par. 10, if the floor of a wagon was to be considered as a working platform, were we not permitting a railing on wagon floor to serve as a guard in accordance with Par. 15?

Pars. 24, 25, 26 and 27, Mr. Hale recommended, should be replaced by the following substitute: "All couplings within 7 ft. of the floor or working platform or within 36 in. of a bearing shall be concentric with the shafting and guarded as follows: Dangerous projections shall be completely enclosed or guarded in such a manner as will prevent the clothing of persons from being caught thereon."

In Par. 31, Line 2, the words "to stop immediately all power-transmission equipment" were objectionable, and as a substitute the following was recommended: "To disengage the power driving all engine-stop systems." To his knowledge there was no means of stopping all the power-transmission equipment "immediately" or "instantly" without inflicting considerable damage. Reference to "locking in stop position" should be confined to clutches and tight- and loose-pulley equipment.

Par. 41 permitted removal of guards for repairs and adjustments, while Par. 42 stated that guards should not be removed. This inconsistency should be corrected.

In conclusion, he recommended that action in adopting any code of standards for power-transmission machinery should be deferred at this time. There was an urgent need of harmonizing so far as possible, the code that might be adopted by the Society with other standard codes now in force, and it would appear that ample deliberation in this connection would tend to eliminate unnecessary waste and confusion by giving a little more time for careful consideration of the draft submitted.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

Strength of Boiler Furnaces

To the Editor:

In reply to Mr. H. J. Vander Eb's comments published in the February, 1917, issue of The Journal upon my communication on the Strength of Boiler Furnaces which appeared in the October, 1916, issue, the point I wished to bring out was the undesirability of a lap joint, and my discussion was leveled at the A.S.M.E. Boiler Code rule only, inasmuch as it permits a lap joint. I would like to see some criticism of the theory I suggested in the August, 1916, issue of the Journal of the American Society of Naval Engineers, on page 729, because, failing that, I maintain that a lap joint in a cylinder subjected to external pressure is far weaker than it has been hitherto supposed to be, and therefore all rules permitting it are bad. Interest centers round the A.S.M.E. Boiler Code rule as being probably the most influential one in the future.

Regarding the points raised by Mr. Vander Eb:

1 *Fairbairn's Rule.* This was taken because of its interest as the parent formula. It is customary to consider this as applying to jointless flues (if used at all). A careful perusal of Fairbairn's original paper prohibits its use for a lap joint. It is true Fairbairn used joints brazed and riveted, but it is equally sure that he regarded them as very different from a conventional lap joint. They were probably spliced joints and carefully brought to a true circle. As proof of this, note that Experiment 23 was an *ordinary* lap joint and that Experiment 4 was a single-strap butt joint. The relative strengths of these two joints were in the ratio 69.3 : 100.

In using results for the calculation of constant in formula, *Experiment 23 is ignored but 24 is taken.* Apart from this convincing fact, the phraseology often shows Fairbairn's clear conception of the importance of circularity.

I agree with Mr. Vander Eb's criticism of Fairbairn's formula. I think this is generally admitted.

2 *Hutton's Rule.* As this rule is closely allied to Fairbairn's, it is presumably intended for jointless flues (or truly circular flues, which are nearly equivalent), pending more definite evidence to the contrary. The fact that it is sometimes used for lap-jointed flues simply results in a smaller factor of safety than is supposed to exist.

3 Regarding the supposed unfavorable dimensions of the particular concrete case I took, it was the failure of this actual flue, due to buckling just outside the lap joint, that caused me to investigate the action of the joint analytically and, incidentally, to compare a few formulæ.

4 My application of the German Government rule was incorrect. I accept Mr. Vander Eb's correction.

5 I have never found any authority for using Lloyd's rule on lap-jointed flues. The fact that this is done in some instances merely goes to show the need of definite regulations in the matter to prevent appropriation of part of factor of safety.

6 *Board of Trade Rule.* I regret omitting to increase the constant by 10 per cent to allow for steel instead of wrought iron. This, however, will not check with Mr. Vander Eb's figure. My allowing for a single-riveted lap joint was quite correct, as the constant I took was for a double-riveted joint, which necessitated a reduction in the ratio of the supposed efficiencies. The several sources of information I consulted did not give a constant for a single-riveted lap joint.

7 The fact that Boiler Code rule takes into account the full length of the flue instead of separate sections, as some formulæ do, is admittedly in its favor where such conditions exist. Where such conditions do not exist it is rather pointless to argue what would happen if they did exist. Ultraconservatism under one set of conditions is no offset for shortcomings under other conditions.

I wish again to emphasize the weakness of a lap joint. I believe all formulæ which permit lap joints result in giving a much smaller factor of safety than is commonly supposed. I should very much like to see a discussion on the theory I

suggest, as hitherto we have looked upon the action in a lap joint as somewhat obscure from an analytical standpoint and not lending itself to definite analysis.

Until a fallacy in my theory is found I hold the opinion that a lap joint is capable of being analyzed, or at least that we can figure a certain condition that the actual state of affairs is equal to or worse. Moreover, this condition is surprisingly bad.

It is important to note that where a formula does not permit of a lap joint, and an adjustment is made according to the conventional theory for lap joints, as was done in the first part of my A.S.M.E. paper, the results are very questionable. The absurdity of the orthodox theory is grasped when it is considered that if the rivets fill the holes perfectly the efficiency will come close to 100 per cent when the joint is in compression. Actually I have shown that the joint proper may be left almost out of the question, as the weak spot is just where lapping begins. This is a well-known fact experimentally, as the double thickness of the plate remains intact, the buckling occurring just where this leaves off.

JOHN AIREY.

Chicago, Ill.

WORK OF THE BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in THE JOURNAL, in order that anyone interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee as approved by the Council on April 19-20, 1917, in Cases Nos. 146 to 152 inclusive. In this report, as previously, the names of inquirers have been omitted.

CASE NO. 146

Inquiry: Is it necessary under the requirements of the Boiler Code that pressed steel manhole plates shall be stamped as to the quality of the steel, heat number and tensile strength provided they are ordered flange or firebox steel?

Reply: The rules of the Boiler Code do not specify that pressed steel used for manhole plates should be stamped. The plates to be so stamped are specified in Par. 36 of the Code.

CASE NO. 147

Inquiry: What is the correct location for the bottom gage cock in a vertical tubular boiler? One-third the length of the tubes above the top of the lower tube sheet is found to be too short for short tubes and too long for long tubes.

Reply: It is the opinion of the Committee that this inquiry is answered by Case No. 86. In the revised Code the fusible plug limits given in Par. 430 of the Boiler Code will be estalished as the lowest permissible water levels for the various types of boilers.

CASE NO. 148

Inquiry: Will the design of steel handhole cap for use in water tube boilers of the waterleg type, shown in Fig. 7, meet with the approval of the Boiler Code Committee? This cap requires no gasket to make it tight, being inserted in the hole from the inside of the waterleg and expanded from the outside with a special expanding tool, which is also used for the purpose of truing up the holes, making them standard size and slightly tapering from the inside outward.

Reply: The Committee has decided that it will not express approval of any specific construction. Attention is called to the fact that a device of the sort should meet the requirements of Par. 251 which calls for the ends of all tubes, suspension tubes and nipples when not beaded to be flared not less than 1/8 in. over the diameter of the tube hole on all water tube boilers and superheaters, this flare in the present instance to be on the pressure side of the plate. If the requirements of this paragraph are met, there is nothing in the Code to prevent the use of the design, provided the material from which it is constructed meets the requirements in Par. 5.

CASE NO. 149

Inquiry: Will the arrangement of equalizer pipe for double drum water tube boilers, shown in Fig. 8, meet with the approval of the Boiler Code Committee for working pressures up to 225 lb.? The equalizer is to be made of extra heavy cast iron flanges, the joints in the pipes to be welded.

Reply: It is the opinion of the Committee that this design will not be permissible under Par. 277 of the Code.

CASE NO. 151

Inquiry: Are cast iron dovetail or slip lugs permitted under the rules of the A.S.M.E. Boiler Code for horizontal return tubular boilers?

Reply: It is the opinion of the Boiler Code Committee that there is nothing in the Code to prevent the use of this type of bracket, provided it is properly designed and conforms to Pars. 323, 324, and 325, and is used only where cast iron brackets are allowed.

CASE NO. 152

Inquiry: Is it necessary that safety valves for use on industrial steam locomotives, that are not subject to federal inspection or control, shall, if constructed to meet the requirements of the A.S.M.E. Boiler Code, be fitted with the lever specified in Par. 282? It would appear advisable to make the use of the lever optional inasmuch as 70 or 80 per cent of the railroad locomotives in the United States are using safety valves without levers.

Reply: If the safety valves referred to are to be applied to boilers that are to be constructed and inspected under the Boiler Code, it will be necessary to apply the levers and in all other respects conform to the requirements of the Code.

Progress of the Code

Members will be interested to know what progress the Boiler Code has made in the various states, and the following are excerpts from a report made by Mr. Thomas E. Durban.

chairman of the administrative council of The American Uniform Boiler Law Society, on that question.

NEW YORK

The Code Committee of New York has formally adopted the A.S.M.E. Code and reported it favorably to the Industrial Commission. The Commission consists of the following: John Mitchell, Chairman; Edward P. Lyon, Louis Wiard, James M. Lynch, and Henry D. Sayer. A great deal of the work has been done by Thomas C. Eipper, Deputy Commissioner, and chairman of the Committee on Boilers.

Probably no state will give the matter of the Boiler Code greater care than did the State of New York. The Code Commission went up and down through the state, and then published a tentative code, and went up and down the state again, getting criticisms and comments on this code, pursuing much the same course that the Boiler Code Committee of The American Society of Mechanical Engineers pursued in its original work, but gave the public greater chance, perhaps, to criticize and make suggestions than has ever before been accorded. Meetings were held in Buffalo, Syracuse, Rochester, Utica, Albany and New York, and much interest was developed and much valuable information obtained. It is a great compliment to our Committee that, after all this strenuous work, the A.S.M.E. Code was adopted verbatim.

We have just been advised by the State Industrial Commission of New York that the Commission, at a meeting held June 5, 1917, adopted the proposed rules for boilers in factories in the State of New York, as formulated by their Advisory Committee, effective July 1, 1917, new construction, effective January 1, 1918.

MICHIGAN

An enabling act was passed unanimously by the house and senate, and has been signed by the governor, and a committee will be appointed to proceed with the adoption of the Code.

In all the effort made, the understanding has been that the A.S.M.E. Code would be adopted. It is reported that the Code will not be placed in effect till early next year.

Great assistance has been rendered by Mr. J. C. McCabe, Chief Inspector of Steam Boilers of the City of Detroit; Professor M. E. Cooley, of the University of Michigan; Professor Bissell, of Lansing; Mr. E. C. Fisher, of Saginaw; and Mr. T. H. Hinchman, of Detroit.

NEW JERSEY

An enabling act was passed by the legislature and signed by the governor, the same as in Michigan, and it is understood that in due time New Jersey will issue the Code and announce the date of its going into effect.

The Code will be put into operation under the jurisdiction of Colonel Lewis T. Bryant, Commissioner of Labor. A Board of Boiler Rules has been appointed which consists of three inspectors, Messrs. Case, Scott, and Walker, and two appointees from the community at large: F. W. Casler, Mem. Am.Soc.M.E., representing the boiler users, and Frank Van Winkle, representing the boiler operators.

MINNESOTA

Minnesota has issued a notice through the duly appointed representatives of the Inspection Board of the state, that on and after January 1, 1918, all boilers must be made according to the A.S.M.E. Code. This has been approved by the governor, and renders the Code absolutely effective after the date mentioned.

Much of the credit for the accomplishment of this is due to Mr. Max Toltz and Mr. Oliver Crosby, of St. Paul.

MISSOURI

The City of St. Louis has passed the Code to put it in operation, as has also Kansas City, and it is understood that the City of St. Joseph is contemplating similar action. With the example set by these cities, at the next meeting of the legislature the Code will probably be adopted by the State of Missouri.

COLORADO

The new Industrial Commission of the state will probably have the power to adopt the Code, and the Boiler-Law Society is in correspondence with the Commission at this time.

CANADA

The Province of Manitoba is revising its boiler code, and expects to call a meeting in the near future with the idea of getting the coöperation of the other provinces in Canada, in the hope that a universal rule can be made for Canada. The Boiler-Law Society is in correspondence with the various provinces, and there has been expressed a desire to make the A.S.M.E. Code operative in Canada. In this the Society has the strong support of the Province of Ontario, which is one of the leading provinces in Canada, and also of the leading boiler manufacturers throughout the entire Dominion.

SUMMARY

The states and cities in which the Code has been adopted or is in process of adoption are:

New York	Indiana
New Jersey	Michigan
Pennsylvania	Wisconsin
Ohio	Minnesota

California

Kansas City and St. Louis, Missouri

Respectfully submitted,

(*Signed*) THOS. E. DURBAN,
Chairman.

An American Committee of Engineers has been formed in London which will be glad, among other duties, to give assistance to any American engineers arriving in England on any official business connected with the War. This assistance would probably take the form of offering advice and hints as to saving time in approaching British official departments.

The address of the committee is 6 Copthall Avenue, London, E. C., and the Hon. Secretary is Mr. C. W. Purington.

A memorial fountain has been erected in the old engineering building of Tulane University, in honor of Prof. Henry F. Rugan, associate professor of mechanical arts at the University at the time of his death, September 3, 1916. Mr. L. W. Zeller made the presentation speech on behalf of the students, and Prof. W. H. Creighton, dean of the College of Technology of Tulane University, in accepting, praised the research work on the growth of cast iron by Professor Rugan.

Society Affairs

Engineering Survey

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

ABRIDGED LIST OF OFFICERS AND COMMITTEES[1]

OFFICERS AND COUNCIL, 1917

President

Ira N. Hollis

Past-Presidents

Members of the Council for 1917

Alex. C. Humphreys
W. F. M. Goss
James Hartness
John A. Brashear
D. S. Jacobus

Vice-Presidents

Terms expire December 1917

Wm. B. Jackson
J. Sellers Bancroft
Julian Kennedy

Terms expire December 1918

Charles H. Benjamin
Arthur M. Greene, Jr.
Charles T. Plunkett

Managers

Terms expire December 1917

Charles T. Main
Spencer Miller
Max Toltz

Terms expire December 1918

John H. Barr
H. de B. Parsons
John A. Stevens

Terms expire December 1919

Robert H. Fernald
William B. Gregory
C. R. Weymouth

Chairman of Finance Committee

Robert M. Dixon

Treasurer

William H. Wiley

Honorary Secretary

Frederick R. Hutton

Secretary

Calvin W. Rice

Executive Committee of the Council

Ira N. Hollis, *Chairman*
John H. Barr
Arthur M. Greene, Jr.
D. S. Jacobus
Charles T. Main
Spencer Miller

COMMITTEES, ETC.

STANDING COMMITTEES

Chairmen

Finance, Robert M. Dixon
Meetings, Robert H. Fernald
Publication, Fred. R. Low
Membership, To be appointed
Library, John W. Lieb
House, Frederick A. Scheffler
Research, R. J. S. Pigott
Constitution and By-Laws, F. R. Hutton
Standardization, Henry Hess

SOCIETY REPRESENTATION

American Association Advancement of Science
American Society Testing Materials, Joint Conference Committee
American Society for Testing Materials, Modification Briggs Standard for Pipe Threads
Classification of Technical Literature
Conference Committee on Electrical Engineering Standards
Conference Committee of National Engineering Societies
Conservation
Engineering Foundation
Expert Testimony Committee
John Fritz Medal, Board of Award
Joseph A. Holmes Memorial Association
Military Engineering Committee
National Defense Committee
Naval Consulting Board of the United States
Standardization of Pipe and Pipe Fittings for Fire Protection
Trustees United Engineering Society

SPECIAL COMMITTEES

Chairmen

Administration, Robert M. Dixon
Am. Soc. M. E. Junior Prizes
Am. Soc. M. E. Student Prizes
Boiler Code Committee, John A. Stevens
Committee on Engineering Resources, George J. Foran
Conference Committee on American Engineering Standards
Conference Committee to Determine Cost of Electric Power, W. B. Jackson
Engineering Education
Flanges and Pipe Fittings
Increase of Membership, A. L. Williston
Joint Committee on Standards for Graphic Presentation, Willard C. Brinton.
Local Sections, D. Robert Yarnall
Machine Tools Standardization
Metric System, L. D. Burlingame
National Defense Committee
National Museum
Nominating Committee, L. E. Strothman
Patent Laws
Pipe Threads, International Standard, Edwin M. Herr
Power Tests, Geo. H. Barrus
Refrigeration, D. S. Jacobus
Research Committee,
- Sub-Committee on Bearing Metals, C. H. Bierbaum
- Sub-Committee on Cutting Action of Machine Tools, Leon P. Alford
- Sub-Committee on Fuel Oil, Raymond H. Danforth
- Sub-Committee on Investigation of the Clinkering of Coal, Lionel S. Marks
- Sub-Committee on Lubrication, Albert Kingsbury
- Sub-Committee on Materials of Electrical Engineering
- Sub-Committee on Safety Valves
- Sub-Committee on Steam Flow Meters, R. J. S. Pigott
- Sub-Committee on Worm Gearing, Fred. A. Halsey

Student Branches, Frederick R. Hutton
Tellers of Election, Robert H. Kirk
Tolerances in Screw Thread Fits, L. D. Burlingame

SECTIONS COMMITTEES

Chairmen and Secretaries

Atlanta, Oscar Elsas, Cecil P. Poole
Baltimore, W. W. Varney, A. G. Christie
Birmingham, J. H. Klinck, J. G. Hatman
Boston, W. G. Starkweather, A. C. Ashton
Buffalo, David Bell (Secretary to be appointed)
Chicago, A. D. Bailey, A. L. Rice
Cincinnati, F. A. Geier, J. T. Faig
Detroit, G. W. Bissel, S. J. Hoexter
Erie, J. F. Wadsworth, M. E. Smith
Indianapolis, W. H. Insley, (Secretary to be appointed)
Los Angeles, F. G. Pease, T. J. Royer
Milwaukee, W. M. White, F. H. Dorner
Minnesota, H. L. Brink, E. A. Wilhelm
New Haven, H. B. Sargent, E. H. Lockwood
New Orleans, H. L. Hutson, E. W. Carr
New York, J. J. Swan, A. D. Blake
Ontario, R. W. Angus, Chester B. Hamilton, Jr.
Philadelphia, L. F. Moody, J. P. Mudd
St. Louis, R. L. Radcliffe, E. H. Tenney
San Francisco, B. F. Raber, C. H. Delany
Worcester, Geo. I. Rockwood, R. G. Williams

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[1]A complete list of the officers and committees o the Society will be found in the Year Book for 1917 and in the March, 1917 issue of The Journal.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

EVERYONE is asking what the Society is doing to help the Government. First, a committee, consisting of Messrs. George J. Foran, Chairman; A. D. Blake, Henry C. Meyer, Jr., C. M. Allen and John H. Barr, has issued a personal classification sheet to every member of the society, and the replies are being collated. Already four hundred names of members of the society have been furnished the Government in answer to specific requests from the War Department. This is in addition to the work of the Employment Bureau, through which the Society gives special attention in the matter of placing men in positions in the industries.

Second, the society is an active member of the Engineering Committee of the Advisory Commission of the National Council of Defense, and several meetings have been held leading to definite and constructive assistance in the manufacture of munitions and in foreseeing the wants of the Government in the matter of power.

Third, as has already been stated, many of the members of the Society are serving on the Engineering Committee of the National Research Council, which is maintained by the funds of the Engineering Foundation, and in which this Society is a participant.

Fourth, as a result of the Spring meeting of the Society, a committee has been appointed by the Council, with the President as chairman, which will first investigate and then recommend to the Council how this Society can best assist in the establishment of a comprehensive system of the manufacture of munitions in the United States, including the establishment of a Central Bureau for master gages and district headquarters for copies of those gages, with provision for the comparison of working gages with those copies of the master gages, similar to what it is understood is in vogue in Canada.

The United States must in this present crisis be conducted as one business, with every man, woman and child working to a common end.

In another column are given the appointments on the Engineering Council, and it is possible now to accomplish many of the activities which the engineering profession, as a whole, may undertake. A meeting for the organization of the Council will be called in the near future.

The Society is also in conference with the Adjutant-General of the State of New York, through whose office has been established the Resource Mobilization Bureau of the State of New York, and is prepared to render similar services to the officers of other states in connection with taking industrial censuses.

The Secretary would be pleased to receive suggestions of ways in which the Society can render further service, and also offers of individual services in addition to what may be included in the personal classification sheets just issued to the membership.

CALVIN W. RICE,
Secretary.

COUNCIL NOTES

A MEETING of the Council was held on May 21, in Cincinnati, Ohio, in connection with the Spring Meeting. The following members were present: Ira N. Hollis, *President*, John H. Barr, C. H. Benjamin, W. F. M. Goss, James Hartness, Oberlin Smith, F. R. Low, chairman of the Publication Committee, and Calvin W. Rice, *Secretary*.

Engineering Resources. George J. Foran, chairman, C. M. Allen, John H. Barr, A. D. Blake and H. C. Meyer, Jr., were appointed a special committee on Engineering Resources to prepare a Personal Classification Sheet[1] for the purpose of putting on file immediately, classified data of the membership, to be of assistance in placement activities in the present national emergency.

Finance Committee. Upon recommendation of the Finance Committee, it was decided to subscribe to ten thousand dollars of U. S. Liberty Bonds, taking the necessary money from funds of the Society, even at some inconvenience.

Engineering Council. Five representatives of our Society were appointed on the Engineering Council, as follows: Charles Whiting Baker, John H. Barr, Arthur M. Greene, Jr., Ira N. Hollis and D. S. Jacobus.

Constitution and By-Laws. Amendments to the Constitution and By-Laws as presented by the Committee on Constitution and By-Laws were referred to the Business Session of the Spring Meeting. These amendments deal with standing committees, professional committees, discussion of political matters, and quorum at Council meetings. They will be again brought up at the Annual Meeting.

Joint Committee on Terminology. In response to an invitation from the National Electric Light Association, H. C. Anderson, N. A. Carle and F. R. Low were appointed to represent the Society on an advisory committee on Terminology.

Sections. The following executive committees for the Sections of Baltimore, Indianapolis, New York and Toronto were approved:

Baltimore: W. W. Varney, chairman; L. B. Robertson, vice-chairman; A. G. Christie, secretary; C. C. Thomas, treasurer, and Wm. Chatard, member executive committee.

Indianapolis: W. H. Insley, chairman; L. M. Wainwright, vice-chairman; B. G. Mering, treasurer; F. C. Wagner and L. W. Wallace.

New York: John J. Swan, E. J. Prindle, A. D. Blake, J. H. Norris and W. H. Greul.

Toronto: G. V. Ahara, R. W. Angus, C. R. Burt, L. H. Fletemeyer and C. B. Hamilton.

[1] This form has been sent out to the membership during the past month.

Student Branches. The establishment of a Student branch at Michigan Agricultural College, East Lansing, Mich., was approved.

Standardization Committee. Upon recommendation of the Standardization Committee there is to be appointed a committee on standardization of small hose couplings, other than fire hose couplings. A committee on standardization of roller chains is also to be appointed.

A.S.M.E. Boiler Code. Interpretations in cases Nos. 146 to 152 were approved and ordered published in THE JOURNAL. They are included in this issue.

CALVIN W. RICE, *Secretary.*

SPRING MEETING ENTERTAINMENT

THE entertainment arranged by the Cincinnati Local Committees for the Spring Meetings of our Society and of the National Machine Tool Builders' Association, demonstrated alike the inventive capacity and hospitality of Cincinnati engineers. Event succeeded event in almost startling array, and with a perfection of detail such as only a master hand can give.

THE SMOKER

Tuesday evening was "pleasure first" night, with which no one was supposed to allow any duties to interfere. It was the night of the smoker, and, so far as known, every engineer in attendance at the meeting responded to the call to be at the Business Men's Club "promptly at 8 o'clock" to participate. Shortly after arrival the company formed in a procession, headed by President Hollis and F. A. Geier, and was conducted to the large hall of the club by a fifer and drummers, veterans of the Civil War, who portrayed the "Spirit of '76," as well as the spirit of hospitality of 1917. When in the hall the visitors found themselves facing the street of a mining town of the far-western type, realistic in every detail. It proved to be Losantiville, the pioneer settlement from which grew the city of Cincinnati. Here were the early settlers true to life—historic characters, all of them, including the engineer who was to lay out and develop the city that was to be. There was an attack by Indians, and then a peace conference, at which the engineer saved the day by a portrayal of the possibilities of the future for the community. Peace declared, all were invited "inside" to celebrate.

The complete program of the evening comprised 18 numbers. A band played spirited music, and patriotism was cultivated by a quartet in khaki, which sang several national airs amid appropriate surroundings. There was a mock trial, with many unique features, including the musician, who demonstrated that he was an "engineer," and so eligible for jury duty, by playing most remarkably on the one string of a violin which he had constructed of a "cigar box and a broom handle." In this and in the laughable presentation of the Cincinnati plan of education which followed, the characteristics of several prominent members of the profession were portrayed in a way that delighted the audience. The mock trial was preceded by a rapid-sketch artist, who brought into the limelight several members of our Society and of the National Machine Tool Builders' Association.

At the close of the evening, promptly at 12 o'clock, Dr. Hollis was called to the stage and addressed by Chairman Geier, who expressed the pleasure that all Cincinnati members would feel in presenting him with a token of their esteem. Thereupon H. M. Norris, of the entertainment committee, headed a procession for the stage, and bore a large vase to the platform. But alas! as the top step was reached, Mr. Norris tripped and fell, the vase was shattered, and a look of consternation was on every face. Nothing abashed, Mr. Geier stepped forward and said that the committee would now make a presentation of a Cincinnati product, and thereupon gave Dr. Hollis a bit of beautiful Rookwood pottery, a framed plaque representing a woods scene in the vicinity.

A bounteous repast—no mere luncheon—was served during the evening; and at intervals the hall was made beautiful by remarkable kaleidoscopic lighting effects produced by throwing lights against slowly rotating colored balls with myriads of reflecting surfaces.

ENTERTAINMENT FOR THE LADIES

While the men were at the smoker the ladies were not forgotten, for they were asked to assemble in the small ballroom of the Hotel Sinton to witness a performance under the direction of Helen Schuster-Martin, Managing Director of The Little Playhouse Company, Cincinnati. Two plays were given, "The Maker of Dreams," by Oliphant Downs, and "How He Lied to Her Husband," by Bernard Shaw. These were followed by a dancing pantomime.

The ladies' committee, of which Mrs. R. K. LeBlond was chairman, issued a very attractive program for the occasion.

In many ways throughout the meeting the stay of the ladies in Cincinnati was made pleasant for them through their gracious reception by the Cincinnati ladies. For Monday visits were planned to the wonderful new city hospital and to the Woman's Club. On Tuesday was an excursion to Rookwood Pottery and the Art Museum, and in the afternoon an automobile ride to Fort Thomas and tea at Hotel Altamont. Tuesday was styled "Ladies' Day." It was, indeed, a day of pleasure for the visiting ladies.

On Wednesday and Thursday were other excursions, shopping trips, automobile rides, etc., in addition to the events in which both men and women participated.

BOAT TRIP AND AUTOMOBILE RIDES

On Wednesday all went on the *Island Queen* to Fernbank Dam and back, and enjoyed a delightful afternoon. The spacious dancing floor of the large boat was well patronized, and there was an amusing cakewalk competition by three "darky" couples engaged for the occasion, who did the stunt in true Southern fashion. Prizes were awarded according to the amount of applause.

On Thursday afternoon there was a procession of 160 automobiles bearing the party for an afternoon's outing, and, as some one remarked, "Not a 'flivver' among them." Two service automobiles accompanied the party. They were not needed, but their presence indicated the extreme care that was being given by the local committees for every detail. The ladies had had luncheon at the Zoological Garden, where they were met by the men, and from where all went to the Country Club for tea. A considerable number also were taken on rides on Friday afternoon.

VISITS TO SHOPS

For the engineers present, one of the great features was the opportunity of visiting the shops of the city, so many of which

have new and modern structures. The development of these shops in output and in progressive methods during the past few years has been very noteworthy.

As a courtesy on the part of the Lunkenheimer Company, a very handsome souvenir was distributed in the form of a paperweight bearing the American eagle mounted on a flag-decorated standard. Not only was this an attractive gift, but one that interested many because of the refinements of production required in its manufacture.

WEDNESDAY EVENING'S ENTERTAINMENT

The guests who went to the grand ballroom of the Hotel Sinton on Wednesday evening expecting to participate in the usual dance and reception were both surprised and pleasantly disappointed. The dance was held, it is true, but not until a most elaborate entertainment had been given on the ballroom stage. There was a series of finely executed moving pictures of the maneuvers of the Ohio cavalry troop on the Mexican border, besides pictures of Cincinnati and vicinity, and a film prepared specially for the occasion of the Cincinnati Committee preparing for the convention. The finance committee was shown collecting the funds, and woe-betided any wealthy manufacturer who entered the room, for his pockets were instantly rifled and his funds commandeered for the use of the committee. In disbursing the funds, the committee decided after their own manner how this should be done, incidentally pocketing occasional stray dollars.

There were music and professional dancing on the stage, and the entertainment concluded with an elaborate interpretive dance performance by the Goldenburg Players of Cincinnati. This was the portrayal of a fanciful tale in which children largely participated, and drew the enthusiastic applause of the audience. It was the most spectacular performance of the whole meeting, and greatly enjoyed and appreciated.

C. Wood Walter

J. B. Doan, President N. M. T. B. A.

A. H. Tuechter

One of the Pleasant Features of the Spring Meeting was the Association with the National Machine Tool Builders' Association. President Doan and Messrs. Geier, Walter and Tuechter Constituted the N. M. T. B. A. Executive Committee.

Business Meeting at Cincinnati

As usual, preceding the first session of the Spring Meeting was the regular business meeting. The chief item of business was the announcement of certain proposed changes in the Constitution which will later be submitted to the membership for letter-ballot and then will come up for discussion and action at the next Annual Meeting. These changes relate to age limit for junior members; reduction in the number of Standing Committees; change in the number of members constituting a quorum of the Council; provision for an increased number of so-called Annual Committees; etc.

President Ira N. Hollis announced that the Council had voted to invest $10,000 of the Society's funds in a subscription to the Liberty Loan, even at some slight inconvenience; and that whereas the Council alone had authority to do this, nevertheless it was desired to apprise the meeting of this action. In taking this action the Council felt that, as the agent of the entire Society, it was voicing the overwhelming opinion of the membership in its desire to subscribe to the success of what everyone had so much at heart.

It was further announced by President Hollis that a Committee on Engineering Resources had been appointed, which was about to issue a blank to the membership for the purpose of securing data upon the professional experience of each member and his ability to serve the Government, should the call come for engineers to enter Government service. He said that he believed the country would not make the mistake that England made at the outset of the war by sending her best industrial men to the trenches. While many engineers would go into the Army, and many of the graduates of his own institution, the Worcester Polytechnic Institute, had already gone as reserve officers, he thought every man in the Society ought to do contentedly and willingly the thing that he was best adapted to do.

MAJOR GENERAL GOETHALS ELECTED HONORARY MEMBER

To the list of illustrious men who have been honored by the Society there is added one more name—that of Major General George W. Goethals, who will go down in history as the builder of our "Big Ditch," the Panama Canal.

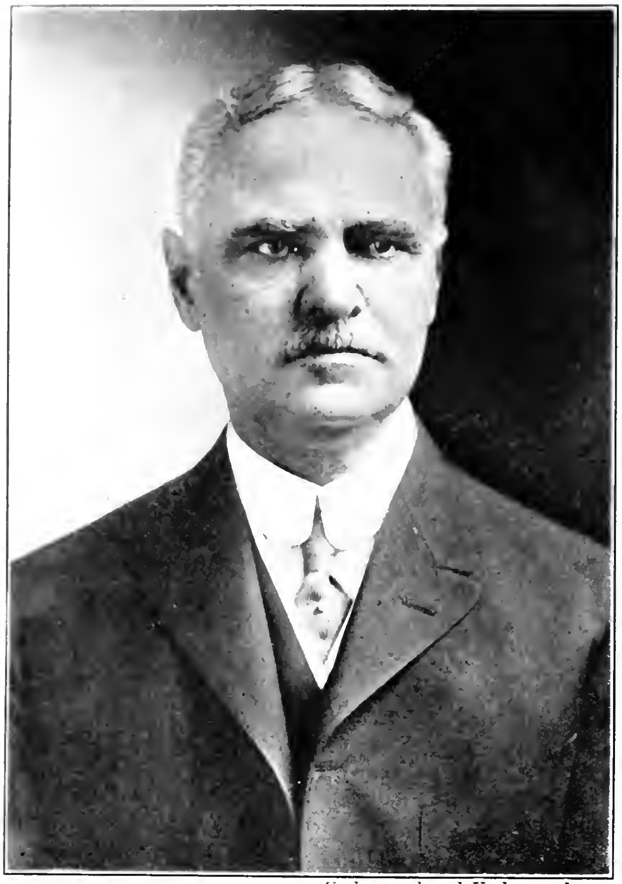
The preeminent gifts of "the Colonel," as thousands of Canal workers have known him affectionately during their work on the Isthmus, have been demonstrated in many ways but most conspicuously in two directions first, in his truly marvelous capacity for mastering and retaining details, and second, in his ability to win the confidence and inspire the loyalty and enthusiasm of those working under him. He is one of those rare persons whose full knowledge of details does not hamper his mental vision. He possesses the one all-necessary gift for successful leadership—sagacity.

Innumerable sketches of General Goethals' life have been written, but the facts and incidents of a great career are always of interest.

George W. Goethals was born in Brooklyn, N. Y., in 1858. His was not the carefree life of many a youngster, for at eleven years of age he began work as an errand boy in a broker's office, working after school hours and in the evenings. As proof of his efficiency, at fourteen he was cashier and bookkeeper of a firm. At this time he was studying in the College of the City of New York. His early ambition was to be a doctor, and with this end in view he matriculated at Columbia University; but poor health compelled him to give up this plan. He made a number of attempts to get an appointment to the United States Military Academy at West Point before he was successful. However, in 1876, at the age of 18, he received his appointment, and under the strict régime of that famous institution soon regained his full strength and health. He attained there the three principal honors within the reach of a cadet: he stood second in his class in scholarship, he was chosen as one of the four captains of the cadet corps, and he was elected senior president of his class. He was graduated in 1880, receiving an appointment as second lieutenant in the Corps of Engineers. In 1885 he returned to West Point and served as assistant professor of military engineering until 1888.

He gained his practical experience for the great task of Panama by hard work and tireless energy. Among his most important tasks were the construction of dams, canals and locks at Mussel Shoals in the Tennessee River, and the extensive fortification and harbor work at Newport, R. I. In 1903 he was called to Washington as a member of the General Staff, one of the first engineers to be so appointed.

It was in 1903 also that he was appointed chairman as well as chief engineer of a new commission—composed on its technical side of army and navy officers—for the completion of the Panama Canal.



Underwood and Underwood.

Major General George W. Goethals

His work on the Canal is distinguished by its signal efficiency. Everyone on the Isthmus worked hard, but none worked harder than did "the Colonel." He stopped work at night only to sleep, and sometimes, in his own phrase, he "took the Canal to bed with him."

If there was anything more wonderful on the Isthmus than the efficiency of the force that was building the Canal, it was its *esprit de corps*. Everybody from "the Colonel" down and back again believed in the Canal, loved the Canal and fought the great fight that made the Canal a reality. Toward his fellow-workers his motto was, "Be considerate, just and fair with them in all dealings, treating them as fellow-members of the great brotherhood of humanity."

"Tell the Colonel," was the characteristic refrain of a popular song on the Isthmus, and everyone proceeded with his grievance, problem or suggestion to follow that rule. In turn they received ungrudging justice, all-around helpfulness and cordial recognition. The building of the Panama Canal will always stand as a monument of fame to "the Colonel."

In 1913 the degree of LL.D was conferred on him by the University of Pennsylvania. In the spring of 1914 he was awarded medals by the National Geographic Society, the Civic Forum (New York), and the National Institute of Social Sciences. Late in 1913 and early in 1914 he was in demand for various administrative positions, declining the police commissionership of New York City, offered to him by Mayor Mitchel and the "city managership" of Dayton, Ohio. On February 3, 1914, he was appointed by President Wilson the first civil governor of the Panama Canal Zone. By act of Congress, March, 1915, he was made Major General. On June 11th of this year Rutgers College conferred on him the honorary degree of Doctor of Science.

Though appreciative of all his many honors, General Goethals is unusually averse to having any public recognition made of his work, and finds his greatest satisfaction in the completion of what he set out to do.

Just recently, in April of this year, General Goethals agreed to supervise the building of ships authorized by Con-

gress to be built under the United States Shipping Board Emergency Fleet Corporation. In view of the National call upon his services he has been released by Governor Edge of New Jersey from his contract to supervise the $15,000,000 expenditure for reconstructing the highways of that state.

General Goethals' success is due to a few broad, solid and simple principles, at the base of which lies the quality of loyalty. He believes profoundly in action and in taking responsibility. He believes that the sense of duty to one's self and to one's country should be the incentive to achievement—not the hope of reward either in profit or fame.

Formal presentation of the "diploma" of honorary membership will be made at General Goethals' convenience—it is hoped at the Annual Meeting in December.

Report of Nominating Committee

The Secretary announces the receipt of the report from the Nominating Committee, charged with the duty of nominating candidates for offices in the ensuing year:

June 16, 1917

To the Secretary:

Dear Sir—The Nominating Committee, appointed by the President to submit names of nominees for the various elective offices next falling vacant under the Constitution, report that after considering the communications from the membership and as a result of several meetings of the committee and conferences with the Sections, the following gentlemen have been selected. The committee has communicated with each and has their acceptance in writing of the nominations.

For President for one year:
Charles T. Main, Boston, Mass.
For Vice-Presidents, for two years:
Spencer Miller, New York, N. Y.
Max Toltz, St. Paul, Minn.
John Hunter, St. Louis, Mo.
For Managers, for three years:
Fred A. Geier, Cincinnati, O.
D. R. Yarnell, Philadelphia, Pa.
Fred N. Bushnell, Boston, Mass.
For Treasurer:
William H. Wiley, New York, N. Y.

Respectfully submitted,
(*Signed*) L. E. Strothman,
Willis H. Carrier,
Frederick W. Gay,
A. M. Lockett,
Paul B. Morgan.

Engineering Council

In order to provide coöperation between engineering societies and for the consideration of questions of general interest to engineers and their relations to the public, and to provide a means for united action upon questions of common concern to engineers, the United Engineering Society has established the Engineering Council. It has been instituted with the A.S.C.E., A.I.M.E., A.S.M.E. and A.I.E.E., each having five representatives upon the Council and the United Engineering Society having four representatives. Provision has been made for increasing the number of Societies represented on the Council.

The Council may speak authoritatively for all member societies on public questions of a common interest or concern to engineers.

By-laws governing the activities of the Council have been drawn up and added as amendments to the by-laws of the United Engineering Society.

The representatives on the Council who have thus far been appointed, are as follows:

American Society of Civil Engineers:
Geo. F. Swain — John D. Galloway
Frederick H. Newell — John F. Stevens
Alexander C. Humphreys

American Institute of Electrical Engineers:
H. W. Buck — P. Junkersfeld
E. W. Rice, Jr. — C. E. Skinner
N. A. Carle

American Institute of Mining Engineers:
P. N. Moore — J. Parke Channing
S. J. Jennings — Edwin Ludlow
B. B. Lawrence

The American Society of Mechanical Engineers:
I. N. Hollis — A. M. Greene, Jr.
Charles Whiting Baker — D. S. Jacobus
John H. Barr

United Engineering Society:
Clemens Herschel — I. E. Moultrop
B. B. Thayer — Calvert Townley

ROLL OF HONOR

To the lists already published of those members of the Society who have enlisted in the national service is added the following supplement:

Baldwin, Bert L., Captain, Engineer Officers' Reserve Corps.*
Blood, John Balch, First Lieutenant, U. S. S. Nebraska.
Goetzenberger, Ralph L., First Lieutenant, Ordnance, Officers' Reserve Corps.
Hiles, Elmer K., Captain, Fifth Regiment, Engineer Officers' Reserve Corps.
Howell, Arthur K., Ordnance Dept., Officers' Reserve Corps.*
Hurxthal, Alpheus O., Lieutenant, Ordnance, Officers' Reserve Corps.*
Lynde, Charles C., Engineer Officers' Reserve Corps Camp at Ft. Oglethorpe, Ga.
Maynz, Theodore, Engineer of the Signal Corps, Aviation Department.*
Meixner, Bernard A., Captain, Quartermaster Corps or Ordnance Dept., Engineer Officers' Reserve Corps.*
Morton, Harold S., Reserve Officers' Training Camp at Fort Snelling, Minn.
Mount, Carroll H., First Lieutenant, Ordnance, Officers' Reserve Corps.*
Nickerson, Charles W., Assistant Naval Constructor in the Naval Coast Defense Reserve, U. S. N. R. F., with provisional rank of Lieutenant (J.G.).
Penney, Charles F., Special Service Engineer, Engineer Officers' Reserve Corps.*
Reed, E. Howard, Lieutenant Commander, Torpedo Station, Newport, R. I.
Ritter, Ralph B., First Lieutenant, Ordnance, Officers' Reserve Corps.*
Roberts, Theodore C., Major, Engineer Officers' Reserve Corps.*
Shaw, James W., Captain, Engineer Battalion Wis. N. G.
Streeter, Robert L., Captain, Ordnance, Officers' Reserve Corps.
Vaughan, Aubrey W., Captain Quartermaster U. S. R., Asst. to Depot Quartermaster, Boston, Mass.
Wagner, Frederick H., Major, Ordnance, Officers' Reserve Corps.
Walsh, Walter V., Engineer Officers' Reserve Corps.*
Walsh, William F., Captain, Engineer Section, Officers' Reserve Corps.
Zeiger, Nelson A., First Lieutenant, Ordnance, Officers' Reserve Corps.

* Acceptance of commission pending at date of latest list from War Department.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER AUGUST 10, 1917

THE American Society of Mechanical Engineers is an organization for mutual service of over 8000 engineers and associates coöperating with engineers. The membership of the Society comprises Honorary Members, Members, Associates, Associate Members and Juniors, all elected by ballot of the Council. Application for membership is made on a regular form furnished by the Secretary which provides for a statement of the standing and professional experience of the applicant and requires references from voting members personally acquainted with the applicant. The requirements for admission to the various grades will be furnished upon request.

Below is the list of candidates who have filed applications for membership since the date of the last issue of The Journal. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate-Member or Junior, and those in the third under Junior grade only. Applications for change of grading are also posted.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by August 10, 1917, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about September 15, 1917.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be somewhat slower than under normal conditions. The first step in the consideration of an application is taken by the Membership Committee, and this committee is composed of busy men, with fewer opportunities to meet together in these strenuous times.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

Alabama

DUGGER, Neal, Chief Scale Inspector, Tenn. Coal, Iron & R. R. Co., Ensley
KEISER, Franklin B., President, Keiser-Geismer Engineering Co., Birmingham

Arizona

WHITE, John H., with Ray Consolidated Copper Co., Hayden

California

SWEENEY, Morgan L., Superintendent, Western Pipe & Steel Co. of California., Los Angeles

Colorado

LEHMAN, John L. G., Mechanical and Structural Designer, Great Western Sugar Co., Denver

Connecticut

BEEBE, Robert O., Director, Boardman Apprentice Shops, New Haven
BIXBY, Ezra M., Chief Draftsman, Equipment Engineer's Staff, Winchester Repeating Arms Co., New Haven
EISENWINTER, Edward E., Mechanical Engineer, American Brass Co., Waterbury
GRIFFITHS, William H., Leading Designer, The Pratt & Whitney Co., Hartford
ZACHARIAS, Ernest O., Investigating Engineer, Remington Arms & Ammunition Co., Bridgeport

District of Columbia

NELSON, John H., Associate Engineer-Physicist, Bureau of Standards, Washington

Georgia

THAYER, William B., Engineer and Draftsman, Goldens' Foundry & Machine Co., Columbus

Illinois

ADAMS, Clyde L., Instructor in Machine Shop, Lewis Institute, Chicago
CARTER, William C., Superintendent, Link-Belt Co., Chicago
EDWARDS, Joseph B., President and General Manager, Kellogg Switchboard & Supply Co., Chicago
HAYNES, H[illegible] W., Chief Draftsman, S[illegible] St. Works, American Steel & Wire Co., Joliet
LUNDBERG, Charles, Western Editor, The Iron Age (Nobel School), Chicago
O'DONNELL, Thomas E., Department Head, Western Electric Co., Inc., Chicago
REYNOLDS, George D., President and General Manager, Reynolds Pattern & Machine Co., Moline
SCANLON, Thomas J., Engineer-Custodian, Board of Education, Chicago
SLINING, Byron G., Construction Engineer, Illinois Traction System, Peoria

Indiana

CURRY, John R., Secretary, Hall-Curry Construction Co., Indianapolis
MOHLER, Charles M., Superintendent, Empire Automobile Co., Indianapolis
RUBENKOENIG, Harry, Instructor Car and Locomotive Design, Purdue University, Lafayette
SMITH, Dolph I., Chief Engineer, Hill Pump Co., Anderson
WRIGHT, William H., Superintendent, Citizens Gas Co., Indianapolis

Iowa

GIBSON, William C., Works Manager, Morrison Brothers, Dubuque

Kansas

CHAPMAN, Edmund E., Assistant Engineer Tests, Atchison, Topeka & Santa Fe Railway Co., Topeka

Massachusetts

FISHER, Edward J., Engineer in Charge of Gauge Division, New England Westinghouse Co., Chicopee Falls
FITCH, Charles R., General Manager, The Stanley Works, Bridgewater
HOTCHKISS, Walter A., Mechanical Engineer, New England Drawn Steel Co., Mansfield
LEWTHWAITE, Alfred L., Mechanical Engineer, High Voltage Bushing Engineering Department, General Electric Co., Pittsfield
MERRILL, Charles F., Assistant Chief Draftsman, Draper Corp., Hopedale
MOORE, Carl F., Consulting Engineer, United States Smelting, Refining & Mining Co., Boston

Michigan

ALBRIDGE, Kenneth P., Production Engineer, Parker Mfg. Co., Detroit
McMULLEN, George K., President and Manager, McMullen Machinery Co., Grand Rapids
MAPLE, Omar S., Chief Engineer, Diamond Power Specialty Co., Detroit

Missouri

BOEHMER, Earnst J., Chief Engineer, Rice-Stix Dry Goods Co., St. Louis

BRADLEY, Eugene P., Co-partner, Hester Bradley Co., St. Louis

SCHAUM, Arthur H., Chief Draftsman, Heine Safety Boiler Co., St. Louis

New Jersey

BERTHOLD, George H. E., Superintendent, Rajah Auto Supply Co., Bloomfield

FURMAN, George B., Chief Engineer, L. O. Koven & Brother, Jersey City

GULLIVER, Albert E., Chief Engineer, Trenton & Mercer County Traction Corp., Trenton

KIHM, Otto R., Superintendent, American Can Co., Edgewater

LANG, John F., Superintendent, Oxweld Acetylene Co., Newark

McMILLAN, Daniel G., Power Plant Engineer, Singer Manufacturing Co., Elizabeth

PETERSON, Johann, Superintendent, Manhattan Electric Supply Co., Jersey City

SMITH, Ralph L., Engineer, Machine and Tool Designer, The Celluloid Co., Newark

TAYLOR, Frank E., Master Mechanic, Butterworth-Judson Corporation, Newark Transfer

New York

BANKS, Thomas K., Engineer, Steam Meter Department, American District Steam Co., North Tonawanda

BLOHM, August H., Mechanical Draftsman, The Adder Machine Co., New York

EMRICK, George W., Factory Manager, Eastern Flexible Conduit Co., Brooklyn

FOWLER, Richard E., Mechanical and Sales Engineer, Gerdes & Co., New York

GARDINER, Herbert L., Shop Engineer, Kerr Turbine Co., Wellsville

HULL, George W., Engineer and Chief Draftsman, Halcomb Steel Co., Syracuse

JUDSON, Cyrus F., Engineer, A. J. Coccaro & Co., New York

LEGGO, William F., Assistant to Chief Engineer, New York

McCARTHY, Ralph, Secretary, Corrugated Bar Co., Buffalo

McDONALD, Albert, Production Engineering, New York

MILLER, Franklin T., President, F. W. Dodge Co., New York

MOYER, Melbourne S., Accountant, Barclay Parsons & Klapp, New York

NACKE, Arnold L., Salesman, Manning, Maxwell & Moore, New York

O'CONNELL, John J., Assistant Hydraulic Engineer, Electric Bond & Share Co., New York

POWERS, Richard E., Factory Engineer, Oneida Community, Ltd., Oneida

RILEY, Champlain L., Consulting Engineer in Heating, Ventilation and Industrial Plant Design and Equipment, New York

SMITH, Gershom, Vice-President, The Tabulating Machine Co., New York

SNEDEKER, Theodore A., Assistant Treasurer, The Taft-Peirce Mfg. Co., New York

WOLLHEIM, Walter E., Assistant Mechanical Engineer, Nathan Manufacturing Co., New York

Ohio

ATKINSON, Embry S., Head of Tool Design, Domestic Engineering Co., Dayton

CARLISLE, Tyler W., Assistant Secretary and Treasurer, The Strong Carlisle & Hammond Co., Cleveland

JAMISON, Walter K., Superintendent, Domestic Engineering Co., Dayton

KAISER, Louis T., Mechanical Engineer, Thomas Emery's Sons, Cincinnati

MEHLE, J. H., Manager, Cincinnati Screw Co., Cincinnati

MURPHY, James A., Foundry Superintendent, The Hooven, Owens, Rentschler Co., Hamilton

SCHELLENBACH, William S., Mechanical Engineer, Cincinnati

WARDWELL, Frank W., Jr., President and General Manager, The Wardwell Mfg. Co., Cleveland

Oregon

SULLIVAN, Allan C., Chief Engineer in charge of Estimating Dept., Smith & Watson Iron Works, Cortland

Pennsylvania

AMMERMAN, C. S., Ordnance Designer, Bethlehem Steel Co., Ordnance Dept., Bethlehem

BAUER, George A., Vice President, W. E. Shipley Machinery Co., Philadelphia

BENEDICT, John G., Secretary, Treasurer and Manager Landis Machine Co., Waynesboro

CONE, Martin B., Chief Engineer, Baugh & Sons Co., Philadelphia

COOPER, David M., Mechanical Engineer, National Metal Molding Co., Ambridge

DUNCAN, Harold M., Managing Director, Lanston Monotype Corp., Ltd., of London, England, Philadelphia

FLEISHER, Walter A., Head of Power Department, S. B. & B. W. Fleisher, Inc., Philadelphia

FROELICH, Clarence H., Ordnance Engineer, Bethlehem Steel Co., So. Bethlehem

JACKSON, Elwell R., Mechanical Engineer, Edward Board, Special Machinery and Tools, Philadelphia

SIMPSON, William L., General Superintendent, Eddystone Ammunition Corp., Eddystone

SNYDER, Barney B., Representative and Inspector, Chile Exploration Co., Pittsburgh

TAYLOR, Roger, Engineer, Operating Department, Philadelphia Electric Co., Philadelphia

THOMSON, Clarke, Manager, Clarke Thomson Research, Philadelphia

WALLER, C. B. F., Engineer in Charge of Boilers, Bureau of Water, Philadelphia

ZEHR, Vratislav A., Mechanical Draftsman, Switchboard Engineering Dept., Westinghouse Electric & Manufacturing Co., East Pittsburgh

Rhode Island

PEARSON, Mark, Mechanical Engineer, Bradford Dyeing Association, Bradford

Texas

HUGHES, Howard R., President, Hughes Tool Co., Houston

Virginia

SCHMIDT, Otto da Costa, Chief Engineer, Covington Machine Co., Covington

West Virginia

WINDSOR, Walter A., President, Marietta Manufacturing Co., Point Pleasant

Wisconsin

HEM, Eilif S., Erecting Engineer, Allis-Chalmers Mfg. Co., Milwaukee

MILLER, Roy J., Works Manager, Kohler Co., Kohler

Canada

GAINES, Edward C., Designing Engineer, Dominion Bridge Co., Montreal

McNAUGHT, Frank H., Manager, Maritime Foundry & Machine Works, Ltd., Chatham, N. B.

ROBERTS, Arthur R., Associate Professor of Mechanical Engineering, McGill University, Montreal

Chile

VILLEGAS, Jorge Andres D., Manager Engineering Office, Private Practice, Santiago

Hawaii

EWART, Arthur F., Chief Draftsman, Honolulu Iron Works Co., Honolulu

India

IYENGAR, R. Ramauja, Manager, Sandalwood Oil Factory, Bangalore

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

Alabama

PRATT, Merrill E., With Continental Gin Co., Prattville

California

HARTZELL, Earl F., Draftsman and Engineer, Southern Pacific Co., Bakersfield

TOUR, Reuben S., Assistant Professor Gas Engineering, University of California, Berkeley

Cuba

STUART, Joseph L., Mechanical Engineer, Honolulu Iron Works Co., Havana

Illinois

HOSBEIN, Louis, Secretary and Manager, M. H. Detrick Co., Chicago

[illegible], Manager, [illegible] & Co., Manufacturing Plant, Chicago
[illegible] W., [illegible], Chicago
[illegible], Mechanical Engineer, [illegible], Chicago
[illegible], Assistant Superintendent, [illegible] Plant, Aetna Explosives Co., Inc., [illegible]

Indiana

[illegible], Vice-President and Sales Manager, International Machine Tool Co., Indianapolis

Massachusetts

[illegible], Machine and Tool Designer and Draftsman, General Electric Co., Lynn
SHEPARD, FREDERICK J., JR., Treasurer and Chief Engineer, Lewis-Shepard Co., So. Boston

Michigan

BAKER, HERBERT E., Assistant Chief Draftsman, The Shaw Electric Crane Co., Muskegon
HINZ, JULIUS C., 7033 19 Bellevue Avenue, Detroit
HOUCK, FRANK H., Mechanical Engineer, Higrade Motors Co., Grand Rapids
WATSON, WILLIAM W., Manager Order Department, Anderson Forge & Machine Co., Detroit
WOLCOTT, WARD S., Assistant to Chief Tool Designer, Burroughs Adding Machine Co., Detroit

Minnesota

MIKESH, MARTIN A., Designer, Fairmont Gas Engine & Rwy. Motor Car Co., Fairmont
THOMPSON, JESSE L., Assistant to Superintendent of Power, Minnesota and Ontario Power Co., International Falls

Missouri

ARMSTRONG, WILLIAM H., Instructor Machine Shop Practice, The David Ranker Jr. School of Mechanical Trades, St. Louis

New Jersey

BUESSER, FRED F., JR., Estimating Engineer, L. O. Koven & Bro., Jersey City
GERHARDT, JOSEPH A., Estimating Engineer, L. O. Koven & Bro., Jersey City

New York

BROWNE, ROBERT L., Commercial Engineer, Goldschmidt Thermit Co., New York
FEELEY, JOHN J., Assistant Chief Engineer and Master Mechanic, Tuttle & Bailey Manufacturing Co., Brooklyn
GRAMM, EDGAR B., Assistant Chief Draftsman, Combustion Engineering Corporation, New York
HORN, CHARLES J., Chief Draftsman, Otis Elevator Co., Yonkers
LAWSON, WILLIAM S., JR., President and Treasurer, Lawson & Co., Inc., New York
MOSS, HERBERT H., Assistant Engineer, Aetna Explosives Co., Inc., New York
ROMAN, HENRY, Draftsman, Experimental Department, Sperry Gyroscope Co., Brooklyn

Ohio

MATTLE, GUSTAVE A., Pattern Shop Foreman, Modern Foundry Co., Cincinnati
NEWCOMB, MELVIN B., Draftsman, Firestone Tire & Rubber Co., Akron
ROBINSON, KINSEY, with the American Can Co., Hamilton
TABER, MERL N., Metallurgist, The National Supply Co., Toledo
WILLIAMSON, RICHARD A., Foreman in Charge Mch. Operations, Aultman & Taylor Machinery Co., Mansfield

Pennsylvania

CORRIDON, EDWIN R., Designing Draftsman, Ordnance Department, Bethlehem Steel Co., So. Bethlehem
HESS, ERNEST E., Draftsman and Designer, Spang & Co., Butler
HODDICK, FREDERICK G., Ordnance Engineer, Bethlehem Steel Co., So. Bethlehem

Tennessee

WILLARD, JOHN A., Mechanical Engineer, Bemis Bros. Bag Co., Bemis

Wisconsin

CROSSEN, ELMER J., Coke Oven Engineer, The Milwaukee Coke & Gas Co., Milwaukee
WEHR, C. FREDERIC, Superintendent, Wehr Steel Co., West Allis

FOR CONSIDERATION AS JUNIOR

California

HAMAKER, REX G., with Standard Oil Co., Whittier
LACY, RICHARD W., formerly with Lacy Manufacturing Co., Los Angeles
WEBSTER, FREDERICK A., JR., Foreman, Inspection Department, Standard Oil Co., Richmond

District of Columbia

LEWIS, ALLEN D., Draftsman, Office of Chief of Ordnance, War Department, Washington

Illinois

CATTERMOLE, LESTER G., Chief Planning Engineer, Federal Huber Mfg. Co., Chicago
PAINTER, WALTER, Lubrication Engineer, Sinclair Refining Co., Chicago
STEVENS, BERRY T., Assistant Sales Manager, Hard Rubber Department, The B. F. Goodrich Co., Akron
THAL, SAMUEL W., Engineering Department, American Steel & Wire Co., Waukegan

Iowa

WATKINS, ROY A., Superintendent, American Machine Products Co., Marshalltown

Kentucky

RITCHIE, ANDREW O., Designing Power Plants, J. D. Lyon, Engineer, Cincinnati

Maryland

MATHER, HAROLD T., Safety Engineer, Aetna Life Insurance Co., Baltimore

Massachusetts

BROWN, ARTHUR L., Instructor, Massachusetts Institute of Technology, Boston
GOODMAN, HARRY M., With Fore River Shipbuilding Corp., Quincy
HEYWOOD, CHARLES E., Student, Worcester Polytechnic Institute, Worcester
LUNN, JOHN A., Assistant, Massachusetts Institute of Technology, Boston
MUNSON, KENNETH A., Tool Designer, General Electric Co., West Lynn

Mexico

DE AROZARENA, RAFAEL M., JR., Resident Engineer, Hacienda de San Juan Hueyajan, Padruca

Michigan

EDWARDS, HERBERT C., Experimental Research, Packard Motor Car Co., Detroit
REKERSDRES, HENRY, Production Clerk, American Blower Co., Detroit
SCHUPP, ARTHUR A., Student, University of Michigan, Ann Arbor

Minnesota

ABERNETHY, WILBUR K., Sales Engineer, Charge Minneapolis Office, Central Station Steam Co., of Detroit, Minneapolis

New Jersey

BLOOD, HAROLD L., Chief Draftsman, Planer Dept., Pond Works, Niles-Bement-Pond Co., Plainfield
McMURRAY, JOHN H., Assistant Mechanical Engineer, Calco Chemical Co., Bound Brook
WATERS, DANIEL V., Machine Designer, Engineering Dept., S. L. Moore & Sons Corp., Elizabeth

New York

BERKOWITZ, BENJAMIN, Laboratorian, U. S. Navy Department, Navy Yard, Brooklyn
FELL, SHELBY G., With H. H. Franklin Mfg. Co., Syracuse
FERNSTROM, FRODEE S., Mechanical Draftsman, Neptune Meter Co., Long Island City
FINCH, CECIL C., Superintendent, Broadalbin Knitting Co., Ltd., Broadalbin
GILBERT, FREDERICK B., Experimental Engineer, Research Laboratory, Ansco Co., Binghamton
HENRY, WILLIAM M., Officers Training Camp, Plattsburg
JOHN, GEORGE H., JR., Student, Mechanical Engineering, Columbia University, New York
LANGLOTZ, CHARLES L., Assistant Engineer, American Sugar Refining Co., Brooklyn
LOO, PING-YOK, Representative to China, Allied Machinery Co. of America, New York
MAIN, CHARLES C., JR., Assistant Eastern Manager, Curtis & Co. Mfg. Co., New York

MATTHIAS, MAXIMILIAN P., Assistant to Dr. J. C. Olsen, Cooper Union, New York
POSTMAN, BENJAMIN, Testing Bureau, Brooklyn Rapid Transit Co., Brooklyn
SLADE, HENRY L., JR., Manufacturing Machinery, R. Hoe & Co., New York

Ohio

FIKRET, H. HALOUK, Instructor in Mechanical Engineering, Robinson Laboratory, Ohio State University, Columbus
FLAGG, PAUL M., Experimental Department, Goodyear Tire & Rubber Co., Akron
STINSON, KARL W., Instructor Aero Engines, Cadet Aviation School, Ohio State University, Columbus
WILLIAMS, BERKELEY, Graduate Fellow, Department of Mechanical Engineering, University of Cincinnati, Cincinnati

Pennsylvania

CROUTHAMEL, JOHN F., Draftsman, Artillery Dept., Midvale Steel & Ordnance Co., Philadelphia
CUTLER, JAMES B., With I. P. Morris Co., Philadelphia
HANSEN, FREDERICK D., Superintendent Cartridge Case Shop, Eddystone Ammunition Corp., Eddystone
RESNICK, MAURICE, General Engineering Apprentice, Shelby Steel Tube Co., Ellwood City

Texas

BEEN, PAUL, 2nd Engineers, Company C, El Paso
EVANS, MELVIN J., Special Apprentice, Gulf, Colorado & Santa Fe R. R. Co., Cleburne
FORNEY, ROSS H., Chief Dispatcher, Texas Power & Light Co., Dallas

West Virginia

CATHER, CARL H., Instructor in Drawing, West Virginia University, Morgantown

Wisconsin

WOOD, JOHN M., Draftsman, Equipment Department, The Falk Co., Milwaukee

Wyoming

KEELEY, WILLIAM C., JR., Engineer, Mid-West Refining Co., Casper

Cuba

ADAM, LEON E. M., Chief Chemist, Cuba Cane Sugar Corp., Central Moron, Pina

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

Cuba

SOPER, ELLIS C., Chief Engineer, Cuban Portland Cement Co., Cayo Mason

PROMOTION FROM ASSOCIATE-MEMBER

Massachusetts

PERKINS, GEORGE H., Head of Textile Engineering Department, Lowell Textile School, Lowell

Canada

SOUBA, WILLIAM H., Consulting Engineer, C. D. Howe & Co., Port Arthur

Chile

DU MOULIN, WALTER L., Mechanical Engineer, Andes Copper Mining Co., Chanaral

PROMOTION FROM JUNIOR

Connecticut

WILCOX, HERBERT M., Industrial Engineer, Winchester Repeating Arms Co., New Haven

Louisiana

IVENS, EDMUND M., Sales Engineer, Skinner Engine Co., and Ingersoll-Rand Co., New Orleans

Massachusetts

EDWARDS, WILLIAM W., Instructor in charge of Department, Wentworth Institute, Boston
NICHOLL, JOHN S., President, Riverside Boiler Works, Inc., Cambridge

Michigan

FESSENDEN, CHARLES H., Assistant Professor of Mechanical Engineering, University of Michigan, Ann Arbor
ORDWAY, EARL P., Chief Draftsman, Union Steam Pump Co., Battle Creek

New York

BERANGER, JOSEPH P., Chief Engineer, West India Management & Consultation Co., Inc., New York
COLLINS, FRANCIS A., JR., Sales Manager, Auburn Ball Bearing Co., Rochester

Ohio

CANBY, HARRY B., Vice-President, Crawford, McGregor & Canby Co., Dayton
CLAPP, RICHARD B., District Manager, Andrews-Bradshaw Co., Cleveland

Pennsylvania

BRENNAN, JAMES, Consulting Engineer, Pittsburgh

Rhode Island

KEABLES, AUSTIN D., Mechanical Engineer, Slatersville Finishing Co., Slatersville

Tennessee

FEICHT, EDWARD R., Maintenance Engineer, Federal Dyestuff & Chemical Corp., Kingsport

Wisconsin

SHODRON, JOHN G., General Superintendent, James Mfg. Co., Fort Atkinson

SUMMARY

New applications	200
Applications for change of grading:	
Promotion from Associate	1
Promotion from Associate-Member	3
Promotion from Junior	14
Total	218

SUMMARY SHOWING AVERAGE AGE AND POSITIONS OF APPLICANTS ON BALLOT CLOSING MAY 19, 1917

Boiler Inspector	1
Cadet Engineer	1
Chief Engineers	15
Chief Engineers, Assistant	4
Combustion Engineers	2
Combustion Engineers, Assistant	1
Construction Engineers	4
Consulting Engineers	7
Designers	5
Director Technical Research	1
Draftsmen	12
Draftsmen (designing)	3
Chief Draftsmen	12
Chief Draftsmen, Assistant	1
Efficiency Engineers	6
Equipment Engineer	1
Equipment Engineer, Assistant	1
Executives (President, Vice-President, Treasurer, Secretary, Managers and District Managers)	42
Fuel Engineer	1
Industrial Engineers	2
Inspectors	5
Instructors	8
Maintenance Engineer	1
Marine Engineers	2
Master Mechanics	2
Mechanical Engineers	49
Mechanical Engineers, Assistant	12
Operating Engineers	3
Patent Attorney	1
Plant Engineer	1
Production Engineers	3
Professor	1
Professor, Assistant	2
Purchasing Agent	1
Representative	1
Research Engineer	1
Sales Manager	3
Sales Manager, Assistant	1
Sales Engineer	13
Service Manager	1
Students	2
Superintendents	27
Superintendents, Assistant	11
Superintendents, Power	1
Works Manager	3
Miscellaneous	29

NECROLOGY

CHARLES EDWARD HYDE

Charles E. Hyde was born in Bath, Me., November 26, 1855. He attended the public schools of Bath, and, when graduated from the high school there, spent the next three years in the Worcester Polytechnic Institute. The last year of his course was taken in the Massachusetts Institute of Technology. The year after his graduation he spent in Europe for the purpose of examining the shipyards and engine works of the old country, obtaining valuable information in his specialty.

Upon his return he worked as machinist in the Portland Machine Shops, and then as draftsman in the Columbian Iron Works at Baltimore, Md. He was next employed in the drawing office of Cramp's Shipyard, Philadelphia, Pa., and later was chief draftsman for Ward, Stanton & Company, Newburg, N. Y., builders of all types of fast vessels. This last position afforded him the advantage of working with Mr. Stanton, who was noted for his ability as a designer of marine engines.

Returning to Bath in 1884, he entered the employ of the Goss Marine Iron Works as chief draftsman and superintendent, and during his service there he introduced the practical use of the triple-expansion engine, the first to be employed in this country. When this company changed ownership, he was employed by the Bath Iron Works, and was chief draftsman and constructor of the engines of the *Castine*, *Katahdin* and *Machias*.

After leaving Bath he became general manager and president of the New London Marine Iron Works, at New London, Conn. For the last few years he was engaged in business in New York City.

He was a member of the Society of Naval Architects and Marine Engineers and of the Engineers' Club of New York. He became a member of the Society in 1885. He died May 19, 1917.

ROSCOE B. KENDIG

Roscoe B. Kendig was born in Renova, Pa., March 3, 1868. He received his education in the home schools. He began railway work in 1884 as a messenger boy in the employ of the Pennsylvania Railroad. From 1885 to 1890 he served as machine apprentice, and until 1893 as draftsman in Renova. For the next seven years he held the position of draftsman in the office of the superintendent of motive power of the Pennsylvania road, at Williamsport, Pa. In 1900 he was appointed chief draftsman of the Lake Shore & Michigan Southern Railway at Cleveland, O., and in 1904 he accepted the position of mechanical engineer with the same road.

He held this position until 1910, when he was appointed general mechanical engineer of the New York Central lines; and in 1912 he became chief mechanical engineer of the New York Central Railroad Company, which position he held at the time of his death.

He was a significant factor in the development, design and construction of the Collingwood shops of the New York Central Railroad. While he was mechanical engineer of the Lake Shore & Michigan Southern road, the modernization of the locomotive terminal facilities was undertaken under his immediate supervision, and large modern engine houses were erected, many of the features of which have served as a model for later construction of this nature.

He was since 1904 an active member of the American Railway Master Mechanics' Association, and since 1905 of the Master Car Builders' Association. He was a member also of the American Society for Testing Materials and of the Engineers' Club of New York.

He became a member of the Society in 1913. He died May 10, 1917, at Detroit, Mich.

OSCAR PATRIC OSTERGREN

Oscar Patric Ostergren was born in Sweden, May, 1866. He was educated in Stockholm, graduating from the Royal Technical High School with the degree of M.E. in 1888. From 1888 to 1891 he was employed by Treacher, Tenae & Co., civil engineers and contractors, in drafting and surveying a new railroad at Rosario, Argentina. The next year he spent with the Atlas Machine Company, Stockholm, as assistant engineer. He came to New York late in 1892, and was employed in erecting machinery by Robert Hoe & Co. From 1893 to 1896 he worked with Charles D. Mosher, a naval architect of New York, in designing marine engines, and until 1898 he was with Charles L. Seabury & Co., New York City, in the same work. He then became president and general manager of the Ostergren Manufacturing Company, having complete charge of the inventing and designing of liquid-air machinery, internal-combustion engines, and automobiles. From 1902 to 1904 he was with the Fuel Oil Power Company as an inventor and designer of fuel-oil engines. Later he successively held positions with Benjamin Hurd, New York City; Joseph Boyer, Detroit, Mich.; Alger Bros., Detroit, Mich.; and with the Grenetso Engineering Company. He held fifty United States patents on inventions.

He joined the Society in 1910. He died May 11, 1917.

JOHN MITCHELL YOUNG

John Mitchell Young was born in Ardrossan, Ayrshire, Scotland, Sept. 18, 1883. He received his early education in the Glasgow High School for Boys. He then entered the Glasgow and West of Scotland Technical College as a day student, graduating in 1904 from the mechanical-engineering course. He was elected an associate of the college. During his last year in college he carried on investigations having to do with steam turbines, and for a thesis embodying these investigations he received the Montgomerie-Neilson gold medal and prize.

He then entered upon an apprenticeship in the works of William Young & Sons, engineers and ironfounders in Ardrossan. On the completion of his apprenticeship he became a draftsman of sugar machinery with Mirlees Watson & Co., Glasgow. In 1909 he came to the United States, where he took a position as draftsman in the steam-turbine department of the Fore River Shipbuilding Company, Quincy, Mass. He next turned his attention to electrical engineering, and took a position with the General Electric Company, Schenectady, N. Y., as draftsman. Later he took charge of the construction office for the power plant of the Toronto Power Company, Niagara Falls, Ont. He next took up the study of sugar machinery, and became a designer with the Dyer Company, Cleveland, Ohio, and later with the Geo. L. Squier Company, Buffalo, N. Y. For the former company he designed and equipped a complete sugar factory in Louisiana. He became interested in conveying and elevating machinery, and for the next two years he occupied the position of factory equipment engineer and designer with the Otis Elevator Company, Buffalo, N. Y.

He was an associate member of the Institute of Engineers and Shipbuilders in Scotland. He became an associate-member of the Society in 1915. He died March 14, 1917.

AMONG THE SECTIONS

Sections Delegates Meet at Cincinnati

THE Committee on Sections arranged a business meeting at the Spring Meeting at Cincinnati which was preceded by a luncheon attended by the following: President Ira N. Hollis, Past-Presidents Oberlin Smith, W. F. M. Goss and James Hartness; Messrs. John H. Barr and Max Toltz, Managers of the Society; Calvin W. Rice, Secretary; D. Robert Yarnall, chairman, L. C. Marburg and Walter Rautenstrauch, members of the Committee on Sections; also the following representatives of Sections: Atlanta, Earl F. Scott; Baltimore, C. C. Thomas and A. G. Christie; Birmingham, W. P. Caine and J. G. Hatman; Buffalo, C. H. Bierbaum; Cincinnati, Fred A. Geier and John T. Faig; Detroit, George W. Bissell; Erie, Rudolph Conrader and M. W. Sherwood; Indianapolis, W. H. Insley; Milwaukee, Fred H. Dorner; Minnesota, Max Toltz; New Orleans, A. M. Lockett; New York, Ernest Hartford; Philadelphia, D. Robert Yarnall; Ontario, Chester B. Hamilton, Jr.; Worcester, R. G. Williams; and Providence, L. D. Burlingame and A. H. Annan.

Dr. Hollis spoke forcibly concerning the broad principles underlying the Society and its duty to the profession, and particularly of the ideals entertained by the Council for furthering the sections work. Following this speaker, the chairman called for reports from the delegates representing the various sections, and each gave the experiences of his section in turn.

One excellent point brought out and very generally endorsed was that each section of the Society should send to every other section notices of all its meetings, so that each section could be continually posted on just what is going on in the other sections. It was thought that this matter could best be handled by having each section secretary send to the headquarters of the Society twenty-five copies of each meeting notice and having the secretary of the Sections Committee readdress these to the other sections.

A question was raised concerning the amount of money that the Society should appropriate to the sections and it was decided to make recommendations to the Council.

Mr. Rice spoke on the matter of publication of sections material in THE JOURNAL and in Transactions. He complimented the sections on the value of this material received in the past, which had led the Publication Committee to inaugurate a new policy—to devote several issues of THE JOURNAL each year to sections papers. He hoped that each section would contribute its full share toward the best realization of that policy by contributing at least two papers each year for publication. The Sections Committee promised to help the sections toward the realization of this ideal.

D. ROBERT YARNALL,
Chairman Sections Committee.

Sections Meetings

BIRMINGHAM

May 16 A feature of the annual meeting was a two-reel moving picture illustrating the old and new methods of cooking,—coal versus electricity, after which the chairman gave a review of the progress the past year.

During the year the hearty coöperation and support of the two state universities has been enlisted and two representatives from each have addressed the Section. Ten or twelve new members have been secured for the Society through the efforts of the Section, which has also been influential in the organization of the Alabama Technical Association, which includes all the members of the national engineering societies residing in the State of Alabama, of whom there are over two hundred. A combination stereopticon and baloptican machine has been purchased for the use of the members, and it is hoped that greater use will be made of it the coming year.

The officers for the coming year were elected as follows: Chairman, J. H. Klinck; vice-chairman, W. P. Caine; secretary, J. G. Hatman. Paul Wright and R. E. Brakeman were also elected members of the executive committee.

R. E. BRAKEMAN,
Section Chairman.

BUFFALO

June 7 Chester L. Lucas, Mem.Am.Soc.M.E., explained to a large and interested audience the manufacture of 9.2-in. high explosive howitzer shells, illustrating his talk with 2500 ft. of moving-picture film.

Mr. Lucas gave the following interesting data concerning these shells: the weight of each is 250 lb. with an explosive element capable of blowing a hole 50 ft. in diameter in the ground; the cost of the shell was two hundred dollars, while the forging alone costs twenty-five dollars and machining about twenty-eight dollars. It takes about ten man-hours to make one shell.

LOUIS J. FOLEY,
Assistant to Secretary.

CHICAGO

May 18 The first social meeting in the history of the Section to which ladies were invited, proved such a success that it was unanimously decided to hold others in the future.

S. J. Duncan-Clark, war analyst of the Chicago *Evening Post*, gave an intensely interesting address on The War Situation of Today. In order to give the audience the proper perspective the speaker reviewed the incidents leading up to the war, starting with the Kaiser's trip to Palestine in 1898 and the concession given by the Turkish Government at that time to build the Bagdad Railway, which was the first step in the program of the empire that the Kaiser had conceived. Then followed the various intrigues to secure right of way to Saloniki and Constantinople, and the final spark at Belgrade that started the great conflagration. Leading his hearers step by step, the speaker ably reviewed the situation on each front with the final optimistic prediction of victory for the allied democracies over the last great autocracy.

A vote of thanks was tendered Mr. Duncan-Clark and a collection taken for the Red Cross.

The following officers were elected for the coming year: Chairman, Alexander D. Bailey; vice-chairman, H. T. Bentley; secretary, Arthur L. Rice. G. R. Brandon and P. N. Engel were elected members of the executive committee.

THOMAS WILSON,
Section Corresponding Secretary.

MINNESOTA

May 10 K. C. Richards, superintendent of the Minnesota By-Products Coke Company, gave an exceedingly interesting illustrated lecture on coke and its by-products, which was followed by several discussions.

By unanimous vote the following officers were elected for the coming year: Chairman, H. LeRoy Brink; vice-chairman, J. A. Teach; secretary and treasurer, Edward A. Wilhelm.

D. M. FORFAR,
Section Secretary.

NEW ORLEANS

April 2 A general business meeting at which the principal event was the election of officers, resulted in the following elec-

tion [illegible] meeting [illegible] Chairman, H. F. Hudson; secretary, L. W. [illegible]; W. E. Gregory, A. M. Lockett and R. F. Burwell, members of the board of direction.

H. F. Hudson,
Section Secretary.

WORCESTER

Jun. [illegible] After a brief business meeting the delegates to the Spring Meeting gave their reports. Ira N. Hollis, President Am. Soc.M.E., followed with an address.

Dr. Hollis confined his remarks to the war situation, telling of the impressions he had gained while talking with high army and navy officials who accompanied the British and French Commissions to this country. He laid particular emphasis on the fact that this war is a huge business proposition, where the skill of the engineer in handling men and materials is perhaps the most important factor. His remarks touching on the submarine question were particularly interesting and instructive.

The following were elected officers for the coming year: Chairman, George I. Rockwood; secretary, Richard G. Williams. H. P. Fairfield, V. E. Edwards and F. W. Parks were elected members of the executive committee.

Richard G. Williams,
Section Secretary.

Student Branches

CARNEGIE INSTITUTE OF TECHNOLOGY

May 26 The Training of the Engineer was the subject of an interesting talk by J. H. McAlpine, of the Westinghouse Machine Company. The speaker outlined the training required, from the time of entrance to school until the chosen field had been reached.

The following officers were elected for the coming year: President, E. F. Obert; vice-president, E. P. Bateham; secretary, R. G. Brandin; treasurer, E. F. Morgan.

J. H. Davis,
Branch Secretary.

UNIVERSITY OF CINCINNATI

May 22 Several members of the Am.Soc.M.E. were present at the final meeting of the season and addresses were made by Ira N. Hollis, President, Am.Soc.M.E.; Calvin W. Rice, Secretary, Am.Soc.M.E.; William Kent, Mem.Am.Soc.M.E., and Carl G. Barth, Mem.Am.Soc.M.E.

The election of officers was also held at this meeting, with the following results: President, Henry A. Wolsdorf; vice-president, E. H. Schubert; secretary and treasurer, Christ L. Koehler; publicity manager, Oliver F. Gang.

Henry A. Wolsdorf,
Branch Secretary.

UNIVERSITY OF ILLINOIS

May 10 In connection with the Pi Tau Sigma contest, C. Spindler spoke on the Eight-Cylinder Gasoline Engine. Mr. Spindler pointed out the advantages of this type of engine over the four-, six- and twelve-cylinder engines in use for automobiles. The talk was well illustrated with blackboard and chart demonstrations.

May 25 The conclusion of the Pi Tau Sigma contest was reached with the talks delivered at this meeting by J. T. Kelly, on the Heat Treatment of Steel, and by C. Z. Rosecranse, on The Railway Dynamometer Car.

The officers for the coming semester were also elected, as follows: President, H. C. Dieserud; vice president, J. T. Kelly; secretary, L. I. Phillis.

H. C. Dieserud,
Branch Secretary.

LEHIGH UNIVERSITY

May 10 The annual election of officers was the main feature of this meeting, which was purely one of business. The results were as follows: President, J. P. Clymer; secretary, W. A. Bornemann; treasurer, N. Dymtrow.

W. A. Bornemann,
Branch Secretary.

OHIO STATE UNIVERSITY

May 29 This meeting took the form of a banquet, and speeches were made by several faculty members and students. Later, William T. Magruder, Mem.Am.Soc.M.E., spoke on Aviation and illustrated his talk with a large number of lantern slides, which were of much interest to those present.

The officers for the coming year are as follows: President, Paul Bucher; secretary, Fillmore D. Swan; treasurer, E. A. Edwards.

F. E. Smyser,
Branch Secretary.

PENNSYLVANIA STATE COLLEGE

The officers for the coming year have been elected as follows: President, Robert S. Clark, Jr.; vice-president, L. C. Grove; treasurer, Robert K. Cochrane; secretary, P. G. Musser.

STEVENS INSTITUTE OF TECHNOLOGY

May 11. The following officers have been elected for the ensuing year: President, Herbert Peter; vice-president, Raymond S. Mileham; secretary and treasurer, G. Crosby Hiss.

G. Crosby Hiss,
Branch Secretary.

EMPLOYMENT BULLETIN

The Secretary considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping anyone desiring engineering services. The Society acts only as a clearing house in these matters.

POSITIONS AVAILABLE

In forwarding applications, stamps should be enclosed for transmittal to advertisers; applications from non-members should be accompanied by a letter of reference or introduction from a member, such reference letter to be filed with the Society. Copy for notices must be in hand by the 15th of the month.

DESIGNER on heavy machine tools and similar machinery. Good opportunity for high-grade designer chiefly with drawing-office experience. Salary, \$2,400. Location, Pennsylvania. 40.

TOOL DESIGNER who is resourceful and can follow work through to completion. Technical man with practical shop experience. Salary, \$25 to \$35 per week, according to ability. Location, Connecticut. 185.

SALES ENGINEERS. It is desirable that applicants be young men between 25 and 30 years of age, preferably M. E. graduates of some approved engineering college, and of good appearance; would be expected to undergo a period of probation and training in various offices of company for responsible and higher positions in sales work. If a call cannot be made, application may be made by letter in applicant's own hand writing, stating age, education, previous business training, if any, salary desired, etc. Location, New York. 205.

SALESMEN for power-plant equipment—boilers, engines, forced-draft blowers, pumps and elevators. Commission basis. Location, New York City. 402.

TEACHER for large public institution of the Middle Northwest; strictly high-class man who can conduct classes and give lectures

upon automobiles. Must be technical graduate, with practical experience and not afraid of work. Location, Wisconsin. 421.

INDUSTRIAL ENGINEER—COST ACCOUNTANT. Well-established firm can offer exceptional opportunities for effective and interesting work to engineering graduates who have had substantial experience with modern industrial accounting; special reference to manufacturing costs. In reply state age, education, experience, present and expected salary. Location, Massachusetts. 431.

DRAFTSMAN, capable of designing machines of comparatively large size for boring and milling purposes; also fixtures and tools for use on such machines, to hold and perform work as shown by blueprints. Location, Providence. 525.

EXPERIENCED MAN to take charge of manufacture of soap powder. Salary $30 to start. Location, New York. 563.

DRAFTSMEN for stoker department of concern manufacturing a specialty. Work involves layouts of stoker installations and requires general knowledge of boiler-room work. Salary depending upon man's ability and experience, $25 per week to start. Good draftsman with a little knowledge of this class of work more valuable than good designer. Location, Philadelphia. 565.

PUMP DESIGNER experienced in design and construction of turbine pumps particularly, for large pump manufacturers. Location, South. 581.

DRAFTSMEN AND DESIGNERS familiar with power-plant and factory layouts. Location, Boston. 629.

COMBUSTION ENGINEER experienced in hand and stoker firing of bituminous coal, to study boiler efficiency and other combustion problems. Location, Delaware. 725.

PIPE AND POWER-PLANT MEN wanted by large rubber concern in Ohio. 727.

ENGINEER skilled in handling of materials, to study such work at plants of large industrial corporation; experience with conveying machinery and other mechanical means of transport of materials. Location, Delaware. 782.

TECHNICAL GRADUATE in mechanical engineering, with one or two years' experience in power-house installation and design; should understand piping layout and boiler setting, and be capable of inspecting such work during installation. Location, New Jersey. 865.

DRAFTSMAN who would be interested in investing some money in shop; one familiar with horizontal return tubular boilers and boiler-shop work in general. State age, experience and salary desired. Location, New Jersey. 881.

MACHINERY DESIGNER in turbine department of large electric company. Location, Massachusetts. 894.

MASTER MECHANIC for lead-smelting plant operating blast furnaces and concentrating mills; must be man of strong personality, capable of handling varied classes of mechanics. Give full details of education and experience. Location, Utah. 906.

DRAFTSMAN experienced in factory design and installation of elevator and conveying machinery in general cement-plant work. Location, Pennsylvania. 949.

RECENT ENGINEERING GRADUATE to take up economy studies in pole line and cable-plant construction; one experienced in estimating the cost of such construction given preference. State experience and salary desired. New York concern. 952.

SALESMEN on machine tools to represent large New York exporting corporation in China, Australia and South Africa. 964.

DESIGNERS. Men experienced in steam-engine and turbine work prefered. Location, East Pittsburgh. 967.

DRAFTSMAN familiar with power-house work, installation of equipment, piping, etc., and competent to work out different problems involved from general outline, without need of more or less constant supervision. Salary $25 to $28 per week. Location, New York. 969.

DRAFTSMEN experienced in design of chemical plants or machinery. Salary $30 to $50 per week, depending upon experience and ability of man. Location, New York State. 982.

MECHANICAL ENGINEER with technical education and at least five years' experience at plants manufacturing chemicals; work to be mainly advisory engineering in connection with manufacture of chemicals. Location, Delaware. 991.

MATERIAL SUPERINTENDENT wanted before October 1, by Chicago machinery manufacturer, at initial salary of $200 per month; will be responsible for all factory functions with exception of maintenance of equipment, training hands, tool designing, process inspection; will be immediate subordinate of works manager, and have to compete with one man for advancement. Give education and physical condition in detail; name firms, nature of duties, and number of months spent in each capacity. Location, Illinois. 992

DRAFTSMAN on structural steel. Experience in powder, coal plants, industrial plants, power houses, layout, etc. Location, New York. 1011.

EXPERIENCED PUMP DRAFTSMAN for checking and detailing. Steady work, pleasant surroundings. Location, Middle West. 1021.

DRAFTSMAN for patent office drawings. Salary $25 to $35. Location, New York. 1022.

DRAFTSMAN to make measurements and drawings of machine tools; work will require considerable time and position has good promise for future. Young man desired with technical education and some practical experience, especially in machine-tool work. Location, Buffalo. 1033.

ASSISTANT to mechanical laboratories; prefer technically trained man, who would be able to conduct classes and look after equipment of shops of mechanical laboratories. Salary $120. Location, Brooklyn. 1060.

TECHNICAL GRADUATE capable of undertaking the standardization of materials and processes in large, small-tools manufacturing plant. Must be familiar with chemical and physical testing of metals and other materials, and with mechanical operations. State age, experience and references. Location, Philadelphia. 1087.

DRAFTSMEN having three and five years' experience on boiler and stoker work. Location, New York. 1090.

DRAFTSMAN capable of doing accurate checking on drawings. Location, Virginia. 1093.

METALLURGIST for firm making steel automobile parts, one of the largest in its field; familiarity with modern chemical and metallographical control essential. Must have sufficient initiative to lay out proper methods and the necessary personality to see that those methods are followed. Location, Pennsylvania. 1094.

DRAFTSMAN on piping and general machinery. Salary $20-$35. Location, Connecticut. 1099.

COMBUSTION ENGINEER familiar with large steam plants. Experienced in efficiency work. Location, Philadelphia. 1102.

DRAFTSMAN and ESTIMATORS for work of varied character with large concern. Offers good opportunity for advancement. Location, New Jersey. 1104.

DRAFTSMAN, technical graduate, capable of assuming full responsibility of drawing room, designing tools, fixtures, jigs, gages. One having shop and executive experience preferred. Location, Ohio. 1105.

PRODUCTION SUPERINTENDENT with experience in foundry and machine-shop work. Technical graduate 30-45 years of age preferred. Must be good executive, alert and aggressive in getting work through factory. Shop has approximately 800 men and does all kinds of power-transmission work. Location, Middle West. Salary $3000-$4000. 1106.

TECHNICAL GRADUATE wanted to do mechanical drafting and assist in other work in factory. In answer state age, education, past positions, and salary expected to start. Location, New Jersey. 1111.

MECHANICAL-ENGINEERING DEPARTMENT of a Middle West State college desires applications from men suitable for the position of foreman in machine shop. Successful applicant must have had several years' actual machine-shop work and be familiar with methods of mass production and scientific management. Desirable that he have college training, although not absolutely necessary. Should have had experience as foreman or assistant foreman in some successful shop, and preferably some teaching experience, although this is not absolutely necessary. Prefer young man not over 35 to 40 years of age. Location, Michigan. 1112.

DESIGNER of tools and jigs for large, high-grade factory, to build up a new department. Must have experience in heavy motor-truck work and first-class motor manufacture. An unusually good opportunity for the right man. Give complete information in first letter. Location, Middle West. 1114.

ENGINEER OF TESTS to assume charge of physical testing laboratory of large corporation. Excellent opportunity for technically trained man with from two to four years' experience in testing work. In first letter state age, education, experience in detail and salary expected. Location vicinity of New York City. 1117.

SUPERINTENDENT of boiler house and power house in connection with blast furnace plant. Location Ohio. 1118.

MECHANICAL ENGINEER. Experienced in design of apparatus for chemical plants. Capable of working from rough sketches and other data. Salary $125 per month. Location, New Jersey. 1125.

PRACTICAL EFFICIENCY ENGINEER, not theoretical, for manufacturing company in Ohio. 1126.

MEN AVAILABLE

Only members of the Society are listed in the published notices in this section. Copy for notices should be in hand by the 15th of the month, and the form of the notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

WORKS MANAGER or SUPERINTENDENT in moderate-size plant, with view to making permanent connection. Technical graduate, age 31. Wide experience in purchasing materials, employment of all classes of labor, design and layout of factories, and installation of scientific production methods, standardization, and management in various industrial plants. At present employed as industrial engineer by large Eastern manufacturing corporation; work nearing completion with this concern after six years service. G-245.

WORKS ENGINEER or MANUFACTURING SUPERINTENDENT, experienced in modern manufacturing methods, and capable of getting maximum production from equipment and men employed. G-246.

PRACTICAL FOUNDRY MAN. Capable of handling any foundry position. G-247.

CHIEF OPERATING ENGINEER for large central steam-electric power company or holding company. Age 44, married. Twenty years varied experience in steam generation and utilization and design and installation of systems up to 7000 boiler hp. and 2500 kw. Thoroughly conversant with the principles and practice of economy in steam generation and utilization. Good organizer; university graduate. At present employed. References given. Location preferred east of Mississippi River. G-248.

MECHANICAL ENGINEER, with extensive all-around experience, desires change. Charge of mechanical engineering, design or mechanical superintendent. Heavy-machinery and industrial-plant experience. G-249.

SUPERINTENDENT of CONSTRUCTION or MECHANICAL ENGINEER. Specialty: plant construction and maintenance, installation of all power-plant and shop machinery, buildings, foundations, etc. Fifteen years' engineering experience in the West. Technical graduate, age 34. Desires a live job, any location. G-250.

MECHANICAL ELECTRICAL ENGINEER. Columbia graduate. As sales manager or superintendent. At present employed as manager of a very large concern. Experience in internal-combustion engines, gas producers, power installations, foundry and machine-shop practice and marine-power plants. Unusual business and technical training. Fully conversant with French, Italian and Spanish. Minimum salary to start, $4,000. G-251.

MEMBER. Technical, practical, with twenty years' broad experience in design, construction and operation of steam-electric power plants and transmission systems. Good executive. Has shown economy in steam generation with both anthracite and bituminous coal. At present with railroad near New York as engineer of power, light and heat. Desires position as superintendent or chief engineer of electric or steam-power system of large inland power plant, or in ore or coal-mining regions, South or West. G-252.

MECHANICAL ENGINEER. Age 35, married. Wide experience in the design of automatic and general machinery; also experience in general structural work, engine and boiler testing. Familiar with shop methods and following-up work through shops. Desires position with a firm in the Eastern states, preferably Philadelphia. At present employed. First-class references. G-253.

MECHANICAL ENGINEER. Married. Technical education. Thirteen years devoted to experimental work, education, development and production work on internal-combustion engines and self-propelled vehicles. Specialty, internal-combustion engines. Familiar with modern shop practice; can handle men. Open for a position with view of permanent connection. Highest references. G-254.

TECHNICAL GRADUATE, M.E., married, age 27. Shop experience, factory inspector, branch manager, sales experience. Now engaged in safety-engineering work. Desires position as assistant to executive or in sales department. Location preferred in East. G-255.

GENERAL PRODUCTION and FACTORY EXECUTIVE. Age 32, married. American. Technically trained, clean cut and aggressive. Ten years' active experience in layout, organization and supervision of manufacturing projects along efficiency lines. G-256.

EXECUTIVE, MUNITIONS MANUFACTURE. Age 38. Twenty years' experience in almost every capacity, in Corliss-engine manufacture; as works manager recently organized, equipped and operated shop of 1000 men and successfully completed contract for artillery ammunition. Rejected by Engineer Officers' Reserve Corps on account of slight physical defect. Desires position where experience and ability will be fully utilized on the "big job." Present otherwise satisfactory position not directly useful to United States now. G-257.

GRADUATE IN MECHANICAL ENGINEERING. M.I.T. '15. Fourteen months' testing experience with a large electrical concern and some production experience. Desires work along production engineering or works-management lines. At present employed. G-258.

SALES ENGINEER, electrical-mechanical, technical graduate, age 34, married, American citizen. Twelve years' sales experience. Speaks Spanish and Portuguese. At present located in Cuba as consulting engineer, desires position in the United States, preferably in the West. Thoroughly acquainted with Denver, Salt Lake and San Francisco terrritories. Possesses executive ability, has specialized last seven years in electrical machinery, although has thorough knowledge of steam engineering. G-259.

PURCHASING ENGINEER. Presently engaged, would consider change for responsible position. Especially equipped through service with large organizations, and in technical and commercial valuation of materials, electrical and mechanical equipment, machine-shop processes, and building construction. G-260.

YOUNG MECHANICAL and ELECTRICAL ENGINEER. Technical graduate, age 28. Four years with large manufacturer of internal-combustion engines, steam pumps, compressors, gas producers, generators and motors. Two years assistant inspector of gas and electricity in a large city. Practical shop and engineering experience. Sales or engineering position with a future desired. G-261.

DIRECTOR or PRINCIPAL of TRADE or VOCATIONAL SCHOOL. At present head of department technical high school. Six years' practical experience, seven years' teaching. Desires to locate where ability counts and greater opportunity for advancement exists. Present salary $1750. G-262.

CHEMICAL and MECHANICAL ENGINEER. High-grade technical graduate in mechanical engineering who has also had thorough chemical training desires to change from present employment to position in a chemical industry where ability to operate economically, improve and develop methods will be appreciated. Sixteen years' experience, seven in chemical industry. G-263.

EXECUTIVE or ASSISTANT SUPERINTENDENT. Technical education, American, age 36. Practical mechanic, familiar with design of special machinery, tools, jigs, fixtures, etc., for manufacturing duplicate parts on interchangeable system. Twelve years in drafting room, including chief draftsman; six years' shop experience, one as foreman. Salary $2000 per annum. Location preferred, Eastern States. G-264.

WORKS MANAGER or SUPERINTENDENT. American, age 43. Twenty-two years' practical experience in interchangeable-parts manufacture, automatic and semi-automatic machine design and manufacture, power-plant equipment such as valves, piping, brass, gray and malleable iron fittings, tools and fixtures. Successfully held the positions of apprentice, tool maker, general foreman, chief draftsman, mechanical engineer and superintendent. At present employed; best reason for changing. Minimum salary $4,000. G-265.

YOUNG ENGINEER. Technical graduate. Two years' good engineering experience, desires position in engineering sales or purchasing department of manufacturing concern. G-266.

STRUCTURAL and MECHANICAL ENGINEER. Age 33, technical graduate. Six years' experience in designing structural steel and reinforced concrete. At present employed. Desires permanent and responsible position, in either executive or engineering departments, where past experience can be utilized. G-267.

SALES ENGINEER. Technical graduate. Six years' experience in steel work. Three years' experience in selling cast iron and cast steel. Desires position as salesman for large foundry; has large clientele and can produce gratifying results. G-268.

ENGINEERING SURVEY

A Review of Engineering Progress and Attainment in Mechanical Engineering and Related Fields, Including a Digest of Current Technical Periodicals and a Selected List of Engineering Articles

Recent Papers on Engineering Research

In view of the peculiar importance now attaching to engineering and scientific research and the very general desire to know more of the nature, purpose and progress of such work, it has been thought advisable to present here brief synopses of certain of the papers and addresses that have appeared in the last year or so in American and foreign periodicals. The list of articles so abstracted, however, should not be considered in any sense an exhaustive one.

J. J. CARTY CONTRASTS INDUSTRIAL AND SCIENTIFIC RESEARCH

In his presidential address to our sister society, the American Institute of Electrical Engineers, presented at the annual meeting in Cleveland in June 1917, J. J. Carty made an attempt to direct attention to certain important relations between purely scientific research and industrial scientific research and to point out how manufacturers of various types might avail themselves of the advantages of research.

The stupendous upheaval of the European war with its startling agencies of destruction, the product of both science and the industries, Mr. Carty said, has brought about a great awakening of our people, out of which has come a growing appreciation of the importance of industrial scientific research, not only as an aid to military defense, but as an essential part of every industry in time of peace.

Industrial research conducted in accordance with the principles of science is no new thing in America. The Research Department of the Bell Telephone Companies, founded nearly forty years ago, and which is under the direction of Mr. Carty, has grown from small beginnings with but a few workers to a great institution employing hundreds of scientists and engineers. The larger electrical manufacturing concerns have also founded industrial scientific research laboratories, and while vast sums are spent annually upon industrial research in these laboratories, Mr. Carty states that he can say with authority that they return to the industries each year improvements in the art, which taken altogether have a value many times greater than the total cost of their production. Money expended in properly directed industrial research, conducted on scientific principles, is sure to bring to the industries the most generous return.

Industrial scientific-research departments can reach their highest development in those concerns doing the largest amount of business. The conditions today are such that, without coöperation among themselves, the small concerns cannot have the full benefits of industrial research, for no one among them is sufficiently strong to maintain the necessary staff and laboratories. The small manufacturer may, however, obtain the full benefits of industrial research by taking his problem to one of the industrial research laboratories already established for this very purpose. If this be extensively done, such laboratories would be enabled to extend and improve their facilities so as to render better service, but until the manufacturers themselves are aroused to the necessity of action in the matter of industrial research, there is no plan which can be devised that will result in the general establishment of research laboratories for the industries.

In the present state of the world's development there is nothing which can do more to advance American industries than the general adoption by our manufacturers of industrial research conducted on scientific principles.

In the minds of many there is confusion between industrial scientific research and purely scientific research, particularly as the industrial research involves the use of advanced scientific methods. The distinction is to be found not in the subject-matter of the research, but in the motive. Industrial research is always conducted with the purpose of accomplishing some utilitarian end. Pure scientific research is conducted with the philosophic purpose for the discovery of truth and for the advancement of the boundaries of human knowledge. With all this, however, it must be borne in mind that the two are closely interrelated.

While a single discovery in pure science, when considered with reference to any particular branch of industry, may not appear to be an appreciable benefit, yet when interpreted by the industrial scientist—which includes the engineer and the industrial chemist—and when adapted to particular uses by him, the contributions of pure science, as a whole, become of incalculable value to all the new industries.

Mr. Carty strongly emphasized the fact that while discoveries of the pure scientist are of the greatest importance to the higher interest of mankind, their particular benefits are usually indirect, intangible and remote; and he showed how, through the utilization of American universities, means may be provided for an adequate establishment of scientific research in this country. (*Proceedings of the American Institute of Electrical Engineers*, vol. 35, no. 10, October 1916)

W. R. WHITNEY MAKES PLEA FOR RECOGNITION OF RESEARCH AND LIBERALITY TO WORKERS

In an address delivered at the alumni dinner of the Massachusetts Institute of Technology, January 6, 1917, W. R. Whitney, Director of the Research Laboratory of the General Electric Company, made an urgent plea for the better recognition of the value of scientific research work and a more liberal treatment of those engaged in this pursuit. He emphasized particularly how generally the world's greatest discoveries have been disclosed in their first stages by men who were highly trained and experienced in experimenting. The foundations of advance are most often made by such men as experimental-science professors, who with minds skilled in observation and keen in appreciation, have had opportunity to long continue the investigation of some phenomena of nature which they observed.

More chemists and physicists should be trained in our schools than are absorbed in our industries. They are needed much more generally in scientific-research laboratories in the college or elsewhere, where the country's future interests are

concerned. An investigator of the type of Faraday may be safely said to be worth thousands of ordinary men. It is necessary to recognize clearly that the great industrial development has not grown out of an accident or a single observation, but has been the result of painstaking work. It was a professor at Louvain, Minckelers, who apparently started us in the use of illuminating gas. He was not aiming to illuminate houses, but was trying such gases in balloons. He also tried lighting his lecture room by this means. Engineering development from this peculiar discovery did not take place for ten or more years, but it was the inquisitive mind of the trained physicist and chemist which made the engineering possible.

There are many more just such widely interesting developments which only await the careful study of the trained inquirer. Very little or nothing seems to have been accidental. Our position has resulted from gradual accretions of knowledge from many experimenters.

The speaker cited many cases where proper encouragement given to scientists had led to the development of important contributions to engineering in the broad sense of this term. (*General Electric Review*, vol. 20, no. 2, February 1917)

CHARLES P. STEINMETZ WANTS TO SEE RESULTS INDUSTRIALLY USEFUL

Industry, and with it all our modern civilization, depends on engineering, says Charles P. Steinmetz, Chief Consulting Engineer of the General Electric Company. Engineering, however, is nothing but applied science, and science thus is the foundation and scientific research the ultimate means which have created our civilization. Of late the industrial development has been so rapid and the demand for the results of scientific research so great and urgent that universities, which for ages have been the chief homes of scientific research, have not been able to supply it and the industries had to enter the field of scientific research themselves. Besides, universities and educational institutions rather retrograded in scientific research, became submerged in a false commercialism, which figured the output of the college in student-hours per professor, judged efficiency by the percentage of students graduated, and too often wasted the university's best assets, its professors. Thus we find in colleges men who have shown themselves capable as investigators to do scientific research work of the highest order, overloaded with educational or administrative routine and deprived of the time for research work. Private industries rarely commit such crimes of wasting men on work inferior to what they can do; industrial efficiency forbids it.

Thus, when the advance of industry demanded a more rapid extension of our scientific knowledge, scientific-research laboratories were established in the industries and some of them very soon showed their ability to produce scientific work of high character. But these scientific-research laboratories of the industry represent only a part, often a minor part, of the research work done within the industry, and in many places opportunity is afforded for the right men to carry out scientific research. Thus, in the materials testing laboratories of our industrial corporations, in their standardizing laboratories, development sections, etc., research work is being carried out and, as a rule, is encouraged by the corporations.

Under the head of industrial-research laboratories come also the commercial testing laboratories, development laboratories, etc., which have been established and serve the same purpose to the smaller industrial organizations as do the private laboratories to the great industrial corporations.

Theoretical scientific-research work in industrial establishments should be of such character that it may lead to results which are industrially useful. Actually, however, there is no scientific investigation however remote from industrial requirements which might not possibly lead to industrially useful developments. Indeed, experience has shown that it is rare that some industrially valuable results do not follow sooner or later, no matter how abstruse and remote from apparent utility a scientific investigation may appear. To illustrate—when the General Electric Company undertook research work on the electrostatic corona and dielectric phenomena in the air, no immediate or direct benefit could be seen for the company. But before the research was completed it had led to a redesign of practically all high-voltage transmission apparatus and has thus proved valuable in industrial design.

Some kinds of research can be carried out more efficiently by educational institutions, and others by the industries. Research requiring little in facilities, but a large amount of time and attention from research men is especially adapted to educational laboratories, while investigations requiring large amounts of material or of power rather than time of the investigators, are specially adapted to the industries, and often beyond the facilities of the educational institution. The best plan is a division of research between educational and industrial laboratories in accordance with their facilities wherever possible; as, for example, was done in an investigation of the phenomena of the dielectric field by the Consulting Engineering Laboratory of the General Electric Company on one hand, and Johns Hopkins University on the other.

The closer relation of industrial research laboratories to engineering practice leads to a tendency which, in general, may be expressed by saying that in the results of industrial research a probable error is greater, but the possibility of a constant error less. On the other hand, in industrial research the liability exists of limiting the work to such a narrow field that it has little general scientific value. Inversely, in educational research there is sometimes the tendency to generalize beyond the limits justified and so draw wrong conclusions. The quality of the work is about equal in both, and in the industry may vary from scientific research of the highest quality down to investigations which are of little, if any, value.

The essential difference between industrial and educational research, however, is found in their method of publication. The publication mediums of scientific research carried on in educational institutions are the scientific publications, while the publication mediums of the scientific research carried on in the industry are the technical or engineering papers. Unfortunately, a large number of scientists still look on publication in the technical press as unscientific, and as a result a large and steadily increasing part of the scientific research of the country is practically lost to the scientist. In one case certain tables of physical constants, published only a few years ago, neglected to take account of a mass of data on an important subject that had been recorded in engineering proceedings. Such an attitude of our scientists constitutes, in the opinion of Mr. Steinmetz, a serious menace to our Nation's progress. (*General Electric Review*, vol. 20, no. 2, February 1917)

CLAYTON H. SHARP ADVOCATES INDEPENDENT RESEARCH LABORATORIES

In discussing the position of independent laboratories in the engineering industries Dr. Clayton H. Sharp, Technical Director, Electrical Testing Laboratories, New York City, calls attention to the fact, which is becoming more and more clearly recognized, that with the sharpened competition which must

ensue at the close of the war any and all means for increasing our industrial efficiency will be considered with far greater seriousness than ever hitherto.

The great American manufacturing organizations realize the importance of laboratory testing and research and have provided means for carrying it on, but the manufacturers of smaller resources do not make a correspondingly large use of laboratory assistance. This may be ascribed to two causes: First, because they are not so fully aware of their own need for laboratory assistance and of the possibilities of laboratory work in increasing their efficiency; second, because of particular difficulties in securing such laboratory facilities as correspond to their needs.

Pure scientific investigation may be best carried on in the university, but for the adequate pursuit of industrial research work it is necessary to look to organizations constituted differently. The smaller manufacturer might take his laboratory problems to a technical school for solution, but this plan is open to the objection that the funds of the institution, being given for a public purpose, should not be diverted to private ends. Against this it may be urged that it is to the advantage of the technical school to take on a certain amount of industrial work, not only in research but also in testing. Such work necessarily brings both instructors and students into contact with certain practical problems of the outside industrial world, a world of which they know much in theory, but often too little in practice.

There are, however, certain disadvantages in having industrial problems handled by the technical school. The lack of contact with the actualities of practice, on the part of instructors and students who handle the problems, greatly lessens the value of the technical school as an organization for industrial research. The technical-school men are not equipped to consider the problems of cost, of the intellectual and psychological limitations of workmen, of transportation, of market conditions, of company policy, of technical and commercial usage in the field, any or all of which may have their influence on the result.

It is the independent laboratory that has to provide for the smaller manufacturer what the private laboratory does for some of the great corporations. To fulfill these functions properly, the independent laboratory must be adequately supported, properly manned and abundantly equipped. Its staff must be organized on particular lines. Its engineers must be familiar with the practical and commercial features, as well as the technical details of the work which they encounter. It must include physicists and chemists accustomed to look at the fundamental features of the problems presented. The fees charged by such a laboratory must be adequate to cover not only all expense but also to yield a sufficient profit as well.

In return the laboratory must deal with its clients in a highly confidential manner, conserving individually all of the results of the work for which they are paid. It must be prepared to turn over to its clients the inventions and patents which are the direct outcome of any specific piece of work.

The equipment of such a laboratory must be extensive to enable it to handle the great variety of work afforded to it. A very large supply of electrical power is an absolute requisite. To some extent a laboratory of this sort must possess from its very inception a considerable investment for its equipment. All this makes the establishment of such laboratories a matter of considerable difficulty, notwithstanding the great importance of the results which they may achieve for the industry. (*Journal of the Franklin Institute*, vol. 183, no. 2, February 1917)

ALBERT H. HOOKER CITES NIAGARA FALLS WORK

In a paper presented before the American Electrochemical Society on February 11, 1916, Albert H. Hooker, Works Manager of the Hooker Electrochemical Company of Niagara Falls, New York, presented a paper on Niagara, the Commercial Research Laboratory of the Nation.

In this paper the very significant statement is made that when the Niagara Falls Power Company started their tunnel about 1891, not one of the products now made by the company's use of power was then known to commerce. Aluminum, carborundum, alundum, silicon, artificial graphite, calcium carbide, cyanamide, various ferroalloys, sodium, chlorine, chloroform, etc., are all commercial products of the last 25 years, most of them having been developed through the impetus given by this Niagara Falls power development.

The vast importance of these products has scarcely been fully realized. Carborundum, alundum, aloxite, crystolon are all artificial abrasives used in modern grinding machinery for the manufacture of automobiles, guns, shells, shoes and for the grinding of tools. There is hardly an industry where the tremendous decrease in production and increase in cost would not be felt, were we without these artificial abrasives produced by the electric furnace at Niagara.

There are many vast problems in this connection and not in a day, a month, or even a year can these problems be worked out, the equipment developed and installed, and above all the workers trained. (*Metallurgical and Chemical Engineering*, vol. 14, no. 5, March 1, 1916)

MARSTON T. BOGERT DESCRIBES WORK OF CHEMISTRY COMMITTEE OF NATIONAL RESEARCH COUNCIL

In a preliminary statement to the American Chemical Society, M. T. Bogert gave some data on the National Research Council and its Chemistry Committee.

The main object of the National Research Council is, as its name suggests, to aid the cause of scientific research in every way possible. During the period of the Civil War the Federal Government often felt very keenly the need of expert advice in scientific matters of all kinds, and it was to meet this end that Congress, on March 3, 1863, by special enactment created the National Academy of Sciences. The present war has again shown with startling vividness to what extent the military power of a nation is dependent upon its scientific and industrial preparedness. The first step in this direction was made by the Naval Consulting Board of the United States with the coöperation of the 30,000 members of the great national engineering and technical societies. This board took a census of our industrial resources. The next step necessary was a proper classification of the census of the scientific-research resources of our country, and the body to whom the Government naturally turned for assistance was again the National Academy of Sciences. This latter, at the request of the President of the United States, has organized the National Research Council.

As regards the work of the Chemistry Committee, the present report calls attention to the fact that the vast majority of important scientific problems concern more than one science. There is, therefore, great need of some agency which will aid research workers, who wish to do so, to coöperate more intelligently. It is believed that the general committees of the Council can perform this service acceptably and thus act as accelerating catalysts to the growth and development of our science by becoming great clearing houses for the chemical research work of the country and authoritative headquarters

for information likely to be of value to the individual investigators, to our industries, and to our Government.

It should be stated most emphatically that the object of the Council and its committees is to assist, and not to direct. It has no desire or intention to interfere in the slightest with the freedom or initiative of the individual investigator, or to attempt to "organize and coordinate" him. In fact, the Chemistry Committee prefers not to receive any information which cannot be disclosed to any loyal American chemists. Those who are willing to place at the service of our Government confidential information of any kind should communicate direct with the secretary of the appropriate department or with the Director of the Council of National Defense.

The report proceeds to point out in which way the Council can hope to accomplish what is not being adequately cared for already by existing agencies. In the first place, the Council with the assistance of the Research Committees it is organizing in all of our leading educational institutions, can aid in obtaining for an investigator better recognition on the part of the community and of his own institution and an amelioration of his lot, by securing for him more freedom and better equipment for research, adequate assistance and a living wage. A deliberate and carefully considered recommendation by an authoritative body, such as the National Research Council, with the weight of the National Academy and of the Federal Government back of it and based upon information gathered by committees of leading experts, cannot be lightly passed over and is apt to be productive of results.

Thus the Council might well point out to our educational institutions the shortage of men properly equipped for high-grade research work in science; the fact that young men are being drafted into the industries, by present high wages, as soon as they are graduated and before they have had any special training in research; that the future is being handicapped by the loss to these same industries of so many inspiring teachers and investigators; the need of new advanced textbooks and reference works in science in our own language; of colleges and schools devoted to highly specialized training and instruction in relatively narrow fields of pure or applied science; and of great scientific research endowments, like the Rockefeller Institute of New York, and the Mellon Institute of Pittsburgh.

One of the first tasks confronting the Council is that of securing an accurate and properly classified list of the scientific investigators of the country; showing where they are located, in what lines of research they are interested, and how their work can be aided and encouraged.

The plan adopted for accomplishing this is to send out a questionnaire to all our educational and research institutions, and it is particularly requested that all chemists who receive such questionnaires from the American Chemical Society, the National Research Council or from any of their committees, will fill them out and return them promptly to the proper office. The data received in reply will be sorted out and classified in the office of the general committee and then forwarded to the chairmen of the appropriate sub-committees. The chairmen of these sub-committees will thus be put in possession of all information relating to their own particular fields, and will be then in a position to determine how best to help their fellow-workers. Reports on the situation in each branch of science will come periodically to the office of the general committee, together with recommendations and suggestions from the heads of these sub-committees concerning important investigations now under way or which should be initiated.

The committees of the Council are already of great assistance in bringing together the problem and the man best qualified to attack it. Both the Government and our industries are frequently entirely at a loss as to who are the proper men to consult when important research problems confront them. On the other hand, many skillful investigators are delighted to find that certain of these same problems, of whose very existence they have remained in blissful ignorance, fit in admirably with the kind of research work they enjoy most, and the fact that the problem has direct practical bearing imparts to the work added zest and charm.

Another form of coöperation which will help in meeting this same difficulty is that inaugurated by the University of Illinois and which has since been introduced at other institutions giving instruction in chemical engineering. Briefly stated, it consists in having the chemical engineering students, for their summer work, manufacture fine chemicals for sale to investigators in other institutions. The students thus get practical experience in the manufacture of chemicals, receive pay for the work, and the product is sold at its approximate cost. This does not in any way invade the territory of the commercial manufacturing chemist, for the reason that the chemicals so produced by the universities will be only those which are used in such small amounts that they are of no interest to the manufacturer. Through the Chemistry Committee of the Council, duplications in this work can be reduced to a minimum, each institution producing a different list of research chemicals for which it has provided the requisite equipment, and the Committee can then tell an investigator at once to which institution to apply for the special chemical desired. (*Journal of the American Chemical Society*, vol. 39, no. 5, May 1917)

A RESEARCH DEVELOPMENT IN ENGLAND

As an illustration of the development of research in England, we read in *The Engineer* for February 16, 1917, that the Advisory Council of the Government's Department of Scientific and Industrial Research has added to the list of its technical committees a Standing Committee on Glass and Optical Instruments.

The Committee met on December 11, and having regard to the urgency of the problems requiring investigation in respect to these essential industries, appointed a series of sub-committees to which various special problems were referred. Among these problems the more important are:

- *a* Raw materials for glass and glass making
- *b* Optical properties of a large range of glasses
- *c* General physical and chemical properties of glass and glassware for scientific and industrial purposes
- *d* Testing and standardizing of glassware
- *e* Workshop technique
- *f* X-ray glass properties
- *g* Optical calculations and lens designing
- *h* Optical instruments
- *j* Translation of foreign works on optics.

This brief description indicates certain lines of investigation which have been brought forward. The Standing Committee does not propose to limit itself to these subjects, but is prepared to consider and report upon the necessity for investigation in other directions, relevant to its terms of reference. Manufacturers who have experienced difficulties requiring investigations for their solution in connection with the subjects of glass and optical instruments or who desire to make suggestions for special researches on these subjects are invited to communicate in the first instance with the Secretary of

the Research Department, Great George-street, Westminster, S. W., who will direct the correspondence into the appropriate channels for attention.

ALFRED SAXON FORESEES AGREEMENT ON RESEARCH NEEDS

In a paper read before the Manchester Association of Engineers on February 10, 1917, Alfred Saxon, who is a representative of the society in question on the British Standing Committee on Engineering, said that, with reference to industrial research in mechanical engineering, the scheme was likely to take the form of certain well-defined sections of the trade being brought together and agreeing as to the researches that were the most necessary and desirable, each firm joining being asked to contribute towards the cost, assisted by a government grant. He considered that the value of the scheme to practical mechanical engineering would depend largely upon whether the government was prepared to assist until the research schemes became self-supporting by the contributions of the firms themselves. He urged that all firms would act wisely by making provision in future for an outlay on research work as a standing charge. Inasmuch as mechanical engineering was the key industry to all the industries, the need of scientific research to assist in the creation of new ideas and new methods and to reduce manufacturing costs and prevent waste of material was overwhelming. (*The Engineer*, vol. 123, no. 3190, February 6, 1917)

ROBERT KENNEDY DUNCAN AND HIS NOTABLE RESEARCH PLAN

No synopsis of papers on industrial research in America would be complete without a quotation from some work by the late Prof. Robert Kennedy Duncan. First as professor at the University of Kansas, then in a broader field of activity at the University of Pittsburgh, Professor Duncan did yeoman work in making available for the American industries such means of research as there were. His work was largely responsible for the establishment of the Mellon Institute of Research at the University of Pittsburgh, which not only did and is doing useful work itself, but served as an example in the recent establishment of a system of research coöperation between technical schools and industries in Australia.

In 1906 Professor Duncan published his Chemistry of Commerce, the object of which, as he stated in the introduction, was to convince the manufacturer, through instances taken here and there, how absolutely applicable is modern science to the economy and progress of manufacturing operations.

At that time he preferred against American industries the grave but nevertheless largely true charge that in our country, astonishing to say, success in many cases has been achieved actually by working in accordance with the motto, "Save at the spigot and waste at the bunghole."

Professor Duncan early realized the tremendous importance of the German system of research as an element in industry and often expressed his ideas in a striking manner. "The Badische Anilin und Soda Fabrik of Ludwigshofen am Rhine" is a name to conjure with in Germany, and no robber castle on that historic river was ever more dreaded than is this modern fortress of industry by those against whom it is commercially and inimically inclined. It was in England in 1831 that Peregrin Phillips discovered that sulphur dioxide and air would unite with the most agreeable ease in the mere presence of platinum. However, nothing came out of this discovery in England, because there was no sympathy there between learning and manufacture. In Germany, on the other hand, there was no tariff wall against English ideas and the matter was taken up. Difficulty after difficulty arose, and plan upon plan went to the scrap heap. They found they were using little air when they ought to use much; they found they were using heat when they ought to use cold; they found that platinum was being constantly poisoned by impurities in the roasted gas. But after an enormous expenditure of knowledge and time and labor and money, they won. The roasted sulphur gas and air are scrubbed and dried and cooled and passed over platinized asbestos, only to be collected therefrom as sulphuric acid—more than 200,000 tons in 1904. And all this has added significance from the fact that here a highly valuable product is obtained through the utilization of a by-product, the waste sulphur from the zinc blend. Here the enormous dividends paid by these companies attest the profitable nature of the application of pure science to industry.

The industrial fellowship was one of the solutions of the problem as to how the American manufacturer might secure the benefits of the highest grade of research at a reasonable cost. The scheme proposed was to have a special research department in the university. The company which desires a certain problem investigated endows an industrial fellowship or fellowships for a period of one or more years. The exclusive purpose of such fellowship is the discovery of improvements in the particular branch in which the donor is interested, and the holder of the fellowship gives his whole time and attention to that particular problem.

The fellow is appointed by the university authorities. He is a member of the university and pays all regular fees, works under the advice and direction of the professor in his department, and periodically forwards through this latter the reports of the progress of his work to the industrial company which donated the fellowship.

All the discoveries made by the fellow during the tenure of his fellowship become the property of the company, subject to the payment by them to the fellow of one-tenth of the net proceeds arising from such discoveries.

The concluding words of Professor Duncan's book may be worth recalling at the present time:

"Everywhere throughout America, wherever there is the smoke of a factory chimney, there are unsolved, exasperating, vitally important manufacturing problems—problems in glass, porcelain, starch, tanning, paints, drugs, meats, iron, oil, metallurgical products—problems wherever man deals with substance. It seems clear that these problems can best be answered by combining the practical knowledge and the large facilities of the factory with the new and special knowledge of the universities, and by making this combination through young men who will find therein success and opportunity.

"A Temporary Industrial Fellowship does this: it affords a young man every incentive to lay his hands on the vast body of correlated knowledge called Science, and to make it subserve the practical needs of the human race."

The Society for the Promotion of Engineering Education has cancelled its meeting planned to be held at Northwestern University, and will hold its 1917 annual meeting in Washington, July 6 and 7, in connection with the Educational Committee of the Advisory Commission of the Council of National Defense. The topic of the meeting will be The Relation of the Engineering Schools to the National Government during the Present Emergency.

New Tidewater Tin-Plate Plant

It is expected that the first unit of the new tin-plate plant now being built for the Bethlehem Steel Company at Sparrows Point, Maryland, will be ready for operation by July 1.

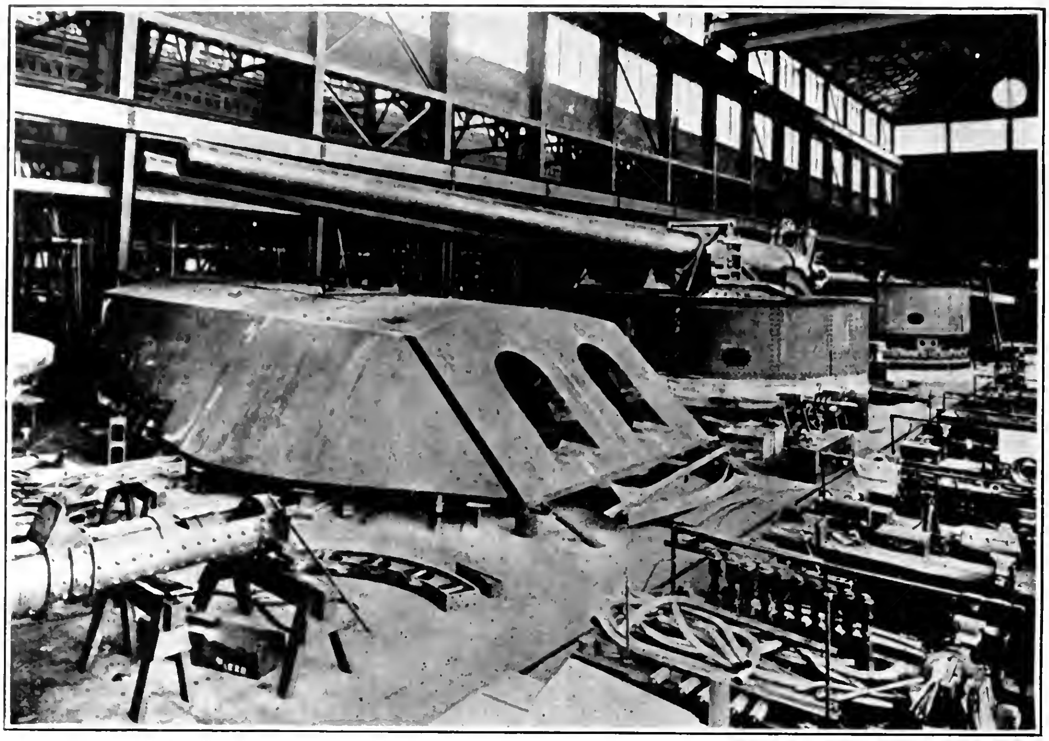
This plant forms part of the tremendous construction program recently undertaken by the Bethlehem Steel Company in various sections of the country. The Sparrows Point plant was formerly operated by the Maryland Steel Company and the tin-plate works will form another link in the growing chain of steel products manufactured by the Bethlehem Steel Company. It is laid out for an eventual production of 2,000,000 base boxes annually. The initial unit of 12 mills now nearing completion will have, however, a production of only 1,000,000 base boxes of tin plate a year.

The buildings are of permanent and fireproof construction and of generous size throughout. Although only twelve mills are being installed at present, the buildings, foundations, etc., have been completed for the eventual twenty-four mill layout.

Some of the drives used are of considerable interest. The hot mills, which are of very massive construction, are divided into two main groups of six each, each group being driven by a 1200-hp. motor designed to operate on 2200-volt, 25-cycle alternating current. The motors are connected to the hot-mill spindles by means of cast-steel cut helical reduction gears. The speed reduction is eight to one.

The cold-rolling department consists of 12 stands of 24 by 36-in. cold rolls driven in tandem of three by a rope drive and a 1200-hp. motor. The Wuest herringbone reduction gear is interposed between the motor and the rope pulleys. The rope drive is inserted in the power-transmission system in order to be sure that the sheets will leave the mill with the most desirable surface possible, and it is believed that a rope drive tends to give a better surface to sheets than a rigid gear drive.

In connection with the above description, attention is called to the accompanying photograph, very recently taken (Underwood and Underwood) and not published elsewhere, of the gun-machinery room of the Bethlehem Steel Company.



Underwood and Underwood

GUN-MACHINERY ROOM OF BETHLEHEM STEEL COMPANY

Work of American Colleges and Universities During the War

The report has been received of a meeting held in Washington, May 5, of college presidents, called by Dr. Hollis Godfrey, Chairman of the Advisory Commission of the Council of National Defense on Science and Research, including Engineering and Education. The object of the meeting was to formulate a comprehensive policy for coöperation between the higher institutions of learning and the Government and to determine a general policy to be pursued by the American colleges and universities, so that their resources would be available, to the fullest extent, for Government service.

In a statement of principles issued, it was held, first, that all young men below the age of liability for selected draft who could avail themselves of the opportunities afforded by our colleges should do so in order that they might later be able to render the most effective service. Second, that the colleges should consider the advisability of dividing the college year into four quarters of approximately 12 weeks each, and that, where necessary, courses be repeated at least once a year so that the college course might be best adapted to the needs of food production. Third, that students pursuing technical courses, such as engineering, would render more valuable service by continuing their training than if they were to enroll in military or naval service before graduation. Fourth, that the colleges should include as a part of their course of study, teaching in military science in accordance with the provisions of the National Defense Act of June, 1916.

Resolutions were passed looking to coöperation between the Government and the colleges, by which means the latter would

be kept informed of the plans of the Government in its various departments for the prosecution of the war, in so far as they concern the work of the colleges; and of the extent and type of technical or military training which it may seem desirable to the Government that the colleges should undertake.

A committee was appointed by the Chairman to serve as a special section on education of the Committee on Science, Engineering and Education of the Advisory Commission, which took preliminary steps toward the accomplishment of results indicated by the resolutions at the main meeting.

Notes from the Engineering Colleges

Equipment of Laboratories—Investigations in Progress—Changes in Curricula

BELOW is a continuation of the review of professional work being undertaken at the engineering colleges. The articles contain information regarding (1) characteristics of laboratory equipment, (2) tests or researches under way or in prospect, (3) important changes in curricula.

The articles will be concluded next month.

Armour Institute of Technology

Equipment: The laboratory equipment differs very little from that of institutions such as Cornell or the University of Illinois. Special equipment for research work in automotive engineering, refrigeration, heat transmission through insulating materials, fan blowers, and lubrication.

Experimental Work: Specialization in testing automotive engines and appliances; work for commercial concerns; method of testing internal combustion engines; testing various materials for use in connection with Government work.

Brown University

Equipment: Usual college apparatus, to handle mechanical tests of materials up to 400,000 lb. in tension, compression and cross bending and to 60,000 in.-lb. in torsion. Especially well equipped with auxiliary measuring apparatus and with means for measuring power.

Experimental Work: Determination of causes affecting precision of machine tools; study of electric high-temperature heating furnaces for industrial purposes. Plans under consideration for closer coöperation in matters of instruction between the University and the industrial establishments of the community.

Curriculum: Entire revision of the engineering curriculum has been authorized by the Board of Fellows to go into effect next fall, as the result of a careful study by a large committee of engineers and educators. The new course is designed to develop the broader type of engineer. It has come about as a result of the demand for engineers trained in the fundamental sciences and their applications, with power to express themselves with clearness, accuracy and force; and with a knowledge of human relations to enable them to enter executive offices and industrial organizations as well as to direct the work of construction ordinarily expected of an engineer.

Under the new curriculum the student may either take a course which will fit him for a broad choice of positions; or, if he is to specialize, he can postpone specialization until he has had an opportunity to determine the field for which he is best fitted. He will not be forced to an early decision as to the particular branch of engineering which he is to pursue.

Throughout the course emphasis is placed on the fundamentals of science and engineering together with such applications as may be necessary to drive home the principles and give the engineering point of view. Courses which give mainly information easily secured while on practical work after graduation are either eliminated or made elective. Subjects fundamental to all branches of engineering are required of all students, but opportunity will still be given for specialization in civil, electrical and mechanical engineering for those who desire it. Engineering courses are introduced in the freshman and sophomore years to parallel the courses in mathematics and physics and to give an opportunity to apply the theories to actual problems. Foreign languages as a requirement are eliminated, although they may be elected. The course allows considerable flexibility in the choice of subjects. The requirements are as follows:

Freshman Year: Trigonometry, analytic geometry and elementary calculus; mechanical drawing, first semester; descriptive geometry, second semester; surveying and engineering mechanics; rhetoric and composition; chemistry or substitute; during part of the summer vacation a course in either surveying or shop work will be required.

Sophomore Year: Differential and integral calculus; economics and either social or political science; physics, mechanics and graphics, English or approved substitute.

Junior Year: Mechanics and structures; electrical engineering; heat and power; materials of engineering, first semester; hydraulics, second semester; approved elective.

Senior Year: Engineering economics, report of special investigation, two engineering electives, two approved electives.

The electives include advanced surveying; railroad engineering; geodesy; highway engineering; structural design; water supply and sewerage; advanced electrical engineering, direct and alternating currents; traction engineering; transmission engineering; shop practice, organization and management; machine design; power plant engineering; gas power engineering; experimental engineering; conference courses in heating and ventilation; refrigeration, fire protection, etc.; mathematics, chemistry, physics; French, German, Spanish or Portuguese; English, public speaking, history, philosophy, social and political science and economics; the entrance requirements are unchanged.

Kansas State Agricultural College

Equipment: For testing materials, a 200,000-lb. Olsen universal testing machine, a 250,000-in.-lb. torsion testing machine, a 100,000-lb. and a 50,000-lb. Riehlé testing machine, a 10,000-lb. beam testing machine, cement and concrete testing equipment, two impact machines, a hardness testing machine, equipment for testing bituminous road materials, etc.

The equipment includes also a number of dynamo electric machines, a compound steam engine of 50 hp., 12 steam engines with different types of valve gears, three steam turbines equipped with condensers; pumps; a Smith suction gas producer, which supplies gas to a 25 hp. Foos gas engine and can be operated either with producer gas, natural gas, water gas or with light and heavy liquid fuels; 30 other gas and oil engines, one 3½-ton Frick compression machine for refrigeration, one ½-ton York compression machine and one 2½-ton horizontal compression machine, equipment for testing trucks and traction engines.

Research Work, Tests: Concrete and aggregates, insulation for electrical conductors, lightning arresters, machine tools, heating and hardness tests on metals, Kansas molding sands.

Investigations: Refrigeration; sewage disposal; uses of electricity in the home; oil engines and oil traction engines, automobile motors, lubricating oils for automobiles, properties of paints, thermodynamic investigations on steam and internal-combustion engines. Members of the engineering faculty are encouraged to take up investigations of value to the profession, which are carried on under the auspices of the engineering experimental station.

Curriculum: The engineering courses are being revised as the college is changing from the three-term plan to the semester plan. In this connection a study has been made of the time devoted to the various subjects in thirty of the leading engineering colleges. In the new courses of study these results will be incorporated.

Lewis Institute

The Cement Users' Association makes use of the strength of materials laboratory for its investigations in cement and other materials entering into concrete construction, while the Institute continues to use the laboratory for the purposes of instruction. This arrangement has proved very satisfactory. The students are showing interest in the work of the laboratory, and there seems to be a stimulus to good work in the presence of this busy, scientific workshop.

New Mexico College of Agriculture and Mechanic Arts, School of Engineering

Equipment: This is a typical land grant college, with emphasis in its course in experimental and extension work in agriculture and engineering. The agricultural experiment station is conducting work regularly along improvements in methods and efficiency in this state. The organizing of an engineering experiment station is now under consideration.

Experimental Work: Considerable experimental work was done on arc welding and testing of brick; it is hoped materially to increase this research work and particularly to do work of help to the United States Government.

Curriculum: In addition to the regular engineering courses, it is planned to give a six weeks' practical course in highway construction and concrete, to further the good road movement; also to give a practical six weeks' course in electricity, automobile mechanics and tractor operation, the use of the tractor in New Mexico being still in its infancy. A one-year short course in automobile mechanics proved very successful last year.

Oregon Agricultural College

Equipment: Apparatus for testing materials, cement, etc.; highway, hydraulic, steam, oil and gas engines; fuels and oils; metallography of iron and steel, including some special apparatus for tests in power transmission, on insulating materials, and on heating and ventilating equipment.

Experimental Work: In addition to the regular instructional work this department does the laboratory work for the Oregon State Highway Department and during the past year the majority of the special tests have been on Oregon highway and bridge materials.

Pennsylvania State College School of Engineering

Equipment: A thermal testing plant which includes refrigerating apparatus, and a heating system; a separate building thoroughly insulated in which is a second insulated compartment for tests of the transmission of heat through simple and compound walls (additional apparatus is being installed to provide for accurate automatic regulation of temperatures), and a steam laboratory equipped for the testing of steam, gas, kerosene and oil engines of various types and capacities. There is also a completely equipped flour mill for experimental and research work, as well as for class instruction, and a separate building equipped for the study of causes of explosions in flour and cereal mills, with firing apparatus, instruments for the detection of static electricity, and special apparatus for the prevention of the propagation of flame from mills to storage bins.

Experimental Work: On the loss of heat through glass as influenced by wind velocity, humidity and difference in temperature; explosiveness of various mixtures of flour milling materials, and possible sources of ignition; economy of oil engines of the 20-hp. semi-Diesel type; on the life of various types of electric lamps; and relative fire protection offered by unpainted board surfaces, surfaces painted with common white lead and oil, and surfaces painted with a fire resisting special paint.

The study of the explosiveness of various flour-mill dusts has shown that where separate sources of ignition are provided, such as electric arcs, in the attrition mill, explosions could be produced at will, and of an intensity that seemed to indicate that the destructiveness would depend upon the quality and quantity of material ignited.

Rose Polytechnic Institute

Equipment: The institute has just completed a very successful campaign whereby means have been provided for the erection and equipment of its new plant, which contemplates a removal of the entire institute within the next two years. The new site lies two miles outside of the city limits, and will occupy a campus of one hundred and twenty-two acres. The plan to be carried into effect provides for complete new equipment as well as new buildings.

The laboratory equipment includes a 200,000-lb. Olsen testing machine, a 100,000-lb. Riehlé testing machine with recording apparatus, a 32,000-lb. special testing machine, a 100,000-lb. beam-and-column testing machine, a 10,000-lb. chain-, rope- and wire-testing machine, a 4-in. continuous torsion-testing machine, three cement-testing machines with complete apparatus for cement testing, wire-testing machine for elasticity, etc., an alternating-stress machine, continuous and integrating indicators for steam and gas engines, indicator-testing machines, transmission and absorption dynamometers, tool-cut dynamometer, 6-in. journal-friction machine, traction dynamometers for cars and engines, Kelvin electric balances for standardizing wattmeters, volt and ammeters, electrostatic voltmeters up to 100,000 volts, apparatus for testing insulating materials; testing instruments and transformers; dividing engine and comparator for length standardizing.

Experimental Work: Construction and test of hydraulic shunt flow tube; study and comparison of the road resistance of various road-building materials, especially with reference to automobile traffic; relative strength of square and filleted corners; effect of humidity conditions on the power production of gasoline engines; experimental investigation of aluminum-

chromium alloys; efficiency test on internal combustion engines; electric hysteresis test and losses in iron; strength tests on bridge members; utilization of wood waste; utilization of city garbage.

SIBLEY COLLEGE, CORNELL UNIVERSITY

Equipment: The mechanical laboratories consist of the following:

The Materials Testing Laboratory, which is equipped for tension and compression tests with an Olsen 300,000-lb. machine, a Riehlé 100,000-lb. machine, a 200,000-lb. Emery hydraulic machine; for transverse tests with a Riehlé machine of 200,000 lb. capacity and a Fairbanks machine of 10,000 lb. capacity. There are two Thurston autographic torsion machines, one Olsen torsion machine of 200,000 in.-lb. capacity, and two Upton-Lewis fatigue testing machines.

The Steam Laboratory, which comprises a 150-hp. triple-expansion Allis-Corliss engine and several smaller engines. There is a 35-kw. horizontal Curtis turbine and a 15-kw. De Laval turbine, an Ingersoll-Rand compressor and three air-brake pumps of different types, a 150-hp. Babcock & Wilcox water-tube boiler of marine type, and one 100-hp. Babcock & Wilcox water-tube boiler of standard type, an 80-hp. Heine water-tube boiler and a 25-hp. Roberts safety boiler connected with a Foster independent superheater.

The Gas Engine Laboratory, including gas engines, gasoline engines, and hot-air engines.

The Hydraulic Laboratory, containing centrifugal pumps, water wheels and hydraulic rams; water meters and other auxiliaries.

The Oil Testing Laboratory, Refrigeration Laboratory, Cement Laboratory, Fuel Testing Laboratory, which are similarly equipped.

The electric equipment includes a Dynamo Laboratory, Standardizing Laboratory, and a Wireless Laboratory.

Work Shops include a foundry occupying floor space of about 4800 sq. ft., a forge shop with the usual equipment of standard forges and small tools, a pattern shop with floor space of 8440 sq. ft.; the machine shop has the same floor area as the pattern shop. It is equipped with an electric traveling crane and representative modern machine tools. A part of the workshop equipment is installed to illustrate the latest practice in production with specialized labor-saving machinery.

WASHINGTON UNIVERSITY (ST. LOUIS)

Equipment: Laboratories are equipped to do research work on fuels, gas and steam appliances, automobiles, etc., and especially equipped for testing cutting tools.

Research Work: Tests have been made on steam-turbine nozzles, automobiles, kerosene carburetors, and high-speed steel cutting tools, but the work was not all completed owing to the seniors carrying on the work being excused for military duty. In the tests on cutting tools particular attention was paid to the effect on the life and power of the tools when the lip and front angles were varied. In cutting soft steel the best results were obtained when using a lip angle of 25 deg. and a front angle of 14 deg. In the carburetor tests it was possible to operate a 9 by 11-in., 300 r.p.m. two-cylinder, four-cycle Bruce-Macbeth gas engine on various mixtures of kerosene and water and of kerosene and gasoline. The experiments were not carried far enough to arrive at any definite conclusions as to the best mixtures to use.

SHEFFIELD SCIENTIFIC SCHOOL, YALE UNIVERSITY

Equipment: General teaching and research laboratories in physics, chemistry, mechanical engineering, electrical engineering, mining engineering, cement testing. The mechanical-engineering laboratory is equipped to handle problems relating to motor vehicles, steam and gas engines, house-heating boilers, and the testing of materials. The mining laboratory has special facilities for investigations in the fields of ore dressing, metallurgy and metallography.

Research Work: Testing of house-heating boilers (Journal A.S.M.E., Nov. 1916); commercial sampling and analysis of producer gas (Journal A.S.M.E., Dec. 1916); hardness tests on brass[1]; shearing strength of heat-treated steels; power losses in pneumatic tires (Bulletin S.A.E., Feb. 1917); grinding brass ashes in the conical ball mill (N. Y. Meeting, A.I.M.E., Feb. 1916); tests on the Hardinge conical mill (St. Louis Meeting, A.I.M.E., Oct. 1917); comparison between electrolytic and two varieties of arsenical Lake copper with respect to strength and ductility in cold-worked and annealed tests (Trans. A.I.M.E., 1916); growth of grain and diffusional characteristics on annealing bronze containing from 4 to 8 per cent tin (International Ztsch. für Metallographie, Oct. 1916); tests with various aggregates and sands; survey of sands in the vicinity of New Haven, Conn.

Industrial Research: Some investigations were conducted under a coöperative agreement with certain manufacturers. A similar arrangement is described by Professor Mathewson in his paper Coöperation with Metal Industries in Metallographic Work (Am. Inst. of Metals, 1916). As it may be of interest to manufacturers and other engineering schools, a brief outline of it is as follows:

A graduate student whose undergraduate work in this or other universities shows promise of ability to handle research work, is chosen by conference between the company and instructor involved. The aim of the company in the agreement then entered into is to obtain the solution of one or more of the technical problems with which it may be confronted, or, at the end of one or two years, to obtain as an employee a man especially trained in its work. As a means to accomplish one or both of these ends, the company furnishes the machine, apparatus, or material to be tested and pays the student during his graduate work a small salary, usually just sufficient to cover his living expenses, tuition and fees. The aim of the student is special training along a line in which he is particularly interested, the attainment of his advanced degree, and the chance to show to his future employer ability to handle such problems as may be presented to him. In return for the financial aid which he receives he agrees to devote at least half of his working time to the special problem submitted by his company. The other half is devoted to study of the collateral subjects required by the department for the granting of the degree which the student seeks. The student further agrees to enter the employ of the company in question at a wage not greater than that paid in like positions to recent graduates not specially trained and to remain with his employer at such wage for at least 1 year. If the student is to obtain a degree, the special work forming the basis of his investigation must be such as will involve real research and not mere routine manipulation. The subject is chosen by conference between the three parties to the agreement. The work is carried on under the direct supervision of the instructor involved. The school furnishes the general laboratory and library equipment essential to the pursuit of any extended investigation. In return it is expected that the results of the investigation shall be, in part at least, available for publication, if they are deemed of interest to the profession.

TULANE UNIVERSITY OF LOUISIANA

Experimental Work: The College of Technology has well-equipped laboratories. Investigations have been made of

[1] *American Machinist*, May 31, 1917.

pumping plant equipment under the auspices of the U. S. Department of Agriculture, and results have been reported from time to time in the bulletins of that department and in papers before the Society. Commercial tests of metals, woods and cements are frequently made. Other work touches on heat treatment of steel, reported in the *Journal of the Iron and Steel Institute*; physical tests of bricks manufactured in the States of Louisiana, Mississippi and Alabama, published in the *Transactions of the American Society for Testing Materials*; and drainage-pumping plants.

Department of Industrial Chemistry: Researches are made on local manufacturing problems, and it is endeavored to meet the peculiar demands of the locality in this respect.

West Virginia University

Equipment: Machine, woodworking, forge, sheet-metal and pipe shops and foundry.

Steam Laboratory: High-pressure boilers, separately fired superheater, simple and compound engines, steam turbine and condensers of different types; apparatus for testing separators, drop in line pressure, flow of steam, testing indicators, gages, etc.

Testing Material Laboratory: Testing machines ranging from 20,000 to 400,000 lb.; complete equipment for testing highway materials, cement and concrete; Brinell and Shore hardness-testing equipment.

Hydraulic Laboratory: Not extensive but well adapted to instruction work and for a limited amount of research work. Well equipped for measuring flow of streams.

Mining Laboratory: Well equipped for first-aid and rescue work, coal calorimetry and coal analysis; analysis of mine air, etc.; furnace work, mining machinery.

Oil and Gas Laboratory: Fitted up especially for testing lubricating oils and petroleum and for the extraction of gasoline from dry natural and casing-head gas.

Electrical Laboratory: Especially well equipped with dynamo-electric machinery of various types, transformers, rectifiers, condensers, high-tension apparatus and electrical instruments, electric-railway equipment.

Research Work: Combustion of natural gas under boilers and the heating value of natural gas; tests on West Virginia building brick in coöperation with the American Society for Testing Materials; drop in pressure in pipe lines, using differential manometers; correct form and location of sampling tubes for steam-calorimeter work; effect of superheat and change of vacuum on the economy of steam turbines; effect of varying percentages of carbon on the hardness of steels; flow of steam in pipes; distribution of concentrated loads on concrete slabs; crown thickness for concrete arches; study of slag concrete; curves for run-off of streams in Monongahela Valley; standardization of bridges, and culverts for State Road Bureau; study of the distortion of the field of a salient-pole alternator at various power factors; effect of inertia on the performance of a phase converter; effect of orienting the molecules of a gas on the opacity of the gas to Roentgen rays.

The Mining Engineering Department is the official Bureau of Research for the State Department of Mines, and does all the analyses of mine air, etc. The State Road Bureau also uses the laboratories.

Curriculum: Chemical engineering has been added and the course in oil and gas engineering has been enlarged. The plan of continuous sessions will be adopted, enabling those who are physically fit to graduate earlier. By this arrangement the present junior class may graduate by December 15.

News of Other Societies

Institution of Mechanical Engineers

The annual meeting of the Institution was held on Friday evening, April 20, 1917. The President, Michael Longridge, gave the address.

The war had taught us many things, he said, but none more clearly than the importance of our engineering industry. Upon this industry we depended for victory today and for security and prosperity tomorrow.

The mechanical engineer was in no small measure responsible for the transformation of the industrial life of England, and he must also be held responsible for the maintenance and efficiency of the workshop on which the feeding of the people and the defense of the people against their enemies now depended. He became and he remained a trustee for the British Empire.

In the view of the speaker the British engineers had not fully done their duty. As an example, he quoted the story of the engine-building trade of Lancashire. There was a time when Lancashire's supremacy in this branch of engineering was beyond dispute. But when the speaker went to the Paris Exhibition in 1900, he found that in elegance of form, in completeness of finish, in careful arrangement of details, the engines exhibited by some of the continental countries excelled the British stationary engine. It was, however, only through the repeated loss of orders that much later British engineers were forced to recognize the esteem in which continental products were held by customers. Later still the time came when complete steam engines built abroad were brought to England, erected and set to work by foreign workmen, even in the very home of British steam-engine manufacture, in Lancashire itself.

Some of the causes of the relative retrogression of British mechanical engineering, Mr. Longridge said, were beyond the control of engineers. Others they could remove in part or altogether. And of these he named inefficient technical education, lack of trade organization, and the policy of the trade unions. (Abstracted through *The Engineer*, vol. 123, no. 3200, April 27, 1917, pp. 371-374. *g*)

Canadian Society of Civil Engineers

At a luncheon of the Ottawa Branch of the Canadian Society of Civil Engineers on April 26, 1917, Colonel David Carnegie, Ordnance Advisor to the Imperial Munitions Board, delivered an address on the manufacture of munitions in Canada and the permanent assets to Canadian industry resulting therefrom.

In September 1914, said Colonel Carnegie, when General Sir Sam Hughes undertook the first order for shrapnel shells, Canada's capacity to produce shells amounted to 340 18-Pr. shrapnel shells per week. These were made at the Dominion Arsenal, Quebec. The capacity of Canadian factories today approximates 400,000 18-Pr. shrapnel complete rounds per week, including cartridge cases, primers, fuses and propellants. In addition to this amazing output there is a weekly capacity in Canada for nearly 400,000 high-explosive shells, ranging in sizes from 18-Pr. to 9.2 in., making an approximate total weekly output of 800,000 shells. This large output, along with other supplies made independently, requires each week about:

25,000 tons of steel	200 tons of antimony
2,500 tons of brass	150 tons of resin
750 tons of copper	500 tons of cordite

250 tons of zinc	500 tons of trinitrotoluol
1,500 tons of lead	300 tons of nitrocellulose powder.
Several tons of ferromolybdenum.	

Over 300,000 boxes are required for these shipments per week, and about 3¼ million lineal feet of board are used in making these boxes.

The weekly value of these products can only be understood by people who have learned to think in millions.

The total value of orders for munitions placed in Canada approaches eight hundred million dollars, and the value of the munitions shipped is close upon five hundred million dollars.

When the first order for 200,000 empty shrapnel shells was undertaken no one had any idea of the magnitude of the work, the foundation of which was then laid. That order, which required over six months to complete, represented eleven years' work at the rate of output of the Dominion Arsenal. The present weekly output of 400,000 18-Pr. shrapnel shells from Canadian factories is equal to twenty-two years' output from the Dominion Arsenal.

The uncertainty of securing material for the first order, of the right quality and in sufficient quantity, together with the difficulty in obtaining machinery and skilled labor to produce shells which would pass inspection and gun proof, made even the most courageous manufacturer hesitate to undertake the work without having the assurance of the Canadian Government that they would bear any financial loss incurred in the venture.

Instead of placing orders for the complete shells with each manufacturer, an arrangement was made whereby manufacturers whose domestic trade most nearly approached that required in producing the component parts of the shells were asked to undertake the work. Such parts, when finally inspected, were assembled and finished at the works of other manufacturers, who had to install machinery and plant for the purpose. The manufacturers were therefore not called upon to carry the responsibility for the purchase and inspection of any of the materials used in the shells.

They were also supplied with a complete set of inspection gages to guide them in making or obtaining manufacturing gages and in the standard of finish required by the Government inspectors.

While the manufacturers were relieved of these responsibilities, the cost of production was reduced and the quality of output improved by purchasing the materials through one agency instead of many, and by standardizing the inspection of work in supplying the gages to all makers.

All manufacturers were paid the same price for the same work. No competition was admitted among them, except the rivalry to excel each other in making the largest output that would pass Government inspection. This policy united the manufacturers without restricting inventive skill, ingenuity of design, and new methods of individual works management. It promoted a spirit of comradeship among them and an exchange of visits to their works. Freely were new ideas for cheapening and improving the quality of production used by all.

One could hardly mention this subject without being reminded of the almost insuperable difficulties which were presented in the early days of the war in obtaining gages for munitions. Canadians could never thank the United States manufacturers sufficiently for what they did in coming to their aid at that time. The special skill in making gages to the limits of accuracy required could not then be found in Canada. Today there were at least twenty factories producing gages in Canada, and while they were not independent of help from the States, some idea of the magnitude of the work could be understood from the monthly bill, which amounted to over $150,000 for new gages.

During the month of March about 10,000 new gages and checks were imported, the usual accuracy called for on a gage being 0.0003 in., and for a check 0.0001 in. An army of over 5000 examiners was engaged upon inspection under the direction of Colonel Edwards and his staff of officers.

The Engineers' Club of Brooklyn

THE Engineers' Club of Brooklyn was addressed at its meeting of April 26 by C. E. Drayer, Secretary of the Cleveland Engineering Society, on coöperation between Engineering Societies and the Newspapers to Promote Intelligent Public Opinion. Successful methods of close coöperation with newspapers were described in detail, as developed during a period of five years or more in the Cleveland Engineering Society.

News arose, said Mr. Drayer, from happenings that people wanted to hear about. It was evident that engineering topics which could not measure up to this standard could not compel space in the papers. On the other hand, if the society was doing things which would interest the readers of the papers, the editor could not for long keep accounts of such activities out of his paper and hold his job. But the inferred premise was wrong that editors did not welcome engineering news. They were eager for it if the right kind was supplied. At once the suggestion arose that the best way to learn how to supply copy was to get familiar with the standards of news measurement of the successful editor. The methods found successful in Cleveland would apply equally well anywhere, for people would be found to be people—with very slight variations—everywhere.

Publicity, which had received so much emphasis of late, was a means only, not an end. The end was service to the community first, to the engineering profession second, with mutual profit. When the public learned that the engineer was honest and efficient, capable of administering its affairs better than now done, it would make short work of the old-time politician. The present widespread call for the city-manager form of government over the country was but a demand for capable government. It was a call for engineers, but not for the kind that were content with technical matters, but for men having technical training plus the determination of the lawyer to be a leader in the community and the mixing ability of the politician.

The speaker told of the activities of the Cleveland Engineering Society in building-code legislation, paving supervision and water supply for the good of Cleveland and predicted that the next mayor would be an engineer. He said there would be no dearth of engineering news and that the space in the newspapers would be freely open to engineers when they woke up to their opportunity and took what was awaiting the taking.

Using the Cleveland Engineering Society as an illustration of what could be done when engineers were united in a community, Mr. Drayer urged unity and federation of engineers of the United States after the manner of the Chamber of Commerce of the United States, and noted the wonderful influence of the American Institute of Architects, which, with a membership of but 1200, had nevertheless left its imprint on the nation more deeply than all the engineering societies, because it had been properly organized. He arraigned the recently formed

Engineering Council as missing its opportunity in that it was undemocratic, made no provision for fellowship and did not find its strength for directing legislation where men voted.

Shipping Pig Iron (Not Pigs) in Refrigerator Cars

"So short has been the supply of cars in the South that iron has been shipped to navy yards in refrigerator cars. These came loaded with iced beef, but were seized by the Government as the only available equipment and loaded out with pig iron."

This statement from a report of the iron market, issued by the Matthew Addy Company of Cincinnati, clearly indicates the serious shortage of rolling stock, when even the National Government must adopt such heroic measures as using refrigerator cars for the handling of pig iron.

In discussing the iron market in connection with this rolling-stock situation, the Matthew Addy Company's report says:

"It is apparent that Government needs and Government's right of eminent domain, so to speak, are going to have a profound effect on the iron market. They have introduced a new element into the situation and have made conditions more strenuous. In some districts Uncle Sam is requisitioning cars by the hundreds and ordering steel by the million tons; everywhere it is evident that the Government must be served first and that private consumers must sit at the second table. There is no objection to this. All realize that Uncle Sam is and must be paramount. But that does not change the fact that the private consumer is discommoded, and that in many cases he finds his regular source of supply abruptly cut off. And the thing has just begun. What the end may be is a mere matter of conjecture.

"This week there has been a great increase in inquiry. Demand for iron knows no limits. Part of this demand comes from the fact that iron that was bought has not been shipped, and if consumers cannot get what they have under contract, they must get it elsewhere. As an example of this, one of the large Birmingham producers has in 60 days piled to exceed 45,000 tons of iron on its yards simply because it is impossible to get cars in which to ship, as the Government has requisitioned 50,000 cars for coal and rails. And all the time consumers are clamoring for this very iron. So short has been the supply of cars in the South that iron has been shipped to navy yards in refrigerator cars. These came loaded with iced beef, but were seized by the Government as the only equipment available and loaded out with pig iron. It is things like these that bring to the mind the forcible realization of the fact that the railroads have fallen down in this great crisis. But the people who starved the railroads are the only ones to blame." (*Manufacturers Record*, vol. 71, no. 21, May 24, 1917, p. 47)

The *American Machinist* of May 31, 1917, mentions the receipt of a 600-page catalogue of the Lyons Fair which was held at Lyons, France, from March 18 to April 1 of this year. Considering the conditions under which this fair has been carried out, the *American Machinist* calls the exhibit nothing if not miraculous. Besides a comprehensive representation on a large scale that drew exhibits from practically all the industries of France and her colonies, many allied and neutral countries were represented. The machine tool section of the catalogue covers 14 pages, and among the representatives of the industry one notices the names of 15 American builders of machine tools.

This Month's Abstracts

At the present time, when the United States Government has under consideration the expenditure of hundreds of millions of dollars on aviation, the data on propellers abstracted from two papers by J. Lawrence Hodgson are of particular interest.

The description of a British continuous enameling and stoving machine is reported from an article in (London) *Engineering*.

L. R. Brown, in the *Engineering News-Record*, publishes data of some tests of sand in concrete showing the influence of the duration of tests on the results secured.

The abstract of a paper on the influence of temperature on the bending resistance of mild-steel and copper wires, originally published in the *Zeitschrift des Vereines deutscher Ingenieure*, is here reprinted from *Science Abstracts*. This is because German journals do not reach this country, but appear to be available in London.

W. K. Shepard, in an article on the hardness tests of brass, shows that the plotted relation between the scleroscope hardness number and the ultimate tensile strength for brass is parabolic (straight line for steel). On the other hand, no constant relation was found between the scleroscope and the Brinell hardness numbers for brass.

Attention is called to the article on the performance of lubricating-oil coolers by M. C. Stuart, Mem.Am.Soc.M.E. This article covers the relation between performance and the weight, volume and amount of cooling surface in various types of coolers.

The use of oscillographs for the study of internal-combustion engines, especially in regard to phenomena of ignition, described in the section Measuring Apparatus, deserves particular attention, as this instrument has proved to be an extremely valuable adjunct in the study of electrical machinery.

The Laws of Elastico-Viscous Fluids, by Prof. A. A. Michelson, will be found, in abstract, in the section Mechanics. The writer makes an attempt to formulate the behavior of substances under stress by the simplest expressions which have been found to satisfy all the essential requirements, and states that the behavior of any solid under stress may be considered as the resultant of four elements constituting the laws of elastico-viscous flow.

From papers and discussions before the recent Convention of the International Railway Fuel Association have been taken two abstracts on locomotive feedwater heating: one more or less theoretical, and the other of mainly an experimental character.

The still largely uncertain subject of circulation in flooded systems has been investigated by means of glass models, as described in an article abstracted from the May *A. S. R. E. Journal*.

The section Steam Engineering in this issue contains several abstracts of more than usual interest: Recent Installations of Large Turbo-Generators, a paper read by Richard H. Rice before the American Iron and Steel Institute, presents many data on the most modern practice, with estimates of costs in heat units and money. Another paper, by John A. Stevens, read before the Boston meeting of the National Association of Cotton Manufacturers, also gives data on turbine practice, and in addition presents a highly interesting description of a new type of boiler (Stevens-Pratt), so large that the length of the tubing, both in the boiler and the superheater, is measured in miles.

REVIEW OF ENGINEERING PERIODICALS

SUBJECTS OF THIS MONTH'S ABSTRACTS

Aeronautics

Tests on Model Propellers

Abstracts of two papers presented to the Institution of Automobile Engineers: the first entitled, The Characteristic Curves of a Propeller; and the second, An Experimental Investigation as to the Relation Between the Thrust Ratio of Lifting Propellers and the Number, Arrangement, Shape, Section and Pitch of Their Blades, both by J. Lawrence Hodgson.

The Characteristic Curves of a Propeller. The investigation was undertaken with a view to obtaining a general idea as to the performance of a propeller when it was moved at various speeds forward and backward along its axis of rotation, and to express this information in some simple way so that the approximate performance of any similar propeller working in a fluid medium of any given density might be readily deduced.

If, when comparing the performance of similar propellers working at the same slip ratio, the resistances due to skin friction and viscosity are assumed to follow the velocity-square law and change of density in the neighborhood of the propeller is neglected, there are six main features to be considered. These are, thrust in lb., T; revolutions per minute, N; torque in lb-in., q; speed of advance in ft. per sec., V; density of fluid in which propeller rotates in lb. per cu. ft., W; diameter of propeller in inches, D.

For given values of W and D, it is not possible to predict accurately by any simple theory the manner in which T, N and q will vary for different values of V. This may, however, be determined experimentally and expressed by means of curves. The experimental values may be obtained in three ways: viz., with T constant, or with N constant, or with q constant. In the experiments described in this paper the first way has been adopted.

If, instead of plotting the experimental values of N and q to obtain various speeds of advance for given values of W and V when T is constant, we plot non-dimensional coefficients which connect these values with two or more of the other variables, general curves are obtained from which the performance of any similar propeller under any conditions may be deduced. Such curves No. 1 and No. 2, Fig. 1, may be termed the characteristic curves of the propeller, since they entirely define its performance under any given conditions.

If the units in which the six variables are measured are consistent among themselves, these characteristic curves can be used without recalculation, but the curves in the present paper cannot be so used.

The propeller used for the present tests was 6.25 in. in diameter and had a pitch of approximately 6 in. Its blades were constructed of soft brass and attached to a central boss.

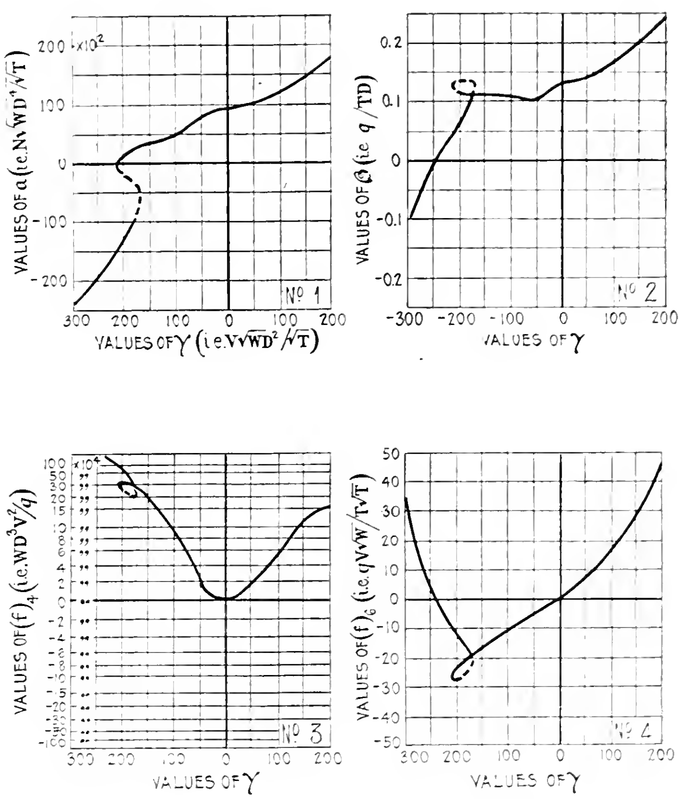


Fig. 1 Characteristic Curves of Propellers

All the tests were carried out in water, and the paper describes in detail the experimental apparatus and method of carrying out the tests.

A series of comparative tests taken in the same bell mouth with similar propellers 3 in. and 6.25 in. in diameter, respectively, showed that at comparatively small positive and negative speeds of advance the proximity of the walls of the bell mouth produced practically no effect.

The experimental results reduced to 1 lb. thrust for the 6.25-

in. diameter propeller are plotted in curves reproduced in the original article.

The following special points of interest are brought out in these curves. It was found that when the speed of advance is negative, it is possible to obtain the same thrust at different torques and with the propeller rotating at widely different speeds. Further, it appears that the experimental mean pitch as determined from the lines of zero thrust (at zero thrust the experimental mean pitch multiplied by the revolutions equals the speed of advance) is greater when the fluid impinges upon the leading edge of the propeller than it is when the propeller is reversed and the fluid impinges upon the trailing edge.

These tests have indicated how N and q are related to V when V, W and D are constant. Under certain assumptions the variations of N, q and V with T, W and D follow quite simple laws for points on the curves for which the ratio V/DN is constant.

Coefficients α, β, γ, which connect N, q and V with the expressions involving T, W and D, are determined as follows:

Since $T \propto N^2WD^4$ for points for which the ratio V/DN is constant, we may write

$$N = \alpha\sqrt{\frac{T}{WD^4}}$$

whence

$$\alpha = N\sqrt{\frac{WD^4}{T}} \quad \ldots\ldots\ldots\ldots [1]$$

Also, since

$$q \propto N^2WD^5, \text{ or}$$

$$\propto \alpha^2 \frac{T}{WD^4} WD^5 \text{ by [1],}$$

we may write

$$q = \beta TD$$

whence

$$\beta = \frac{q}{TD} \quad \ldots\ldots\ldots\ldots [2]$$

Further, since for the points considered the ratio V/DN is to be constant, we may write

$$V \propto DN$$

$$\propto D\alpha\sqrt{\frac{T}{WD^4}} \text{ by [1]}$$

$$V = \gamma\sqrt{\frac{T}{WD^2}}$$

whence

$$\gamma = V\sqrt{\frac{WD^2}{T}} \quad \ldots\ldots\ldots\ldots [3]$$

In the foregoing, α, β, and γ are numerical coefficients which may be calculated from the experimental results.

Curves connecting α and γ and β and γ are plotted at (1), (2), Fig. 1.

These curves, if used in conjunction with equations [1], [2], and [3], enable us, if we know T, W and D and one of the variables N, q and V, to find either of the other two.

The paper proceeds to the discussion of certain problems which may arise in calculating propellers geometrically similar to the model used.

For the solution of such, in similar cases, the writer suggests the derivation of a number of additional equations and curves from the three equations and the two curves referred to above. Such equations are immediately derived by him and collected in a table in the original article.

Among other things, an equation is given for the calculation of the thrusts of the ideal stationary propeller. Further, data are presented showing how the value of the "thrust ratio" t, which is defined as the ratio of the actual thrust to the theoretical thrust, is affected by the number of blades, the blade section, the developed blade outline, the developed edge elevation of the blade, the designed pitch, and the angle between the chord and the aerofoil section and the plane of rotation of the propeller, this latter under the assumption that the pressure face of the blade is perfectly flat.

This is done in the second paper, which represents an experimental investigation as to the relation between the thrust ratio of lifting screws and the number, arrangement, shape and section of their blades. The paper is suitable for abstracting only in parts.

The writer found from an examination of the stream-line flow through a stationary propeller by means of smoke filaments that the minimum diameter of the slip stream is about 0.6 of the blade diameter. Further, the smoke filaments show that in the case of a propeller of the usual pitch ratio having thin blades of good aerofoil section, the rotation of the fluid set up is small. From this the author proceeds to establish equations for the calculation of the thrust of a propeller and the determination of factors affecting the value of the thrust ratio. From a large number of experiments it was found, among other things, that the value of thrust ratio is only very slightly increased by using blades of helical form.

Also an unexpectedly small diminution was found in the value of the thrust ratio consequent upon the rounding off of the leading edge of the aerofoil section. On the other hand, a great reduction was found consequent upon cutting down the blade outline and modifying the edge elevation. Likewise a great reduction was produced by adding round struts and wires to the propeller, but a quite high value of thrust ratio was found possible in the case of propellers strengthened by struts, provided that these are made of streamline form.

The broad conclusions from these tests, which were carried out with the object of obtaining data for the design of lifting propellers of large size, would seem to be that there is little advantage (except reduction of vibration) to be gained by constructing such propellers with more than two blades, or by making the blades helical instead of flat (if the blades are made flat, the longitudinal spars are much simpler). It would also appear to be quite practicable to use blades of thin aerofoil section stiffened up by exposed struts and wires of streamlike form. It is also advantageous to thin down the blades at the tip and along the trailing edge. So far as the experiments show, there seems to be but little to be gained by departing from blades of rectangular blade outline.

Higher values of τ might have been obtained by putting the "planes" considerably farther apart. But this would have been inadmissible in practice for constructional reasons.

A reference to the streamline diagram will show that it is preferable to place the motor or any other necessary obstruction to the flow on the intake side of the lifting screw so as to avoid undue loss of energy by friction in the high-velocity slip stream.

This point seems to be well understood by those who design electric fans and screw-propelled ships. It is, however, of far less importance in the case of an aeroplane propeller, owing to the high velocity of the aeroplane.

The same diagram also shows how necessary it is to "shroud" a circulating fan, such as a radiator fan, which is

required to produce a high velocity on the intake side. (*The Automobile Engineer*, vol. 7, no. 101, April 1917, pp. 90-95, 16 figs., *etA*)

Enameling

Continuous Enameling and Stoving Machine for Small Parts

Description of a machine manufactured in England for enameling and stoving a great variety of parts of different shapes and sizes by continuous mechanically effected rotation. It is stated that it has an output up to 2000 parts per hour, with the attendance of only two unskilled operators.

The machine consists of two distinct units: one, the painting or enameling machine, and the other, the stoving machine. The painting machine consists of a table on which is mounted a vessel in the form of a tube or tunnel through which the articles to be painted are passed at a uniform speed and at a uniform distance from each other by means of an endless chain and wheels driven by a small electric motor. Each part to be painted is hung on a specially prepared hook, and these hooks are so made that they insure the various parts being kept at an equal distance from each other. The speed at which these parts pass through the tunnel can be up to 2000 per hour, and the distance of each part from the other can be varied to suit the requirements. On each side of the tunnel are placed two or more pneumatic paint-spraying machines which operate through coned openings in the sides of the tunnel and are so disposed as to insure the paint from the sprays reaching all the surfaces of the article being painted during the passage through the tunnel. After passing through the painting unit each article is disposed automatically by the machine on a small rod which forms a connecting link between the two units of the apparatus.

The continuous stoving machine consists of a rectangular chamber about 16 ft. long by 4 ft. wide, heated by suitable gas jets and fitted with a sliding door at the rear end. Two continuous chains with suitable sprockets are provided, one on each side of the machine, and operated by a handle so arranged that at each revolution of the handle the chain travels longitudinally inside of the stove a distance of about $4\frac{1}{2}$ in. These chains are provided to carry rods on which are suspended the parts which have been painted. Each rod travels through the stove at a rate equal to that of the number of revolutions of the handle. The result is that by the time the parts on any one rod have traveled through the whole length of the stove they will have been subjected to the heating for a definite period and the stoving operation completed. (*Engineering*, vol. 103, no. 2678, April 27, 1917, pp. 410-411, 1 fig., *d*)

Engineering Materials

Long and Short Sand Tests, L. R. Brown

The writer mentions a case where the results of a 7-day test of sand were so unfavorable that it was rejected. A 28-day test also showed the quality of the sand to be poor. The sand was, however, next tested with a different brand of cement and quite favorably passed the test at the end of half a year.

The writer believes, therefore, that probably the values of combinations of lake sand and cement found in the 7-day and 28-day tests are influenced by properties in the sand that hasten or retard the setting of the cement. Thus, a comparatively high value resulting from a mixture of sand and cement may be due to chemical action produced by the combination of certain chemicals in each that hasten the setting of the mortar, rather than deliver a neutralization of the injurious substances in the sand by the chemicals in the cement.

From his tests the writer comes to the following conclusions:

1 Nearly all well-graded sand has proved reliable on a 6-month test.

2 The reason for the low values obtained in the 7-day and 28-day tests is due to a delay in setting because of chemical properties in the sand or cement.

3 While changing the brand of cement used with a given sand may give higher values for 7 days and 28 days, the 6-month results may be lower.

4 The addition of small quantities of alkali to the mortar probably has only the effect of hastening the hardening of the mortar. (*Engineering News-Record*, vol. 78, no. 10, June 7, 1917, pp. 504-505, *e*)

Influence of Temperature on the Bending Resistance of Mild-Steel and Copper Wires, Lautz

An apparatus has been designed in which it is possible to effect the alternate bending of wires through an angle of 180 deg. while the specimen is heated at temperatures up to 320 deg. cent. in an oil bath. The results of a large number of tests show that the resistance of iron wires to fracture by alternate bending remains fairly constant up to 120 deg. cent. Between 120 deg. and 220 deg. the resistance increases rapidly, and above the latter temperature falls very abruptly. The maximum values are about double those observed at ordinary temperatures. In annealed wires the maximum is very pronounced, but it is nothing like so sharp in unannealed wires; further, it occurs at about 10 or 20 deg. higher in the unannealed samples. Contrary to expectations, copper broke quicker than iron at ordinary temperatures; the number of alternations rose continuously with the temperature. Bending around a sharp edge gives more reliable results than bending around a radius. The work is to be continued so as to determine the effect of variation in composition, and so on. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 60, pp. 785-788, September 23, 1916, through *Science Abstracts, Section A—Physics*, vol. 20, pt. 4, p. 122)

Experiments with Cold-Drawn and Annealed Ingot Iron, O. Bauer

A series of tests was made on cold-drawn and annealed ingot iron. The physical tests consisted of the determination of Brinell hardness, resistance to shock and tensile strength. The chemical examination consisted of solubility tests in 1 per cent H_2SO_4 for 70 hours and rust tests in 1 per cent NaCl for 30 days. It was shown that the solubility in acid gave better results in ascertaining the approximate annealing temperature than the Brinell hardness, and that as the annealing temperature rose, the solubility in H_2SO_4 diminished. The rust tests did not give satisfactory results, and there appears to be no distinct relation between the temperature of annealing and the rusting tendency of the Fe. (*Mitt. kgl. Materialprüfungsamt*, 33, 395-407; *Chem. Zentr.* 1916, I, 1281, through *Chemical Abstracts*, vol. 11, no. 11, June 10, 1917, p. 1625)

The Hardness Tests of Brass, William Kent Shepard

Data of an investigation made by the Sheffield Scientific School to determine the relation between the ultimate tensile

strength of brass and the hardness number as found by the Brinell and scleroscope tests.

Investigations of a nature similar to the present have been made on various styles, and in each case an appropriate straight line relation was found to exist between the ultimate tensile strength and the hardness number, whether Brinell or scleroscope.

In this test annealed brass and brass that had been cold rolled with reductions in thickness from 1 to 15 per cent of the original was used. It was all one grade, about 66 per cent copper and 34 per cent zinc. The data are presented in the form of tables and curves. It was found that the relation between the scleroscope hardness number and the ultimate tensile strength is parabolic for brass, and not a straight-line relation as in the case of steel. Likewise a parabolic relation was found to exist between the Brinell hardness number when determined by each different load and the ultimate tensile strength of brass.

The curves are tabulated to show also that there is no constant relation between the scleroscope and the Brinell hardness numbers for brass. In the curves the points are seen to be widely distributed along a general straight-line direction. (*American Machinist*, vol. 46, no. 22, May 31, 1917, pp. 935-937, 7 figs., *d*)

Hydraulic Engineering

Low-Head Power Development at Prairie Du Sac, H. W. Young

Description of a hydroelectric plant of the Wisconsin River Power Company, of 15,500 kw. capacity, representing recent practice in design of low-head waterpower development.

The construction and efficient operation of plants of the type of the one described here have been made possible through the progress of hydroelectric engineering in the last few years. Until quite recently, the difference in the mean low-water flow and the flood flow of a river has not been given due consideration. As a result, lack of sufficient spillways and adequate machinery to operate properly the flood outlets has endangered, to a great extent, all low-head waterpower developments where these conditions of flow existed. This feature had to be particularly provided for in the Prairie du Sac development, where the mean low-water flow is 5000 sec.-ft. and the high flood flow has reached 26,000 sec.-ft. This big difference has been taken care of by the installation of 41 Tainter gates, 14 ft. high and 20 ft. wide, placed on top of the spillway section of the dam. This permits control of all stages of floods and has a very important bearing on the present successful operation of the plant. These gates are all electrically operated.

The present normal head utilized is 28 ft., maintained the year around, as nearly as possible, by means of the control gates. In time of flood water, however, this is somewhat decreased by the backing up of the water in the tailrace, the loss of head from this cause being sometimes as high as 8 or 9 ft. (*Electrical Review and Western Electrician*, vol. 70, no. 20, May 19, 1917, pp. 828-833, 8 figs., *d*)

Internal Combustion Engineering

(See The Use of Oscillographs for the Study of Explosion Motors in section Measuring Apparatus)

Lubrication

The Performance of Lubricating-Oil Coolers, M. C. Stuart (Mem.Am.Soc.M.E.)

A paper presenting the main data of tests carried out at the U. S. Naval Engineering Experiment Station at Annapolis. This paper covers the relation between performance and the weight, volume and amount of cooling surface in various types of coolers.

With cooler installed and a certain oil selected for use, the variables for the test are limited to quantities of oil and cooling water circulated, and oil and water temperatures. Hence the test is divided into two parts: first, runs in which the rates of flow of oil and water are maintained constant and the temperatures of the inlet oil and water varied; and second, runs in which the inlet temperatures are maintained constant and the rates of flow of oil and water varied.

In the first division of the test runs are made with inlet water of varying temperature, say, 80 to 90 deg. fahr., and at each inlet water temperature runs are made with varying inlet oil temperatures, say, 120, 140, 160 and 180 deg. fahr. The resultant outlet temperatures of oil and water are plotted on what is termed a temperature diagram. Fig. 2 shows the relations between all the temperatures involved in the performance of the cooler at constant rates of flow of oil and water.

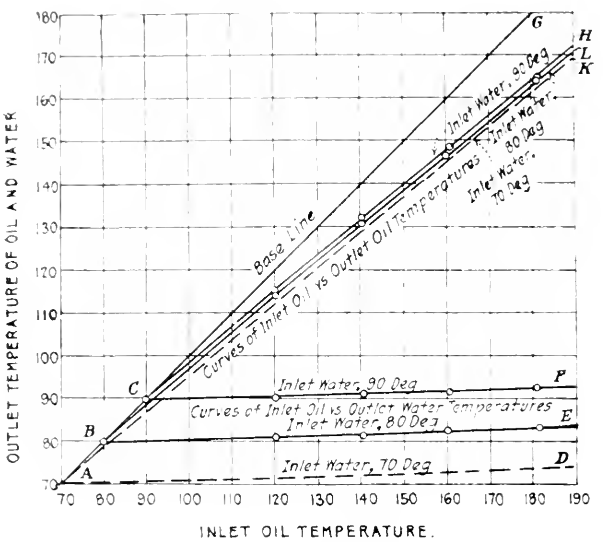


FIG. 2 TEMPERATURE DIAGRAM

This "temperature diagram" is a valuable aid in the analysis of the performance of oil coolers. As shown in Fig. 2, the abscissæ are inlet temperatures and the ordinates are outlet temperatures. A base line, or equal temperature line *AG*, is first drawn diagonally across the diagram. The values of inlet oil temperature versus outlet oil temperatures for the runs in which the inlet water temperatures were 90 deg., are plotted and line *CH* is drawn through the points. The intersection of this line with the base line at *C* is determined from the following consideration. Although the lowest inlet oil temperature was 120 deg., it is evident that if the inlet oil temperature should be reduced to the inlet water temperature, or, in this case 90 deg., the outlet oil temperature would equal the inlet oil temperature. In other words, the curve of inlet oil temperatures versus outlet oil temperature for a constant inlet water temperature intersects the base line at the temperature of the inlet water. In the same manner the curve *CF* of the inlet oil temperature versus outlet water temperature also intersects the base line at the inlet water temperature. The lines

BL and *BE* represent the results of runs made at inlet water temperature of 80 deg.

The important property of the temperature diagram is that the lines are straight, or very nearly straight, and the lines of a group are parallel. By means of this property curves may be constructed for other water temperatures than those

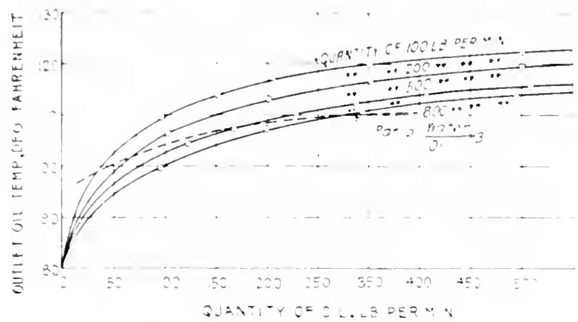


FIG. 3 QUANTITY DIAGRAM

covered in the test. Thus, in Fig. 2, the dotted lines *AK* and *AD* represent the outlet oil and outlet water temperatures, respectively, for an inlet water temperature of 70 deg.

The writer shows how such a diagram may be constructed from data of a single run. The temperature diagram may be

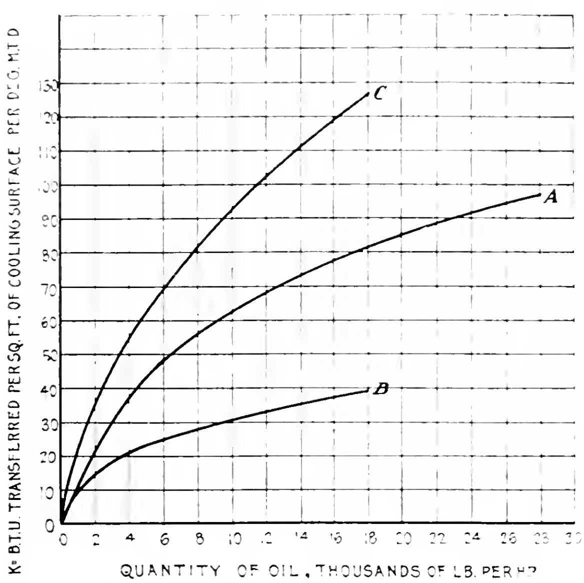


FIG. 5 HEAT-TRANSFER COEFFICIENTS OF THREE COOLERS

used to derive an analytic method of determining the relation between the various temperatures of the oil cooler. In fact, he establishes the following formula:

$$\frac{T_1 - T_o}{T_1 - t_1} = C$$

in which T_1 = inlet oil temperature; T_o = outlet oil temperature; and t_1 = inlet water temperature.

Data from a single run at given quantities of oil and water may be used to determine the value of flow. Then for any other conditions of inlet oil temperature and inlet water temperature the value of the oil temperature drop and outlet temperature may be found by substitution in the above equation.

The writer discusses next the problem of determining both inlet and outlet oil temperatures. The further use of the temperature diagram is in showing the effect of the placing of two or more coolers in series, or the effect of tube length.

The temperature diagram deals, however, only with variable temperatures, and gives no information regarding the effect of various rates of flow of oil or water. Hence, a second division of a test of an oil cooler becomes necessary with the temperatures of inlet oil and inlet water constant and rates of flow of oil and water variable. The results of such a group of runs are plotted in Fig. 3 and constitute what is termed a "quantity diagram." The curves of Fig. 3 are cross-plotted in Fig. 4, to coördinates of water quantity and outlet oil temperature with curves of equal oil quantities. The two figures taken together show the complete relation between oil temperature flow and rates of flow of oil and water.

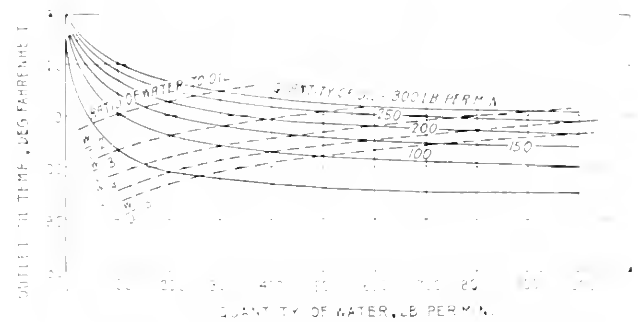


FIG. 4 QUANTITY DIAGRAM IN FIG. 3 CROSS-PLOTTED

The quantity diagram provides a basis for determining the capacity of an oil cooler and rating it. But to say that a cooler has a certain capacity and not state definitely the conditions under which this capacity is produced is very unsatisfactory. The rating of a cooler may be defined as that quantity of a particular kind of oil which will be given the desired temperature drop with certain inlet oil and inlet water temperature and a certain quantity of water, or a certain ratio of water to oil used.

This theoretical discussion is followed by data and discussion of the actual performance of three types of coolers so selected that their performances should be comparable. Cooler *A* is of plain tubes; cooler *B* of plain tubes fitted with retarders; and cooler *C* of special corrugated concentric tubes, with dissimilar oil and water arrangements. The writer considers the heat-transfer coefficient as a measure of the surface effi-

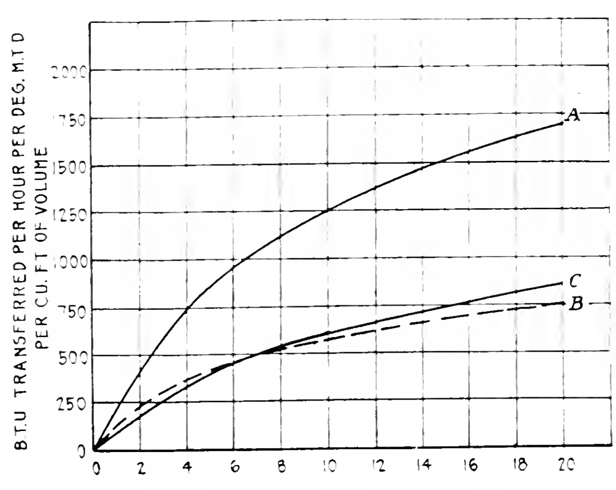


FIG. 6 VOLUME EFFICIENCIES OF THREE COOLERS

ciency of the cooler, but points out that the efficiency of the volume of the cooler is far more important than surface efficiency. A factor which places performance on a basis of volume of apparatus is B.t.u. transferred per hour, per degree mean temperature difference, per cubic foot of volume. From this point of view it is of interest to compare Fig. 5, which gives the heat transfer coefficients, with Fig. 6, giving the volume efficiencies of the same three coolers. Of particular interest is the relative position of the curves B and C to each other in the two figures.

Finally the friction drop in the oil is considered, and it is found among other things that the relative friction drops are in the same order as the relative heat-transfer factors. In this connection it is also noted that weights per square foot of surface are in the order of the heat-transfer factors.

Summing up the subject of relative performance and merit of various types of coolers, the writer states that that cooler is best which will produce a given temperature drop in a given quantity of oil with the least volume and weight and without excessive friction drop. (*Journal of the American Society of Naval Engineers*, vol. 29, no. 2, May 1917, pp. 300-318, 10 figs., *teA*)

NAVY LUBRICANTS AND LUBRICATION. Lieut.-Commander H. T. Winston, U. S. N.

The writer discusses the selection, testing and purchasing of lubricating oils for the Navy Department for various uses, such as lubricating oils for machinery, lubricants for cutting tools, greases, graphites, etc., and in an appendix gives the Navy specifications and tests for these materials.

Among other things the writer states that oils containing only 8 or 10 per cent of blown rape-seed, or other fixed oil, are not very satisfactory, especially at high speeds. The reasons for this are not entirely clear and the personal equation may be an important factor. Such oils do not form a heavy lather and seem to run off bearing surfaces easily, allowing the bearing to heat up. Possibly the mineral-oil contents used in these oils have too low viscosities and do not contain the emulsified constituents needed for sticking to the surface of the bearing. These oils also feed more rapidly than the heavier oils, unless the wicks are reduced in number, or the feed otherwise cut down. Hence, a man familiar only with the heavy oil is likely to let the oil box empty rapidly and the bearing run dry.

Straight mineral oils which form an emulsion with water and are exclusively a home product have been used with very good results in lieu of the compounded oil. This is shown by extensive tests on the torpedo boat *Bailey* at Annapolis, the battleship *Nebraska*, and other vessels. While the straight oil does not give a heavy lather, the bearings do not heat up; in fact, the machinery is cleaner and neater without a heavy lather.

The writer goes fully into the matter of classification of oils and the discussion of physical properties of straight mineral oils. As to the latter, he states that the important lubricating properties are viscosity, cold (or pour) point, emulsibility with water (cold or hot), and carbon actually deposited in an internal-combustion engine. Unimportant properties are carbon passing through the engine, gravity, fire point, flash point and frictional resistance.

Mixing similar *good* oils does no harm, and the resultant product shows no unexpected or abnormal properties.

As regards the so-called "worn-out" oils, the writer states that there is little evidence to show that a good oil wears out or loses any essential lubricating properties under ordinary circumstances. High heat will cause some light oils to become heavier, due to the distillation of a percentage of the original product, but the result is then simply a somewhat reduced amount of good oil with the increased viscosity. Interesting tests have been made on "used" lubricating oils, and a full description of such tests is expected to appear in the *Journal of the American Society of Naval Engineers*. Good oils used in forced-feed lubrication systems showed after about 1000 hours' use some oxidation, but the lubricating properties were not materially changed. The cold points were raised 10 to 20 deg. fahr. and there was an increase in the formation of organic acids and of resins. However, such harmful ingredients are easily removed by filtering the oil through animal charcoal, the filtered product being as good as, or, possibly better than, the original oil. (*The Journal of the American Society of Naval Engineers*, vol. 29, no. 2, pp. 239-261, *gd*)

Machine Shop

CALCULATING THE APPROACH OF MILLING CUTTERS, Francis J. G. Rueter

The distance between the initial and final point of contact with the work, considering the point on the periphery of the cutter, is called the approach. This distance is used in time-study estimating together with the length of the piece or cut to determine the time required by the machine to do the work. The result is called the machine time.

To calculate the approach by the ordinary mathematical method requires too much time. The writer has therefore deduced a simpler formula from which the approach can be calculated by means of a chart in the original article. The solution is also easily made with logarithmic cross-section paper and by a slide rule. (*American Machinist*, vol. 46, no. 22, May 31, 1917, pp. 928-930, 7 figs., *p*)

Measuring Apparatus

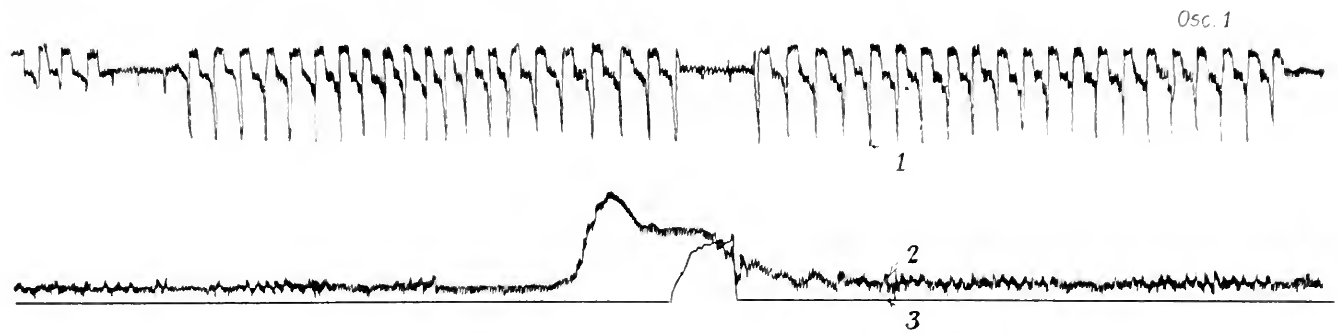
A NEW FORM OF PITOT TUBE, A. Hagenbach and K. Gégauff

Describes an exploration of the space surrounding a circular plate in a stream of air, the direction of the stream lines and the velocity and static pressure of the air being found by means of a new form of gage. This consists of a small tube of 1.6 mm. outside and 1 mm. inside diameter, closed at one end and pierced at the side with a small hole. The open end of the tube is connected with a pressure gage by means of an india-rubber tube. The closed tube is several centimeters long and is placed with the portion containing the opening at the point to be studied, the axis of the tube being perpendicular to the direction of the air stream. The tube is then rotated until the maximum pressure excess is obtained. This, by means of a pointer attached to the tube, gives the angle of the stream line. The tube is then rotated through 44 deg., first on one side of this direction and then on the other. The mean pressure at these points is the static air pressure, for it has been found by preliminary experiments that, for all air velocities, the null pressure is shown at an angle of 44 deg. (for the particular tube employed) from the direction of flow, while at 85 deg. the points of minimum (reduced) pressure are found. The results obtained in the case of air flowing at an average speed of about 6.5 m. per sec. past a normal circular plate are tabulated in full in the paper, and a map of isobars and stream lines is also given. (*Physikalische Zeitschrift*, vol. 18, pp. 21-30, January 15, 1917, through *Science Abstracts, Section A—Physics*, vol. 20, pt. 4, pp. 124-125)

THE USE OF OSCILLOGRAPHS FOR THE STUDY OF EXPLOSION ENGINES, M. Camillerapp

The writer indicates a method of investigating the part played by heat and the behavior of the spark in an explosion engine by means of the Blondel oscillograph.

In the course of a series of experiments made for the purpose of determining the part played by heat and the duration of the spark of the plug in the operation of an explosion motor, it proved to be impossible to use a manograph, because it was necessary to register simultaneously: *a*, the variations of pressure in the cylinder; *b*, the time between two explosions in the same cylinder with the view to determining the speed of the engine; and *c*, the current in the spark and its duration.



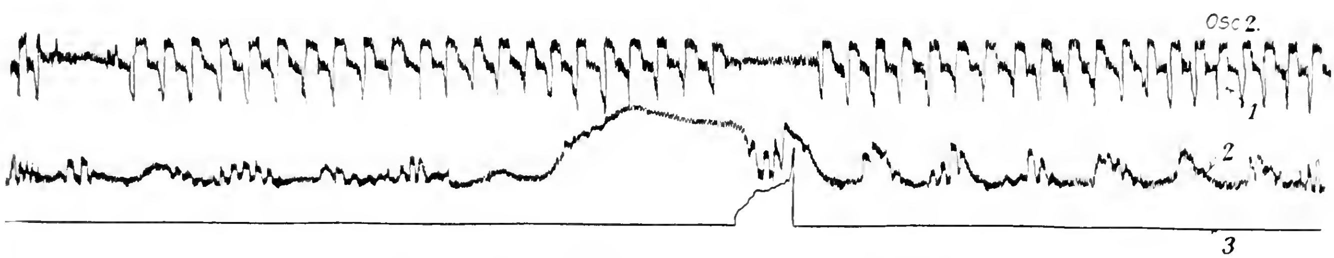


FIG. 7 (TOP) OSCILLOGRAM OBTAINED WITH THE SINGLE MICROPHONE

FIG. 8 (BOTTOM) OSCILLOGRAM OBTAINED WITH THE DOUBLE MICROPHONE

Curve 1 of the oscillograms in Figs. 7 and 8 represents the vibrations of a Lancelot electro- diapason giving 200 double vibrations; this gives the velocity of the photographic film of the decoiler of the oscillograph. This curve also gives the speed of the motor. To do this the current of the diapason passes through a rotary contactor located at the end of the motor shaft. This contactor short-circuits at each revolution with a resistance placed in series with the carrying circuit of the oscillograph. Hence each revolution of the engine is indicated by a fall in the amplitude of the curve of the diapason and the speed of the engine is measured by the oscillations registered between each revolution. The tests were carried out by a special laboratory-type oscillograph, and as quantitative results were not sought and it was only desired to obtain curves that would give an idea of the manner in which the ignition of the gas occurs, a special microphonic apparatus was employed.

Curve 2 shows pressures in the cylinder of the engine. It was obtained by means of a microphone held on the spark-plug frame in a manner illustrated in the original article.

Curve 3 gives the ignition current of the spark plug. A calibration of the oscillograph permits the determination of its volume in milliamperes; the return of the curve to 0 gives the duration of the arc between the terminals.

While the author makes no attempt to present the results obtained in his investigation, he indicates that, contrary to the view held by many engineers, ignition is not followed by a sudden explosion and the spark is not extinguished by the explosion, which he explains by the fact that after all no explosion occurs in the cylinder of the engine in the proper sense of this term; i. e., no sudden increase in the volume of the mixture. (Application de l'oscillographe à l'étude des moteurs à explosion. M. Camillerapp. *Revue Générale de l'Electricité*, vol. 1, no. 17, pp. 643-4. 4 figs. *e*)

INTEGRATING TACHOMETERS, Commander L. A. Kaiser, U. S. N.

Description of an integrating speed indicator for use on board ships so designed as to make possible for the engine room to gain or lose distance as directed from the bridge. The bridge determines by stadimeter or otherwise that the ship is ahead or astern of position and directs the engine room to lose or gain. By consulting the previously prepared table kept near the throttle, the man on watch sets the engine hand ahead or in the rear of the clock, and then by the throttle causes the engine hand to lose or gain until it is in coincidence. If the variable gearing in the indicator is so designed that the engine hand makes one revolution per minute when the engine is making the prescribed speed, then it is evident that it is simply necessary to keep the engine hand coincident with the second hand of the clock, which also makes one revolution per minute.

With this in view, a device was constructed on board the *Washington* and installed by the ship's force under the direction of the present writer. It has been in use for nearly a year. This device consists essentially of a 12-in. flat disk of steel, driven by a 4-in. wheel perpendicular to its face and which is driven by a shaft connected by small gear wheels to the starboard revolution indicator. The distance of the driving wheel from the center of the large disk can be varied by a screw of ½-in. pitch. On this screw is placed a scale of revolutions. A clock of 14-in. dial, with a long second hand, is placed over the center of the large disk, the latter carrying a U, over the ends of which an elastic band is stretched across the face of the clock. When the revolutions of the main en-

cases agree with the pointer on the scale, the disk should make one revolution per minute, the I pointer exactly following the clock hand, and, conversely, by moving the scale indicator until the I pointer exactly follows the clock hand, the number of revolutions of the main engine can be read from the scale.

An instrument was built from *Washington* blueprints and installed on the *Connecticut* during the battleship cruise around the world. The fleet engineer reported that the cruise has demonstrated the necessity for some instrument which will show the exact speed of revolutions of the engines at any time. Such an instrument would make it possible for the engines to be run at constant speed, and in changes of speed enable the man at the throttle to take up new speed with practically no loss of time in counting revolutions as at present.

The character of the traction surfaces, that is, the surface of the disk and the rim of the driving wheel, has an important bearing on the correct functioning of this instrument. It has been found by experience that best results are obtained by making the disk of a saw-steel blank and making the rim of the driving wheel of small radius and of hardened steel. In pouring a stream of oil over the point of contact and also in coating the face of the disk with lard, no slip was discovered. (*Journal of the American Society of Naval Engineers*, vol. 29, no. 2, May 1917, pp. 262-267, 1 fig., *d*)

Mechanics

The Laws of Elastico-Viscous Flow, Prof. A. A. Michelson

When a solid is subjected to a strain beyond the elastic limit, its behavior may be summarized as follows:

1 The application of the stress results in a rapid elastic yield which, if inertia be negligible, is practically instantaneous. If the stress be now removed, the specimen returns to its former position.

2 This is followed by a slower yielding, whose rate, if the stress is not too great, diminishes with time, and which ultimately attains a constant value which may be zero. The return to or near its original position depends on whether the stress was or was not too great.

The writer makes an attempt to formulate the behavior of substances under stress by the simplest expressions which have been found to satisfy all the essential requirements, and states that the behavior of any solid under stress may be considered as the resultant of four elements constituting the Laws of Elastico-Viscous Flow.

The *elastic displacement* is characterized by being approximately proportional to the stress and independent of time. A closer approximation is given by

$$S_1 = C_1 Pe^L$$

in which $L = h_1 P$

The *elastico-viscous displacement* is manifested in a slow return when the stress is removed. This displacement is represented by the formula

$$S_2 = A_2(1 - e^M)$$

where $A_2 = C_2\ Pe^N$, in which $N = h_2\ P$, and $M = -\alpha\sqrt{t}$.

The *viscous displacement* applies to the case where the elastic force is absent or very small in comparison with the viscous resistance. For a specimen which has not been subjected to previous strain, the formula is

$$S_3 = (Ft)^{\rho}$$

where $\rho = \frac{1}{2}$ approximately; near the rupture point ρ approaches unity.

A more complicated formula is given for the general case.

The *lost motion* is explained as follows: If the stress be applied for a short time (even a small fraction of a second), the specimen does not return to the original zero. The difference between the original and the new zero is the lost motion. It seems probable that lost motion may be considered as a function of time.

The following notation is used in the above formulae:

S = displacement (twist)
t = time
$F = C_3\ Pe^N$, where $N = h_3\ P$
h, α, constants
P = applied torque.

(*Proceedings of the National Academy of Sciences of the United States of America*, vol. 3, no. 5, May 1917, pp. 319-323, *t*)

Railroad Engineering

Recent Attainments in Locomotive Feedwater Heating

Supplement to the preceding report which covers the subject mainly from the theoretical standpoint, while the present article shows to what extent the savings from feedwater heating have been actually attained through means entirely consistent with American locomotive practice.

These experiments were made with the heater deriving its heat supply from exhaust steam and resembling in its construction a well-known surface condenser. The heat-exchanging elements were ⅝-in. (outside diameter) brass tubes of such number and length as to give a total heating surface of about 120 sq. ft. As the heat transfer is facilitated by the agitation of the water in its passage through the tubes, this result was accomplished in this case by inserting in each a strip of brass of a width equal to the inside diameter of the tube slightly crimped and twisted to a pitch of 3½ in.

While the proportions of the heater were such, and the agitation of the water so thorough as to yield final temperatures within 10 or 15 deg. of the temperature of the exhaust steam, no undue burden was placed on the feedwater pump. The extent of the dropping pressure in the heater was roughly 1 lb. for each 2000 lb. of water delivered per hour. The average initial temperature of the feedwater over a given series of tests was 50.7 deg. In this same series the average temperature of the water delivered to the boiler was 214.5 deg., indicating the average increase as between the inlet and the outlet sides of the heater of 163.8 deg. The proportions of the heater must have been pretty nearly correct for the conditions of test to permit of a very close approximation to the temperature of the steam.

The effect on the quantity of coal consumed was very marked. On the indicated hp.-per-hour basis, the quantity of coal saved was in no case less than 12.9 per cent, this value in one instance being as high as 28.1 per cent.

On the basis of thermal efficiency of the locomotive, the average increase (disregarding the results in three out of ten tests) was 20.3 per cent, and the highest of these values was only 4 lb. in excess of the average, showing consistency in the results.

Since the average increase in the temperature of feedwater was in excess of 160 deg., the theoretical deduction of 1 per cent increase in efficiency attainable through each 10 deg. rising temperature, as indicated in the report of the Fuel Association Committee, is well within the bounds of conservatism.

The original article contains the diagram indicating the relation between water rate and heat expended in pumping and

recovered by feedwater heater. (*Railway Review*, vol. 60, no. 22, June 2, 1917, pp. 753-754, 1 fig., *e*)

Locomotive-Feedwater Heating

Data from a report by a committee, Monroe B. Lanier, Chairman, presented at the Convention of the International Railroad Fuel Association held in Chicago in May.

The economy expressed in the percentage of fuel saving to be derived from preheated as compared with non-preheated feedwater, is in direct ratio as the temperature difference of the water before and after heating is to the difference between the total heat of the saturated steam at a given pressure and the final temperature of preheated feedwater. With other conditions remaining equal, the higher the initial temperature the greater is the percentage of economy per degree rise of preheat. In fact, the writer gives a curve showing that the theoretical fuel saving from preheat follows a straight-line law.

From an operating standpoint feedwater heating is a prerequisite to the best performances and maximum locomotive efficiency. The utilization of preheat permits a freer steaming boiler, increases the confidence of the fireman and leads to an increase in locomotive capacity. An interesting series of curves is given showing the amount of money to be saved yearly by the railroads through feedwater heating.

As to the sources of preheat, the writer indicates that exhaust steam and waste gases may be used for this purpose. The greatest waste seems to be in exhaust gases, but most of it is unavoidable. The writer presents a calculation showing the content of latent heat in the gases and states that experiments have shown that the abstracting of 16 per cent of the exhaust does not, in most cases, require a reduction in the size of the nozzle to get the same vacuum in the front end and the same draft in the fire. A table is given in this connection covering the subject of distribution of heat in a normal locomotive, the same subject being also illustrated graphically.

The next source of heat for preheating water is that of the smokebox. It is impracticable to design an exhaust heater to preheat water from the tank-boiler temperature, but ample space is available in the front end of the modern locomotive, in addition to space required for superheater, units to build a gas heater of sufficient heating surface to obtain a high degree of preheat feeding by means of an injector, the preheat increasing with the velocity and temperature of the gases.

As the final temperature of the feedwater from the exhaust heater is limited to a point below that of the temperature of the exhaust steam, the smokebox heater presents greater possibilities when injector feeding is practiced, particularly with certain types of injectors.

The writer advocates the advisability of the combined use of exhaust steam and smokebox heating, as after utilizing in preheating all of the exhaust steam possible, there is still a margin of 140 to 180 deg. between the feed temperature and that of the water in the boiler. On the other hand, the practical limit of preheating feedwater by means of smokebox gases is that of the boiling point which at 200 lb. pressure is 388 deg. fahr. (*Railway Age Gazette*, vol. 62, no. 21, May 25, 1917, p. 1101-1105, 3 figs., *g*)

Refrigeration

Circulation in Flooded Systems, A. H. Baer

Data of experiments with the glass model of an ammonia-tank coil and an accumulator. By supplying these with liquid ammonia inside, and with ordinary hydrant water—also with ice water—on the outside, the behavior of the ammonia could be plainly observed.

The apparatus used for the test was similar to that shown in Fig. 9 and the experiments were made with the coil nearly filled with liquid ammonia; first, in the open air, then sprinkled with hydrant water, and finally with ice water on the outside. In general, the direction of flow was, of course, upward and out from the upper part of the accumulator. The observers were surprised to see that the gas in the lowest horizontal pipe flowed backward and up through the bottom of the accumulator. Further, the vapor in the second lowest pipe cast out through the bottom pipe and up through the drain pipe of the accumulator. And in doing so it pushed ahead of it a large part of the liquid in the lower pipe, delivering it to the accumulator and raising its liquid level.

The apparatus was then somewhat reconstructed and a greater head of liquid was provided, but this failed to keep the gas in the lower pipes from flowing backward and up through the bottom of the accumulator.

The glass model was then again checked and a check valve

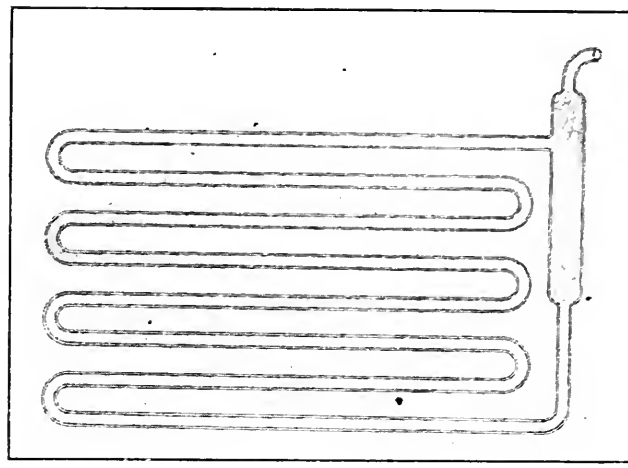


Fig. 9 Glass Model of a Tank Coil and an Accumulator Used for the Study of Circulation of Ammonia in Flooded Systems

was placed in the drain pipe from the accumulator. When this model was partly filled with liquid ammonia and the water applied as before the evaporation of the ammonia was uniform throughout the length of the coil and all gas flowed from the lower pipes up through the entire coil. The gas formed into bubbles which drove ahead of them the liquid, and as the bubbles approach the upper pipe and the outlet of the coils they become larger and the liquid bodies between them become smaller by reason of continual evaporation of some of the liquid while passing through the coils. At the inlet to the accumulator the small amount of liquid remaining between the gas bubbles readily flowed into the accumulator and the vapor only passed from the outlet at the top. The check valve was found to lift when the accumulator became partly filled with return liquid.

The apparatus diagramatically shown in the original was then applied to the ice tank with a check valve especially designed for this purpose. The ammonia feed to the system was purposely arranged to favor lifting of the check valve. Repeated trials showed that the check valve regularly lifted whenever the level of the liquid in the accumulator was raised. Since this variation in level cannot be very great, the check

valve must operate correctly. It has been found that a distance of from [illegible] to 4 ft. between the top pipe of the coils and the bottom of the accumulator is sufficient to provide the necessary liquid head for operating this valve positively and regularly without causing the liquid to fill up more than a few inches in the bottom of the accumulator itself.

This apparatus gave good results and it was thought that the efficiency of an ice plant could be further increased by flooding also the water fore cooler coils. Actually, however, the results were not so gratifying as in the case of the ice tank.

In addition to this the writer describes the present direct flooded system and the so-called submerged flooding system, and discusses the questions of comparative efficiency of plants. (*A. S. R. E. Journal*, vol. 3, no. 6, May 1917, pp. 5-15, 5 figs., *d*)

AMMONIA-AND-WATER MIXER, H. Dannenbaum

Data on the so-called ammonia-and-water mixer specified in the municipal regulations of the City of New York, obtained from experiments made at the factory of the National Ammonia Company, Philadelphia, Pa.

The regulations provide that the refrigerating plants must be equipped with emergency pipes by which, in case of accident, the ammonia can be discharged into water or brought into contact with sufficient water to absorb all the ammonia gas.

The apparatus is constructed so that the ammonia gas can be absorbed by running water, which makes it comparatively simple and inexpensive.

The article describes the apparatus used and the experiments carried out. These experiments have shown that there is a definite minimum amount of water necessary for the successful operation of the mixer, and that when less than this amount passes through, the mixing may cease and ammonia gas enter the sewer. On the other hand, the experiments show that the mixer of the type described properly proportioned will give satisfactory results. A suggestion has recently been made to connect the ammonia mixer to the bottom of the liquid receiver. This would mean that liquid ammonia would be blown into the mixer, but, of course, in considerably larger quantities than the gas. Some experiments have also been made with such an arrangement. (*A. S. R. E. Journal*, vol. 3, no 6, May 1917, pp. 16-19, 1 fig., *d*)

Steam Engineering

RECENT INSTALLATIONS OF LARGE TURBO-GENERATORS, Richard H. Rice

In this paper the history of the development of the General Electric turbo-generator units is first briefly reviewed, beginning with the 5000-kw. vertical machine installed in the station of the Commonwealth Edison Company at Chicago in the year 1903, and leading up to 45,000-kw. units in a single shell now under construction. Without such far-sighted treatment of the situation as has been given by central-station owners, the development of the steam turbine with the rapidity which has characterized it would not have been possible.

A curve is given showing that the steam consumption in 1916 was exactly half of that in 1903. Another curve shows that the price per kw. in 1917 is 42 per cent of that in 1903, and the weight per kw. in 1917 is about 28 per cent of that in 1903. The initial steam pressure has increased from 175 lb. to 300 lb., and the initial temperature from 378 deg. to 660 deg. The vacuum used has also increased from about 27 in. to about 29 in.

Great progress has also been made in boiler-house efficiency. Economizers are being used, and feedwater heaters in the flues are also possible. With the most modern conditions, a boiler-house efficiency of 81 per cent can be obtained with blast-furnace gas.

As a result of all of these improvements, the heat consumption of a complete electric station in B.t.u. per kw-hr. has decreased until it is now about half of the value of 1903. Fig. 10, reproduced herewith, shows the curve.

Estimates are given using information from plants in actual operation of first cost and operating cost of complete blast-furnace and steel-mill plants using respectively gas engines and steam turbines. The plant chosen is one of four blast furnaces, each capable of producing 550 long tons of pig in 24 hours with a coke consumption of 1800 lb. of coke per long ton of pig. The necessary electric generating apparatus for a steel mill has been provided, of suitable capacity to utilize all of the available gas in the case of the gas-engine plant, and to furnish exactly the same amount of power to steel mills in the case of the steam-turbine plant. Some make-

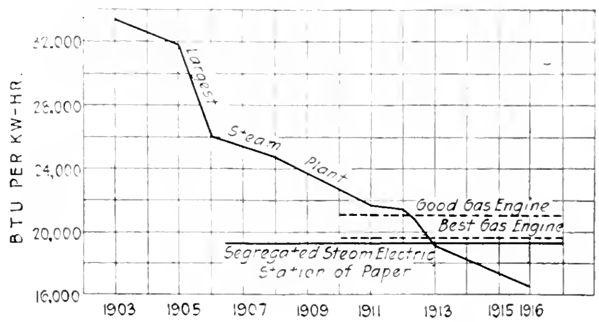


FIG. 10 HEAT CONSUMPTION IN B.T.U. PER KW-HR. FOR COMPLETE ELECTRIC STATIONS ON STEADY LOAD (THE FIGURES IN ALL CASES COVER ALL POWER-PLANT APPARATUS, INCLUDING AUXILIARIES AND EMERGENCY RESERVES)

up coal is required in the gas-engine plant on account of occasional deficiency of gas supply or excessive mill load.

The boilers of the turbine plant have considerable heat-storage capacity and probably would require no make-up coal. However, for conservatism, this is ignored and a small additional amount of coal needed to make the heat balance the same in turbine plant as in gas-engine plant is included in the costs.

A complete outfit of power-plant auxiliaries is included, with such reserve for emergency spares as has been found necessary in practice in the case of gas-engine plants. This calls for steam spares and reserve boilers, capable of being fired by blast-furnace gas or coal in emergencies. Pumping stations are included to supply the demands of the gas washing and electric stations, the blast furnace, and a given amount of water to the steel mills.

This portion of the paper abstracts a previous paper before the Engineers' Society of Western Pennsylvania, March 1917, reviewed in the Engineering Survey, May 1917, p. 461, except that in the present case the boiler plant has been improved by use of modern arrangements previously discussed so as to yield an efficiency of 81 per cent.

In the present case, that part of the plant comprising the electric station is also segregated and independent figures

given. This segregated electric station includes the electric power house, together with that fraction of all parts of the plant directly appertaining to the electric power house, such as boiler house, pumping and gas-washing station, etc. The items necessary to constitute a complete practical modern plant have been included.

Abstracts of the figures and specifications of the plant are given in the appendices to the paper. All costs are based on prices ruling in November 1916.

The overall B.t.u. consumptions of the segregated electric stations of the plants, including all the auxiliaries and emergency reserves, are given in horizontal lines in Fig. 10. The total charges for operation of the plants, including fixed charges, are shown in Fig. 11, first for the complete plant, and second for the segregated electric station.

It will be noted that the turbine plant is very much cheaper than the gas-engine plant, so that the resulting fixed charges taken at 13 per cent are very much less. It will also be noted that the running charges of the cheaper plant are also much the lower. Hence the total charges of the turbine plant are very much lower than the total charges of the gas-engine plant. In other words, the modern steam turbine has reached such a state of development that the modern gas engine is not a competitor.

Utilization of heat units is only one of the secondary operations with which the management of blast furnaces and steel mills is concerned. However, the saving which could be made over existing practice is so large that the author suggests the creation of a separate department of the works to handle the question of power generation, under the control of an engineer of necessary attainments and experience, so that results equal to those obtained by central power stations can be realized for blast-furnace and steel-mill installations.

The utilization of waste heat from open-hearth and heating furnaces (and even from Bessemer converters), the use of by-product gas resulting from the manufacture of coke, and the installation of modern steam-turbine plants at all furnaces, capable of utilizing to the maximum extent possible the heat from the individual furnaces and mills; and the tying together of all plants in a closely developed place like Pittsburgh by electric cables will probably render it unnecessary to develop any power in such a district by the use of raw fuel. (Paper read before the *American Iron and Steel Institute* at New York, May 25, 1917. *hgc*)

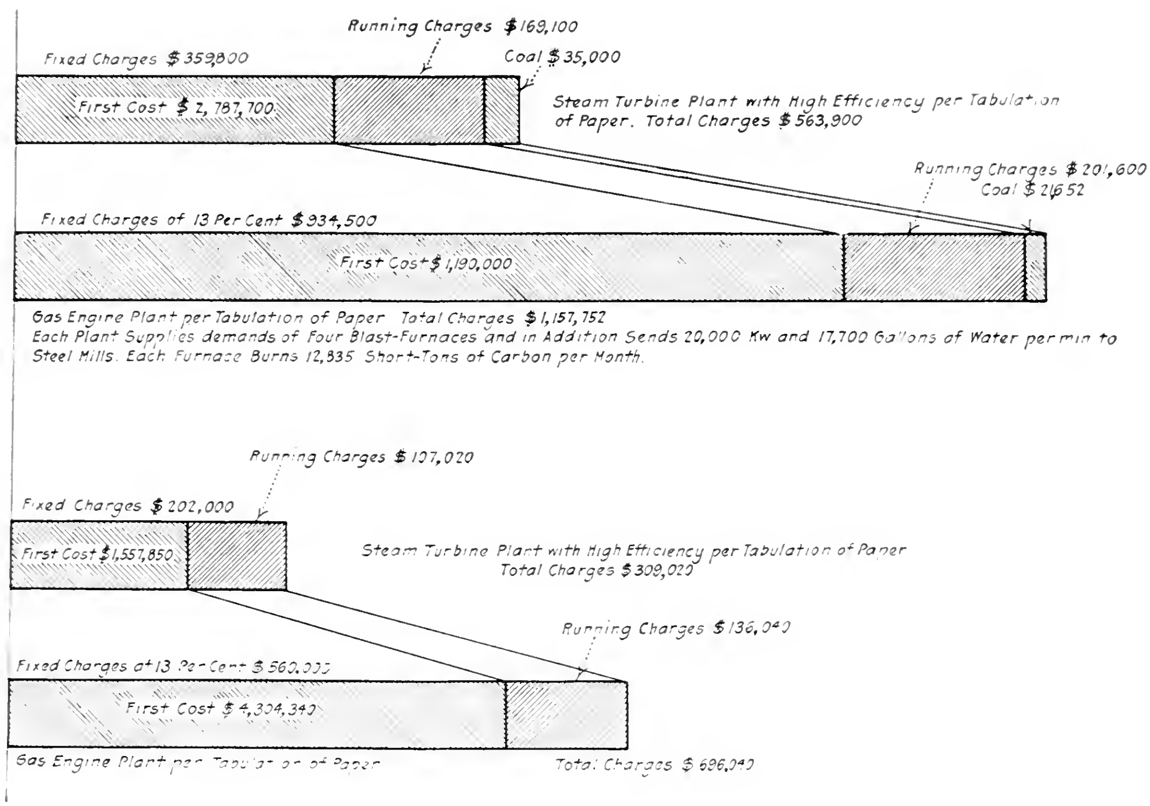


FIG. 11 CHART OF COMPARATIVE CHARGES FOR FOUR FURNACE PLANTS. (THE TOTAL LENGTHS IN EACH CASE GIVE TOTAL COSTS OF EVERY KIND, INCLUDING FIXED CHARGES, REPAIRS, MAINTENANCE AND OPERATION AND MAKE-UP COAL. ALL FIGURES ARE DOLLARS PER YEAR)

THE QUESTION OF THE TAPERING OF THE NOZZLES OF STEAM TURBINES. H. Baer

Deals with the flow conditions in actually constructed turbine nozzles. It was found previously that non-tapered nozzles can advantageously be used for pressure drops far above the critical drop, up to which latter value they are theoretically usable; and the experiments described in the present paper confirm this view. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 60, pp. 646-650, 669-676, August 5 and 12, 1916, through *Science Abstracts*, *Section B—Electrical Engineering*, vol. 20, pt. 4, p. 121)

THERMO-PLUG STEAM BOILERS. Enoch Rector

The thermo-plug steam boiler, Fig. 12, consists preferably of a low cylindrical drum *A*, which in its turn consists of two

flanged heads welded together by the oxy-acetylene process. The heads are properly stayed and the bottom head is drilled and tapped to receive the thermo-plugs, Fig. 13, which have a tapering thread. The plug holes should be as close together as possible, depending on the thickness of the metal and the diameter of the plugs.

The drum is supported by brackets, and the hole enclosed in a spiral coil of pipe *J* wound close and packed together by the oxy-acetylene welding process to form a complete and very rigid outer shell for the boiler. The feedwater is forced through this coil before entering the economizing coil at the top *B*, thereby maintaining the lowest possible temperature on the outside. The economizing coil is suported above the drum into which it discharges, and the flue gases after pass-

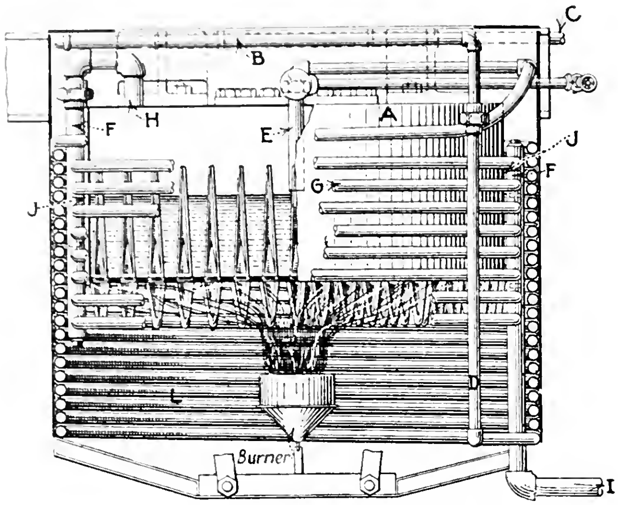


Fig. 12 Thermo-Plug Steam Boiler

ing between the drum and the encasing coil *J* pass between the coils of the economizer.

These boilers have been developed in sizes from 10 to 100 hp. The drums are all 12 in. in height, the diameters ranging from 12 in. to 36 in. The 100-hp. unit consisting of a drum 12 in. high and 36 in. in diameter contains 306 thermo-plugs. It is enclosed in a spiral coil containing 420 ft. of 1-in. pipe and an economizing coil containing 463 ft. of 1¼-inch. pipe. As high as 200 deg. of superheat can be obtained when the

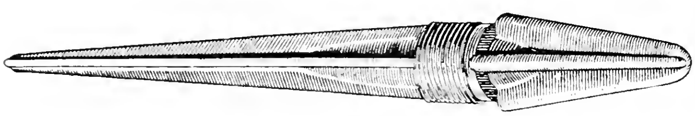


Fig. 13 Thermo-Plug

boiler is forced. The maximum capacity of the boiler is aproximately 420 lb. of water per hour from and at 212 deg. fahr., with an evaporation of 14 lb. of water per lb. of oil. The overall dimensions of the boiler are 4 ft. in diameter by 6 ft. in height, and the approximate weight is 4500 lb.

The external projections of the thermo-plug units should extend into the heated gases with a decreasing section and be so designed as to permit the gases to escape readily. The ends of the plugs projecting outward are made sufficiently long to increase the rate of resistance to heat conduction, so that the ends become incandescent.

In an experimental test in which one burner was used the thermo-plugs in the center became incandescent, while the plugs farthest removed did not show any sign of color. The temperature of the gases 1 ft. above the outer row of thermo-plugs and in passage *J* was 590 deg. fahr. The evaporation was 92 lb. of water per sq. ft. of crown sheet.

The internal projections of the thermo-plugs should be long enough to always extend above the water level. They should have a radiating or wetted surface not less than two-thirds of the external heating surface and they should be tapered to a point with surfaces which permit the ascending steam to escape with the least possible resistance, giving the highest possible velocity. The steam escaping rapidly along these plugs not only assists in keeping the surfaces clean but also drags the water along with it, creating a very violent circulation.

High-silicon cast iron has been found to be the best material of which to make these thermo-plugs, because, among other things, it has a lower coefficient of expansion than the steel of the drum, a condition favorable in this instance to a continuously tight screwed joint.

The writer states that after 3½ years of experimenting with a boiler which has suffered all kinds of abuse, been permitted to run dry a great many times, and had water pumped into it while hot, the boiler is still in perfect working condition and has never sprung a leak. These experiments have all been confined to Newark, N. J., where the water is fairly good.

In the discussion which followed the writer stated that the principle on which the use of the thermo-plugs is based, is the same as that of a target of firebrick in a large oil-fired boiler; the plugs are put in to get high-temperature target surfaces, but at the same time this is the most direct method of transmitting heat through the metal into the water.

In a number of tests water was pumped into this boiler while it was hot. This would be dangerous to do, if the water, in the form of water, could get to a red-hot surface; but with this construction it is impossible to get cold water into the boiler. If the boiler is properly heated there is a large amount of specific heat in the metal which the incoming water will take up while passing through the economizing coils to sufficiently evaporate a portion of it before reaching the main drum.

The boiler is operated at about 300 lb. pressure. Enough economizing coils are put on the top to bring the tenperature of the escaping gases down to 300 deg. fahr. (*A. S. R. E. Journal*, vol. 3, no. 6, May 1917, pp. 20-29, 4 figs., *d*)

The Evolution of the Steam Turbine in the Textile Industry, John A. Stevens, Mem.Am.Soc.M.E., and Associated Engineers

Discussion of the application of the steam turbine in the textile industry, with a brief summary of the history of the development of steam turbines generally. The writer discusses, among other things, the mutual positions of the steam turbine and the steam engine and presents the main reasons for the supremacy of the former, especially in larger sizes. Of particular interest is the following: In the words of the writer, perhaps the most important characteristic of the turbine is the fact that it can be built in almost unlimited sizes. A single unit of 70,000 kw. is now under consideration and larger units contemplated. In this field engine-driven units above 5000 kw. are very uncommon. The largest reciprocating engine known is being installed at the Lukens Steel Company and is to develop 25,000 hp. The largest reciprocating marine engines are capable of developing 20,000 hp.

The paper discusses, among other things, low pressure, mixed pressure, and extraction turbines. The latter also called "bleeder" type, is perhaps one of the most important and convenient developments. It is probably due to the demands of the textile industry, more than any other, that this type of machine was developed. The steam extracted is absolutely free from oil and can be used with great economy without any danger to products in such processes as dyeing, bleaching, slashing, etc., in addition to drying and heating.

The matter of reduction gears is discussed in some detail. From this the writer proceeds to a discussion of the steam turbine on mechanical mill drive. The first application of the steam turbine on a mechanical mill drive of considerable size is said to have been made early in 1913 by the Parsons Company of England, and was a 700-hp. unit for driving a jute mill in Calcutta, India. The turbine was for low pressure, taking steam from old engines. The turbine and engines ran in parallel. The single-reduction gear gave a change of speed from 3000 to 300 revolutions per minute, and the drive from this low-speed shaft to the mill shafting was through ropes.

A considerable number of direct-drive turbines have recently been erected in this country. Of these the writer describes two which he has installed himself. One of these, at the Jackson mill of the Nashua Manufacturing Company, is for 16,800 hp. at 160 lb. steam pressure and with 28 in. of vacuum. It is claimed to be the largest anywhere in use to date. The unit consists of a DeLaval steam turbine with single reduction gear changing from 32,800 to 308 revolutions per minute. Two rope sheaves 64 in. in pitch diameter and each carrying twenty-four 1⅓-in. ropes connect to the two main mill headshafts. The condenser is a Leblanc jet-type condenser located in the basement directly under the turbine exhaust nozzle.

The writer particularly emphasizes the improvement of economy in steam consumption with advance in the art brought about partly by refinements in design and partly by increase in size of the generating units. Two tables in the original article bring out this point very clearly. One of these tables gives efficiency and economy for steam engines driving generators and the other, the same for steam turbines and generators.

From these tables the writer derives the following conclusions: First, the steam engine in the smaller sizes is more economical in the use of heat than the steam turbine. Second, the economy of the steam turbine increases rapidly with increase in size of units. The economy of the latest type of turbine of about 1000-kw. size is practically equal to the best obtainable in the largest and most economical engine built. While the larger turbines are more economical in proportion, the limit of appreciable improvement in economy is reached at about the size of 30,000 kw. Third, the best thermal efficiency reached at the present stage of the art is 26.5 per cent. If, however, all exhaust be used, the thermal efficiency becomes very much higher.

Among other things, the paper describes a new large-size boiler unit designed to be employed in connection with the 50,000- and 60,000-kw. turbines now coming into use in this country. This boiler was developed by a manufacturing company with the assistance of Arthur D. Pratt, Mem.Am.Soc.-M.E., and embodies certain types of general design suggested by the writer. The unit is a complete structure in itself, embodying boilers, superheaters, forced- and induced-draft fan equipment, uptakes, stack, coal bunkers and ash hoppers, even economizers (Fig. 14). This unit is, in reality, made up of four independent sections more completely arranged than has been the usual custom. Any section of the unit may be independently operated while inspecting, cleaning or repairing is going on in the remaining sections. The approximate areas in this unit are as follows:

Grate area..........	936-1108 sq. ft. (projected area)
Water-heating surface.	57,600 sq. ft.
Superheating surface..	14,352 sq. ft.
Economizer surface...	36,800 sq. ft. (contemplated)
Total heating surface.	108,752 sq. ft.

This unit, with one section down for repairs, would easily supply steam for a 30,000-kw. turbine and its auxiliaries, while the entire unit would deliver enough steam to operate a 45,000-kw. turbine. The writer has observed this general type of boiler operating for short periods of time at 400 per cent and over. Under these conditions the entire unit would supply steam enough for a modern 58,000-kw. turbine using high-pressure steam and high superheat.

The unit as shown contains approximately 10.75 miles of 4-in. tubes in the water-heating surface alone. The total length of the 2-in. superheater tubes in one unit as shown is approximately 5.19 miles. The total length of the economizer tubes as now contemplated for one unit is 10.64 miles, or in all, 26.58 miles of tubes per unit. (Paper read before the *National Association of Cotton Manufacturers* at a meeting held in Boston, Mass., April 25, 1917, 39 pages, 22 figs., *hgdA*)

Thermodynamics

Gas Calorimeter Tables[1]

The numerous requests for a brief and concise set of operating directions for a gas calorimeter, and for a convenient set of correction tables, has resulted in the publication by the Bureau of Standards of Circular No. 65, Gas Calorimeter Tables. This may be regarded as a supplement to Bureau Circular No. 48, Standard Methods of Gas Testing. The correction tables are arranged in a sequence most convenient for use in connection with the proposed record sheet.

The record forms for calorimeter tests which are shown in the circular have been used for some time and found to be complete and convenient. It is hoped that these forms will be adopted wherever possible so that there will be greater uniformity in operating methods and the records used. The Bureau is willing to loan the original plates for preparation of electrotypes for these blanks to any one desiring to print them.

The Calculation of the Constants of Planck's Radiation Equation, an Extension of the Theory of Least Squares.[2] Harry M. Reeser

The problem of computing from experimental data the constants, c_1 and c_2, of Planck's radiation equation for the distribution of energy in the spectrum of a black body is attacked by the method of least squares. The data were furnished by Dr. W. W. Coblentz and have been used to determine the constant c_2 by another method. (Bull. Bur. of Stds., *13*, 1916, p. 474).

The observation equations were reduced by taking logarithms of both sides and assigning proper weights to the equations so transformed. The method of assigning weights is given in a general form that can be adapted to any scheme of transformation.

It is shown that the "two-point" method, (Bull. Bur. of

[1] Abstract of Circular No. 65.

[2] Abstract of Scientific Paper No. 204.

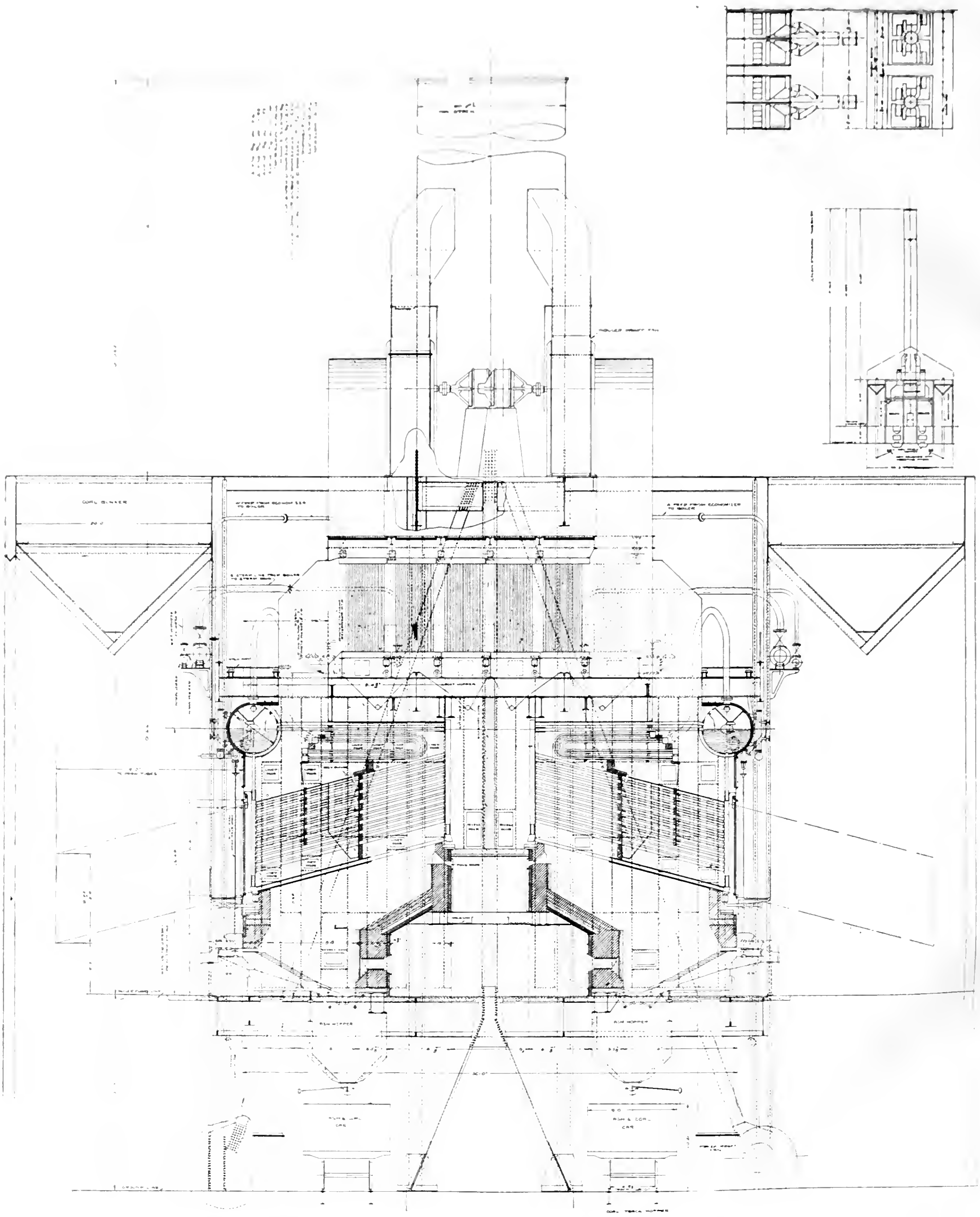


FIG. 14 BABCOCK & WILCOX, STEVENS-PRATT BOILER. LEFT: GENERAL VIEW; RIGHT: VIEW SHOWING ULTIMATE ARRANGEMENT OF FURNACES AND SETTING OF BOILERS, INCLUDING SUPERHEATER AND ECONOMIZER

Stds., *13*, 1916, p. 535) of determining c_2 may be made identical with the least-square solution, if all possible pairs of points are combined and a proper system of weights is applied to the separately computed values before taking the mean. This is suggested by T. W. Wright, in Adjustment of Observations, 1884, p. 141. A short numerical example is given to show that this system of weights being applied to an arbitrarily selected number of computed values, the weighted mean approximates the least-square value better than the simple mean.

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† Abstracted in the Engineering Survey in this issue.

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Heat Treatment of Steel Forgings. H. H. Ashdown. The Journal of the Institution of Mechanical Engineers, May 1917, no. 4, pp. 225-302, 23 figs.

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Computation of water hammer in conduits provided with an air reservoir.

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No. 1 Boulons Normaux d'Assemblage (Numerotation) Acier.
No. 2 Boulons Normaux d'Assemblage (Dimensions des Totes et Filetage) Acier.
No. 3 Ecrous Normaux (Numerotation).
No. 4 Ecrous Normaux (Dimensions).
No. 5 Goujons Normaux d'Assemblage (Numerotation et Dimensions) Acier.
No. 6 Vis Normales d'Assemblage (Numerotation) Acier.
No. 7 Vis Normales d'Assemblage (Dimensions des Tetes et Filetage) Acier.
Standard Dimensions of French bolts, nuts, and screws.

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CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

Change in Government Boiler-Plate Specifications

As the results of protests of manufacturers of boiler plate that the requirements of the rules of the Board of Supervising Inspectors, United States Steamboat-Inspection Service, governing the manufacture of steel boiler plate are too stringent, and unnecessarily increase the cost of making boiler plate to meet regulations, the executive committee of the board has adopted amendments relaxing the requirements for physical qualities of steel plates and for the drilling of tube and stay holes.

Manufacturers claim that the requirements of the existing regulations add from 5 cents to 6 cents per lb. to the cost of steel boiler plate made to meet the rules of Lloyd's Bureau, without in any way increasing the serviceability of the boilers made therefrom. After examining the evidence in support of this claim, the executive committee has adopted the following rule for physical quality of steel plates:

> The tensile strength determined by the tests shall be not less than 58,000 lb. per sq. in. of section, nor more than 73,000 lb. per sq. in. of section, and the elongation measured in a gage length of 8 in. shall be not less than 20 per cent.

No change was made in the regulation regarding the physical properties of iron plates, the tensile strength of which must be not less than 45,000 lb. per sq. in., with an elongation of not less than 15 per cent. The reduction of area must be not less than 15 per cent for 45,000 lb. tensile strength, and for each increase of 1000 lb. up to 55,000 lb. an addition of 1 must be made to the required percentage of reduction of area.

The board further modified the regulations concerning tubes and stays by striking out of section 15, rule 2, the requirement that "all holes for tubes shall be drilled and no part punched," and out of section 16, rule 2, the stipulation that "all holes for stays shall be drilled and no part punched," substituting therefor the following:

> Centers of guide holes not to exceed 75 per cent of the diameter of the full-size finished hole for which tubes and stays may be punched. The remainder shall be cleanly cut, drilled or reamed to full size.

The amendments have been approved by the Secretary of Commerce and become effective immediately. (*The Iron Age*, vol. 99, no. 23, June 7, 1917, p. 1372)

On May 16 a contract was entered into for the boilers for the first of the ships of the new Emergency Fleet being built under the supervision of Major General Goethals.

The contract for these ships, eight in number, of 8800 tons dead-weight capacity, 426 ft. in length and 54 ft. beam, was recently awarded to the Los Angeles Ship Building and Dry Dock Company.

The equipment comprises four standard Heine marine boilers for each vessel, making thirty-two units in all. Each boiler is to contain 2900 sq. ft. of heating surface. The boilers will be oil-fired and built for 200 lb. working pressure.

In general, the design of these boilers is similar to those installed on the *Minnesota* and also now being installed on the ships of the Luckenbach Steamship Company, building at the Fore River Shipbuilding Company and the Sun Shipbuilding Company.

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How to Put the Crippled Soldier on the Pay Roll. By Frank B. and L. M. Gilbreth. Reprinted from The Trained Nurse and Hospital Review, May, 1917.

New York City. Board of Water Supply. Information for bidders, forms of bid, contract, bonds and certificates, etc., for furnishing, delivering, installing and testing electrical lighting apparatus at Ashokan, Kensico, Hill View and Silver Lake Reservoirs and at various structures along Catskill Aqueduct. Contract 168. *New York, 1917.* Gift of Board of Water Supply.

New York City. Board of Water Supply. Information for bidders, forms of bid, contract, bonds and certificates and specifications for borings at Woodstock and Glenford Dikes of the Ashokan Reservoir in the town of Hurley, Ulster Co., N. Y. Contract 186. *New York, 1917.*

—— Information for bidders and forms of bid, contract, bond and certificates for furnishing and delivering Portland Cement for use at Woodstock and Glenford Dikes of the Ashokan Reservoir. Contract 185. *New York, 1917.* Gift of Board of Water Supply.

Southwestern Electrical and Gas Association. Proceedings, 1916. *Houston, 1916.* Gift of Association.

North Dakota Society of Engineers. Proceedings, vol. 3. University, N. D., *1917.* Gift of Society.

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by July 16 in order to appear in the August issue.

CHANGES OF POSITION

Robert Mawson, formerly associate editor of the *American Machinist*, New York, has become identified with Mawson Brothers, general machinists, of Providence, R. I.

John D. Eberhardt has severed his connection with the Associated Factory Mutual Insurance Companies, Boston, Mass., as draftsman of the plan department, and has entered the employ of the engineering department of the Sayles Finishing Plants, Saylesville, R. I

B. H. Liskow, formerly affiliated with the United Engineering Company, Chicago, Ill., has become associated with the Montague Iron Works, Montague, Mich.

Clifford B. Langstroth, formerly supervisor of the heat-treating and drop-forge departments of the Ross Rifle Company, Quebec, Canada, has accepted the position of metallurgist with the Link Belt Company, of Indianapolis, Ind.

James G. Rollow has resigned as combustion engineer of the Southern California Edison Company, Long Beach, Cal., and has accepted a similar position with the E. I. duPont de Nemours and Company, with headquarters at Wilmington, Del.

Warren P. Doolittle has left the employ of the Waterbury Manufacturing Company, Waterbury, Conn., as designing engineer, and has taken a position as chief designer on development work with the United States Rubber Company, with headquarters at the Shoe Hardware Division, Waterbury, Conn.

Siegfried Rosenzweig, formerly mechanical engineer with the Erie City Iron Works and more recently consulting engineer of the steam-engine department of the York Manufacturing Company, York, Pa., has joined the American Spray Company, New York, in a similar capacity.

Frederick R. Pratt has resigned his position as superintendent of mechanical construction with the Industrial Service and Equipment Company of Boston, Mass., to accept the position of mechanical superintendent with D. Goff and Sons, of Pawtucket, R. I.

C. Edwin Clarke, formerly master mechanic of the Cambria Steel Company, Johnstown, Pa., has assumed the duties of chief engineer of the Wilmington Steel Company, Wilmington, Del.

John A. Lafore, until recently affiliated with the Lafore-Foster Company, Philadelphia, Pa., has become identified with the Merion Paper Company of the same city.

Burt D. Thompson, formerly general foreman of the Base Plug Department of the American Brake Shoe and Foundry Company, Erie, Pa., has accepted a position as superintendent of the L. O. Gordon Manufacturing Company, Muskegon, Mich.

Victor W. Zilen, formerly chief draftsman of the motive-power department of the Long Island Railroad, New York, and until recently a member of the engineering department of Public Service Electric, Newark, N. J., has accepted the position of assistant engineer of the Lucey Manufacturing Corporation of Tennessee, Chattanooga, Tenn.

David J. Bonawitz has become associated with the R. V. V. Company of South Norwalk, Conn. He was until recently in the employ of the Pyrene Manufacturing Company, New York, in the capacity of assistant development engineer.

James H. Pennington, formerly associated with the Public Service Commission of Maryland, Baltimore, Md., has assumed the position of works manager with the Struthers-Wells Company, Warren, Pa.

Thomas E. Raymond has become connected with the Massachusetts Institute of Technology, Cambridge, Mass., as assistant instructor in machine design in the department of mechanical engineering. He was until recently engineer with the Metz Motor Car Company, Waltham, Mass.

A. L. Wilson, formerly combustion engineer of the American Sugar Refining Company, has become affiliated with E. I. duPont de Nemours and Company, as efficiency engineer, with headquarters at City Point, Va.

Harold F. Ely, formerly associated with the Alberger Pump and Condenser Company, New York, has accepted a position with the Westinghouse Machine Company, East Pittsburgh, Pa.

William Sticht has severed his connection with the Singer Manufacturing Company, Elizabethport, N. J., and has become connected with the American Lead Pencil Company, Hoboken, N. J., in the capacity of mechanical engineer.

Louis J. Schneider, formerly sales engineer with the Hyatt Roller Bearing Company, Detroit, Mich., has become identified with the Harrison Radiator Corporation, Lockport, N. Y.

Charles Stadler, connected with the Central Products Company of New York, as chief engineer, has become associated with The Stadler Engineering Company, Chicago, Ill.

J. Alfred Svensson has entered the employ of The New Britain Machine Company, New Britain, Conn. He was, until recently, mechanical engineer with the Meisel Press Manufacturing Company, Boston, Mass.

Prof. John R. Allen, head of the department of mechanical engineering of the University of Michigan, has been offered the deanship of the College of Engineering and Architecture of the University of Minnesota.

Gordon M. Campbell, formerly connected with the General Electric Company, West Lynn, Mass., in the capacity of manufacturing engineer, has assumed the position of works manager of the Kerr Turbine Company, Wellsville, N. Y.

William J. Adam, recently superintendent of The Regina Company, Rahway, N. J., has become associated with the Fickling Enameling Corporation, Long Island City, N. Y., and the Davis-Bournonville Company, Jersey City, N. J., as general manager and management engineer respectively.

Gail H. Browne has accepted a position with the Lehigh Valley Transit Company, of Allentown, Pa. He was formerly in the employ of Ford, Bacon and Davis, New Orleans, La.

Samuel C. Weston, recently associated with the Remington Arms Union Metallic Cartridge Company, Bridgeport, Conn., as safety engineer, has entered the employ of Bayles Shipyards, Inc., Port Jefferson, Long Island, N. Y.

George B. Rice, formerly consulting chief engineer of power and manufacturing equipment of Schoellkopf Aniline and Chemical Works, Inc., Buffalo, N. Y., has assumed the duties of general superintendent of the disk record division of Thomas A. Edison, Inc., Orange, N. J.

J. Charles Strott has severed his connection as chief engineer with the Curtis Bay Chemical Company, Curtis Bay, Md., and has entered the maintenance department of the Bureau of Yards and Docks, Navy Department, Washington, D. C.

ANNOUNCEMENTS

P. H. Troth, second vice-president of The Fairbanks Company, is now manager of the New Orleans, La., branch of the company.

Lester G. Briggs, chief engineer of The Fairbanks Company, New York, has been transferred to the Buffalo, N. Y., office of the company in a similar capacity.

Victor W. Kliesrath, for many years chief engineer of the Bosch Magneto Company, New York, has severed his connection with that concern, after a long and successful period as head of the main office, and the technical and engineering departments. During Mr. Kliesrath's association with the firm many improvements in the product were evolved, and he was largely instrumental in bringing the starting and lighting equipment up to the high standard it has attained at present. His plans for the future have not, as yet, been announced.

Norman L. Snow, associated with The Terry Steam Turbine Company, Hartford, Conn., for the past eight years, has recently been elected vice-president of the company.

Through an error announcement was made in last month's Journal that Emile H. Nate had severed his connections with the Nate-Earle Company, Inc., of New York. Mr. Nate is still president and treasurer of the Nate-Earle Company, Inc., and is also acting in a consulting capacity to Hammerston and Nate of New York.

William Mason Towle, professor of industrial engineering at Clarkson College of Technology, Potsdam, N. Y., retires from active service at the close of the present academic year. The trustees have appointed him professor emeritus of industrial engineering.

Charles Whiting Baker has established offices as consulting engineer at 31 Nassau Street, New York.

APPOINTMENTS

Walter J. Sykes has been appointed chief draftsman of the Canadian Copper Company at Copper Cliff, Ont., Canada.

Herbert W. Alden, vice-president of the Timken-Detroit Axle Company, Detroit, Mich., has been appointed a major in the ordnance department.

H. L. Worrois has been appointed chief engineer and production manager of the A. J. Detlaff Company, which is opening a new clutch department to manufacture a new design of disk clutch for automobiles, trucks and tractors.

Harry W. Townsend, formerly factory manager of the Aldrich Pump Company, Allentown, Pa., has been appointed office manager and sales engineer for Western Pennsylvania, for the same company, with headquarters in Pittsburgh, Pa.

Arthur R. Carlyle has been appointed official surveyor for the American Bureau of Shipping, American Lloyds. Mr. Carlyle still retains his position as marine engineer for the Union Oil Company of California, Los Angeles, Cal.

Charles W. Nickerson, for the past nine years in the engineering department of the Westchester Lighting Company, Mt. Vernon, N. Y., has been appointed an assistant naval constructor in the Naval Coast Defense Reserve, U.S.N.R.F., with the provisional rank of Lieutenant, being detailed on Government work in the Third Naval District.

Louis J. Hirt, formerly vice-president of the Pearson Engineering Corporation, New York, has been appointed consulting engineer for the United Gas and Electric Engineering Corporation, and will supervise the construction and engineering work of the subsidiary companies.

THE NEW BOOKS

ALL books received by The Journal will be listed under this heading, generally accompanied by brief descriptive notes. Works of special importance to mechanical engineers will be commented on at length by members and others peculiarly qualified by reason of their experience and training.

Practical Safety Methods and Devices

Practical Safety Methods and Devices. By George Alvin Cowee, E.M., S.B. D. Van Nostrand Company, New York, 1916. Cloth, 5½ x 9 in., 434 pp., 128 illustrations. $3.

The author in his preface very properly sets forth the enormous human loss involved in the annual accident roll of this country. This roll now exceeds the combined annual losses of the Union and Confederate armies during the Civil War. In his introduction he gives some indication of the enormous financial losses as a result of this great waste of human power.

The book is intended to provide for employers, superintendents, foremen, underwriters, safety inspectors and engineers generally, a convenient summary of standard safety methods and devices developed and approved by those who have specialized in this subject. In the introduction the author clearly indicates that mechanical safeguards alone can only prevent about thirty per cent of the preventable accidents, while at least sixty per cent of such preventable accidents can be eliminated by suitable educational methods and regulations. He states that, in his judgment, ninety per cent of all accidents of workmen are actually preventable. He is justified in this claim on the basis of the past experience of those who have given full and careful attention to the subject in the shops. The claim which he makes that accident-prevention activity is a paying investment is also well verified by practice.

The author very properly begins the body of his work by a chapter upon the organization of safety committees. He indicates the necessity of such committees and shows how they may properly be organized for different-sized establishments. Thus, he would have a central safety committee, consisting of a trained officer of the plant, a safety inspector and a foreman or representative from each plant division. He gives very excellent tabulations of the duties of this committee and of the individuals of its constituent membership. He then shows the wisdom of having under this centralized committee, workmen's committees for each department, the membership of which is of limited duration and is arranged so that there are periodical changes of personnel. In addition to detailed information as to individual work of the inspection committees, much valuable information is given as to general educational methods. Thus the author takes up the problem of periodical talks and lectures; motion pictures where available; the use of safety bulletin boards and what they should contain; competitive team work; the offering of prizes; etc., etc.

A full discussion of the general conditions to be found in the shop is included under such headings as Guarding Machinery; Danger Signs; Clothing; Congested Work Places; Ignorance; Intoxicants; Fatigue; Illness; Thoughtlessness and Carelessness; Concentration; Instruction; Discipline; Inspection; Education of Children and Students; and the Education of the Public. These titles in themselves are illuminative and indicate the general proper treatment of the subject. A chapter is given to proper buildings and the elimination of the fire hazard. A careful discussion is made on methods of fire egress, fire fighting, fire drills and fire prevention. A very succinct and brief though satisfactory chapter is devoted to the organization and handling of fire brigades. A practical discussion ending with a set of boiler rulings is given on the type, handling, and care of boilers, following in general the instructions called for by the Code of The American Society of Mechanical Engineers. This is followed by a discussion of steam engines, care relating to their operation, safety stops, speed-limit stops, flywheels, etc. A set of engine-room rules is appended to this discussion. An even more extended discussion is given to the elevator, in which the dangers of this apparatus are clearly brought out and methods for correction given. A chapter is given on the principles of protecting against electrical hazards to life.

Following this is a chapter on transmission machinery, showing illustrated examples of many of the most important types of guards, and describing the underlying principles of such guarding. This is followed by chapters on machine tools, grinding machinery, woodworking machinery, and machines of miscellaneous types. In all of this work, evidently the attempt of the author was to lay down fundamental principles, giving, so far as necessary, illustrations.

A chapter is devoted also to the manufacturing of iron and steel, in which the points distinctly relating to actual production are developed.

Following this the book takes up the most important problems relating to the hazards of handling and storing material and of construction work, dealing with them in much the same manner as with the other subjects mentioned. The book then enters into the subject of safety as related to steam and electric railways, and mining and quarrying. Following this is a long chapter on explosives.

Under a miscellaneous chapter are discussed the subjects of eye protection, respirators, hand tools and their dangers, ladders, traffic, etc. This is followed by a fine set of rules for foremen, and general rules for the shop, and this again by a discussion on sanitation, illumination, heating, and ventilation. In the succeeding chapter on welfare work the author states that often no expense is being spared in making the living and social conditions among the workers as pleasant and attractive as possible, and further that the result of this welfare work is directly reflected in the quality and quantity of the work performed, and the loyalty and efficiency of the employees. The author in making these statements refers to the activity of a number of large corporations in this country. He gives a brief but illuminating discussion of the purpose of welfare work, and the organization necessary to perform it. This is followed by a discussion of occupational diseases and first aid to the injured. An appendix is given upon the subject of asphyxiation or suffocation, including methods of resuscitation by artificial respiration.

As indicated from the discussion above, the book aims to cover a very wide range of industrial activity. Its author's intent, therefore, is, undoubtedly, to bring out the underlying

[illegible] and welfare in the various fields he has dealt with under three general captions: detailed safeguards and methods; the economic and social conditions of industry. Indeed, to do the latter would require a series of volumes the size of this one. He has apparently succeeded quite well and the book should prove a valuable reference to those engaged in industry or those who are making a study of the subject.

The author seems to be particularly commendable on the many recommendations of practical devices suitable for industrial practice. [illegible] comprehensively and without breaking the [illegible], and should prove of distinct value to those [illegible] engaged in industry. The book is well [illegible], illustrated with carefully selected and fairly clear illustrations. It undoubtedly is the result of a large amount of [illegible] cooperative labor on the part of the author and the publisher.

JOHN PRICE JACKSON.

Valuation, Depreciation and the Rate-Base

Valuation, Depreciation and the Rate-Base. By Carl Ewald Grunsky, Eng. D., Member of the American Society of Civil Engineers, assisted by Carl Ewald Grunsky, Jr., E.M., Member of the American Institute of Mining Engineers. John Wiley & Sons, Inc., New York, 1917. Cloth, 5¾ x 9 in., viii + 387 pp., 27 illustrations. $4.

The purpose of the book is the discussion of the various problems connected with the valuation of property, principally that of public utilities, the proper method of treating depreciation, and the determination of a base rate which will be equitable to the public and yield a reasonable return to the owner.

The thoughts advanced are based largely on the long experience of the author in connection with such work, and are given out for the assistance of others who may be engaged in similar work, and for the purpose of developing further discussion toward the standardization of these problems.

The author urges at considerable length and forcefully that the base rate should be on the full normal replacement value, without depreciation, as against present value—used by many authorities and as ruled in many court decisions. The author's method is the proper one to follow and sets forth the principle on which all fixed charges must be estimated in any public or private enterprise which it is expected will continue for many years and beyond the life of many of the elements which go to make up the whole property.

In the consideration of normal replacement value, that is, value as determined by average costs of a series of years, it is stated that there should be added to the value of the physical property all proper overhead expenses, the cost of organization, the legitimate expenses during such a period of time as it would take under ordinary conditions to build up the business to a profitable basis, and the value of intangible property such as water rights, etc.

This statement is agreed to by most all engineers, but not always by the Courts. All of the above would seem to be proper elements of expense which must be met and a proper allowance should be made for them, the only debatable thing being the extent to which they should be carried.

The elements affecting the increase or decrease in the value of properties are discussed and recommendations made as to the proper application of the same.

The amount of unearned increment of value which should be allowed to the owners in determining the base rate is also discussed.

There is also discussed the treatment of overdeveloped properties and the wisdom of having a reasonable margin of capacity for increase in business at a reasonably early date.

The various methods of treatment of depreciation and amortization are discussed at length and the author urges with great earnestness the use of what is defined as the Unlimited Life Method for the treatment of depreciation.

The different courses followed in the valuation of property for various purposes, as purchase and sale, rate fixing, taxation, etc., are described.

The difficulties of determining with definiteness the value of mining and oil properties is explained and an argument made for the taxation of such properties based on output rather than on the physical features of the properties.

The necessity of a careful accounting system in order that all interests may be dealt with intelligently is urged.

The book contains many tables containing valuable information, and those at the end on Probable Useful Life, Expectancy and Remaining Value, and other actuarial tables, many of which have original arrangements, would be helpful to any one engaged in this kind of work.

The subject-matter is clearly developed and illustrated by many worked-out examples. The material is largely original, as is also its presentation, but it necessarily contains much which is common to textbooks on this subject.

The publication will be helpful to advanced engineers and appraisers. It is probably too far advanced to be used as a textbook for students.

CHAS. T. MAIN.

The Industrial and Artistic Technology of Paint and Varnish. By Alvah H. Sabin. John Wiley & Sons, Inc., New York, 1917. 2d ed., cloth, 6 x 9 in., 473 pp., 18 illustrations, including 8 plates. $3.50.

This book has been written to give a correct general outline of the subject, with a brief account of the modern use of paints and varnishes, and the principles involved in their fabrication and application. This edition is nearly one-third larger than the first one and takes cognizance of the changes in the character of the cheaper varnishes due to the use of tung oil.

How to Find Factory Costs. By C. Bertrand Thompson. A. W. Shaw Co., Chicago, 1917. Cloth, 6½ x 9½ in., 191 pp., 53 illustrations. $3.

The author has endeavored to make this book broad enough to apply to all kinds of industries, and it is intended to be useful to the accountant as well as the factory head. Contents: What a Good Cost System Means to You; What Goes to Make Up Your Costs; How to Handle Indirect Costs; What About Interest and Depreciation?; Charging Each Unit with Its Proper Share; The Machine Hour Rate Plan; How to Handle the Cost of Selling; Tying the Costs Into the General Accounts; An Effective System of Classification; Taking Factory Costs Apart; A Cost System that Safeguards; Making Costs and Bids Agree.

The Naval Architects' and Shipbuilders' Pocket-Book of Formulas, Rules, and Tables, and Marine Engineers' and Surveyors' Handy Book of Reference. By Clement Mackrow and Woodland Lloyd. The Norman W. Henley Pub. Co., New York, 1916. 11th ed., flexible leather, 4 x 6½ in., 742 pp., 12 illustrations. $5.

In the present edition a new section on speed and horsepower has been inserted, together with a brief description of modern methods of powering and determining forms suitable from a propulsive standpoint. The sections on strength of materials, riveted joints, and stresses in ships have been considerably extended, and information on British standard sections, screws, keys, etc., has been added.

MOBILE ARMAMENT FOR DEFENSE

By ANDREW M. COYLE, NEW YORK, N. Y.

Member of the Society

This paper points out the general features of the several types of mobile armament which have been developed in Europe, as an aid to the engineers of this country who will now have to take hold of the problem of developing this means of defense.

The author emphasizes the importance of the roadway, a factor which must be carefully looked after and in the direction of which an enormous amount of work remains to be done.

He reviews the history of the armored and armed automobile from the inception of the common automobile provided with slight protection and armed with a machine gun, to the present "tanks." He also describes the development of the armored railway car.

The paper concludes with a description of the various methods proposed for meeting the requirements of heavy mobile guns. Of interest are descriptions of a new system of recoil for mobile guns and the author's non-recoil coast-defense gun, in which latter the breech block abuts upon a hardened steel spherical segment and the reaction at the time of explosion is transmitted to a heavy concrete foundation as a static load.

BROADLY speaking, the subject "Mobile Armament for Defense" would cover every weapon and engine capable of being transported from place to place and used to repel an enemy. I shall, however, confine my remarks to one important branch of land equipment—to those weapons and engines which have been recently developed and present points of novelty both in construction and military value, namely, armed and armored automobiles and railway cars, and heavy mobile guns. These are all in process of development and offer many problems for the engineer.

The prospect of valuable development along these lines is particularly good in this country, for the reason that we are starting with a clear field. We are not bound by types which, constructed under emergency, have to some extent become fixed in the armaments of other countries. We are free to select the best types so far developed and to add thereto the finishing touches of American design.

It is my purpose to point out briefly the general features of the several types of mobile armament which have been developed in Europe, so far as the meager information obtainable permits. Also to explain the simple mechanics involved in the problems presented. I shall, of course, not attempt to describe the armaments now being designed and built by the War Department of the United States. I hope, however, that some of those present will study the problems and be ready to render practical assistance in the work before us.

War in Europe has assumed many of the aspects of a siege. In this country the same condition could not exist, for the reason that we have not the same density of population. We must, therefore, be prepared for the greatest possible mobility of our army and the highest efficiency in our mobile armament.

Our coast line is of such extent that it cannot be defended by any navy we are likely to build or would be able to maintain. Our important harbors, will, of course, be protected by permanent works, but for the defense of all the rest of our coast, we must depend, after the Navy, upon heavy mobile armament. The medium and light mobile equipment is a strong—I might say almost indispensable—adjunct to land operations.

I must digress at this point to comment on the singular mental attitude of some of our good citizens who even today do not realize the imperative necessity of complete military equipment.

Right thought is the foundation of all progress. The first step, therefore, toward mobile armament is to mobilize the wits of our people. If we could only lay hold on the thoughts of these complacent locally minded people—place them on wheels—or even wings—as the Army is doing with our guns, if we could cause them to travel north, south, east and west over our land and to comprehend that this is a land of States United and that it behooves each individual to sacrifice something for the common good, we would accomplish a mobile armament of greater national value than that which shall be wrought in bronze and steel, important as that is.

THE MILITARY IMPORTANCE OF GOOD ROADS

The next important step toward mobile armament is the roadway. The day of field artillery has not passed. The types of carriage and limber which we saw pictured in our school histories as drawn by dashing horses through furrowed lanes and ploughed fields or by men laboriously up mountain sides, are not to be thrown on the scrap heap, though, when possible, motors will take the place of animal power. Roadways are more important in warfare today than ever before. Great military operations have always followed roadways, and as equipment becomes more and more cumbersome and beyond the carrying power of man and beast, roadways must be ever more carefully looked after.

This second step in mobile armament is one of even greater economic than military value. It is difficult to think of any part of the country in which railroads and roadways constructed with reference to military utility would not be of the greatest commercial advantage. At present our avenues of transportation are established mainly with reference to immediate business requirements. Under other conditions they might be established upon a general and comprehensive plan.

I have already mentioned the impossibility of protecting our coast by fixed fortifications. The Navy having been overcome or outmaneuvred, there are a great number of places on our coasts where an enemy could make landing in force—places where, under the protection of the enemy's fleet, thousands of men could be landed in a few hours. While in time of war

Abstract of paper presented at a meeting of the New York Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, March 13, 1917.

each of these places a point of danger, in time of peace many of them are possible harbors. The same roadways which would transport mobile armament would open these harbors to traffic.

Parallel to our eastern coast we already have trunk-line railroads. It is a matter of no great difficulty to extend branch roads to the points of greatest strategic importance and to make surveys and all necessary arrangements to enable our military engineers to construct other branches on short notice. The difficulties are mainly legislative and political. Before this plan can be inaugurated, however, many questions must be settled both as to right of way and as to methods of operation and maintenance. These branches should, if possible, be operated so as to yield a profit.

While in the past few years we have made enormous improvements in our wagon roads, but there remains an enormous amount of work to be done. Here again we find the necessity for cooperation between the national and local authorities.

Obviously, every trunk line and branch should be paralleled by a wagon road capable of standing heavy traffic. By parallel I do not imply proximity. For many reasons it may be desirable to have the trunk lines some distance apart in order that the lines may be separately defended.

Our bridges must be carefully considered. We need many new bridges, and they should all be strong enough to permit of the transportation of heavy ordnance.

For forty years the subject of good roads has been agitated for economic reasons. Let us hope that the present movement toward military preparedness may cause this good work to take definite form and go forward.

We now come to the consideration of the armaments which shall pass over these good roads—when we have them built, or which may have to struggle along on some of the roads as they already are. The defence of the nation will depend upon the equipment of the army. The day when men could be called hastily into action is passed. Numbers and valor count for but little against equipment.

ARMORED AND ARMED AUTOMOBILES

The first machines developed were common types of automobiles provided with slight protection and armed with rapid-fire or machine guns. The rapid-fire gun is necessarily of small size (about one pound), for the reason that the recoil of a heavier gun would be too much for the car. This type of machine is very effective for guarding roadways and may participate in offensive movements, provided it can be operated from some point of safety. The shields protect only the gunners and not the working part of the machine. Its use is to carry these light guns rapidly from point to point. It is not possible to armor automobiles against anything heavier than a rifle bullet, for the reason that armor plate of sufficient weight to withstand even a 1-lb. projectile would make the machine too heavy for service.

These light armored automobiles were improved upon by the British, who developed heavier cars with turrets. These cars were not of graceful design, but are said to have done excellent service. The gunners are well protected, but the running gear is not protected at all. The advance of these machines may be stopped by concentrated fire on the running gear.

The Italians later developed turret machines of more graceful design. At first no attempt was made to protect the running part of the machine, but the gun and gun crew were very well protected; in fact, the machine is a small fort on wheels which can be quickly transported from place to place, but it always will be necessary to use it in a road "cut" or behind some barrier which will protect the running gear from damage. A shield of light armor plate is provided over the engine and furnishes fairly good protection.

In a later Italian machine the wheels are protected. Bars in front are provided to cut barbed wire. These two types of Italian machines are said to be the latest and best types of armored automobile. They are certainly the best in appearance.

The French have developed machines specially designed to carry a Schneider anti-aircraft gun, which is mounted upon the rear of the machine. The gun used on such machines is necessarily small and would not be able to reach an aircraft at a high elevation, but the extreme mobility of the gun renders the outfit a very effective weapon. The Schneider recoil system is very efficient. As the range of elevation of these guns is from zero to zenith, they are effective in any situation and the term "anti-aircraft" is to some extent a misnomer.

The French have made successful use of motor trucks for transporting small howitzers. The howitzers are not fired from the trucks but are skidded off when they are to be put in action. This operation may be accomplished in about the same time it would require to unlimber regular artillery.

The skid-mounted howitzer is a very convenient arrangement—it may be fired from all sorts of positions, from the trenches and from behind low breastworks. When the howitzers are at work the trucks are out of the way. The motive power is withdrawn out of range just as in the case of horse-drawn guns. If the guns remain long in one place the trucks are available for other purposes.

The Davis non-recoil gun is interesting as being the only weapon so far developed which does not react when fired. This result is accomplished by firing a charge from both ends of the gun. That fired toward the rear being of shot and vaseline, breaks up soon after leaving the gun. A round of ammunition for this gun weighs about one and six-tenths times as much as a round of ammunition for a 3-in. field gun. The energy imparted to the Davis 12-lb. projectile is about one-third of the energy represented by the 15-lb. projectile fired from a 3-in. field gun.

If we compare the work done by these two guns on the basis of the amount of energy delivered from the muzzle, it will be seen that the amount of ammunition necessary to be carried to produce a given quantity of muzzle energy is as 4.8:1.

If any way can be found to lessen the reactive force due to recoil without greatly increasing the distance of recoil, it will be of material advantage. In this case the method is so wasteful of material that it is only practical to use it in very extreme cases. I will speak further regarding the question of recoil.

Under the head of automobiles we may consider the "tanks" which have been used by the British. Their primary purpose is for direct frontal attack. They are sufficiently powerful to break down barbed-wire entanglements and will cross trenches, provided the trenches are not very large and the ground about them is solid. But the weight of these machines is so enormous that they will crush in anything but the most substantial ground. The remarks about the weight of armor which can be used on automobiles apply to some extent to these tanks. A direct blow from a 15-lb. projectile will put the tank out of commission. Their armor is heavy enough to withstand glancing blows from quite heavy projectiles. The progress of one of these machines is necessarily rather slow and the enemy should have time to bring into action guns of sufficient size to disable the tank before it has gone very far. I do not think that machines of this kind would be of any use in this country, although they have been of some value on level fronts in northern France.

The new "tanks" of French design are made to crush

through wire entanglements. They have abandoned the trench-crossing scheme tried by the English, which has evidently turned out to be of little value.

ARMORED RAILWAY CARS

The first armored railway car ever used in warfare was constructed in this country. It was built under the orders of General Robert E. Lee, who was an engineer officer and at an early stage of the Civil War saw the value of this equipment. During the Boer War the British developed an armored car (Fig. 1) which is interesting as being the prototype of the modern car of the U. S. Army. The car is divided into three compartments. Those at the ends afford protection to riflemen. The central compartment, which is lower than the ends, is the magazine. Upon the top of the magazine is mounted a 3-in. naval gun.

Complete trains are formed of cars carrying guns accompanied by box cars carrying ammunition and light armored cars. Outriggers are provided for stabilizing the gun cars. Some stabilizing device has to be used on all cars from which guns of large size are to be fired. When in operation, the heavy guns are separated from the rest of the train, the armored cars being used to protect the track against surprise attacks.

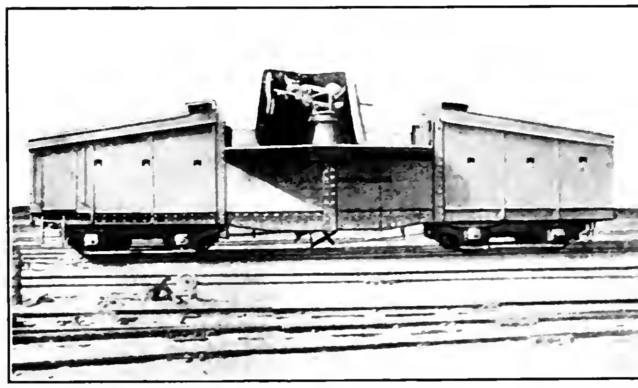
The first modern car built in America (Fig. 2) was constructed on short notice when trouble with Mexico was anticipated. It is a steel box erected upon the platform of a railroad car of standard type. The stakes of this car afforded an excellent support for the steel plates. The port holes are for rifle fire and machine guns. In the center of the car is a well in which a 3-in. field piece is mounted upon a special carriage. The peculiarity of this carriage is that the gun is traversed in azimuth about a center which is nearly below the breech of the gun instead of below the trunnions as would be the case in a pedestal mount. This arrangement provides a clear space back of the gun in which the crew can work and avoids the necessity of extended platforms such as used on English and French mounts.

There are being designed some new types of armored cars which embody great improvement on those shown. I, of course, am not at liberty to show these designs.

It is highly important that an armored car should be provided with independent motive power. While these cars are sometimes used in trains, their most valuable service can be rendered independently, each car patrolling a certain portion of railroad and being continually on the lookout for surprise attacks by the enemy. Of course, an armored car operating on such duty cannot go far from its base, otherwise it would be liable to capture, as is the case with any other detached unit.

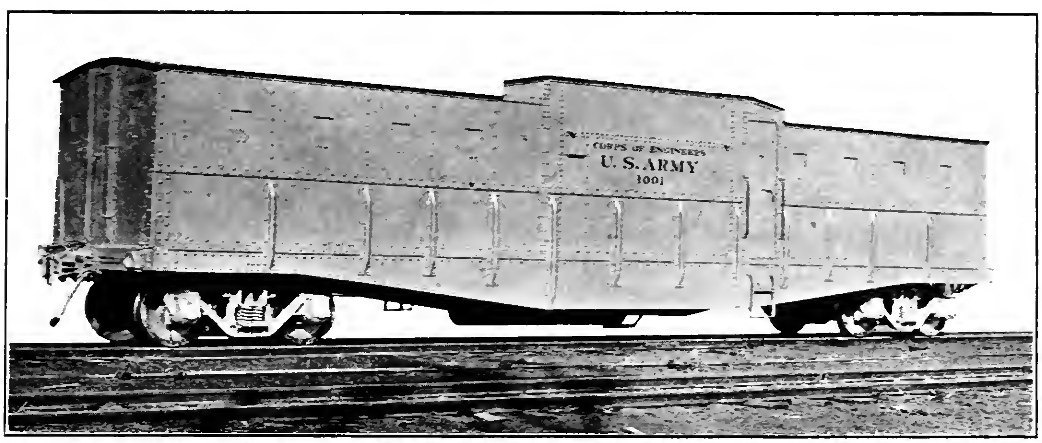
The motive powers available are storage batteries, motor-generator sets operated by Diesel or other internal-combustion engines, steam and also direct-connected gasoline engines.

There has also been developed an arrangement of a gasoline motor suitable for driving an armored car, or, for that matter, any other car. In this construction the middle sill of the car is replaced by two very deep girders separated about six feet. The gasoline engine is of the V-type and should be of not less than 100 hp. It drives the car through a jointed transmission similar to that used on large motor cars. The location of the joints used in this shaft is such that the movement of the truck about the car center is in no way interfered with. The reverse gear is operated in the gear case which is on the wheel shaft, and the pinion may be thrown out of mesh so that when the car is connected up in a train there is no idle machinery in motion. Within the space of this deep center girder the oil tanks, air brake and other vulnerable parts may be located, the web plates of the girder being made of sufficient thickness to resist penetration.



Engineering.

Fig. 1 British Armored Car with 12-lb. Naval Gun Mounted in Center



Standard Steel Car Co.

Fig. 2 First Modern Armored Car Built in America

Before discussing next class, I will call attention to a new type of coast gun which is not mobile.

Fig. 3 is a coast gun. The peculiarity of the gun is that the breech block does not screw into the gun and that the gun does not recoil. The breech block is a simple plug provided with a gas check. This block abuts upon a hardened-steel

surface which is curved, the curve being concentric with the trunnions of the gun. The reaction at the time of explosion acts as a static load upon the abutment. There is no mass in motion. The abutment member is traversed in azimuth in a casting which is a spherical segment. The concrete foundation must be sufficiently massive to stand the static load imposed.

The projectile is brought to the gun upon a carriage which travels about the center of the mount. The power to traverse and elevate the gun, also the electric wires, are brought through a conduit which terminates at the center of the mount. This gun does not disappear, but the splinter-proof housing is small and inconspicuous, and may be concealed from the enemy until he is within close range. The gun has all-round fire and may be elevated to any desired angle up to 30 deg.

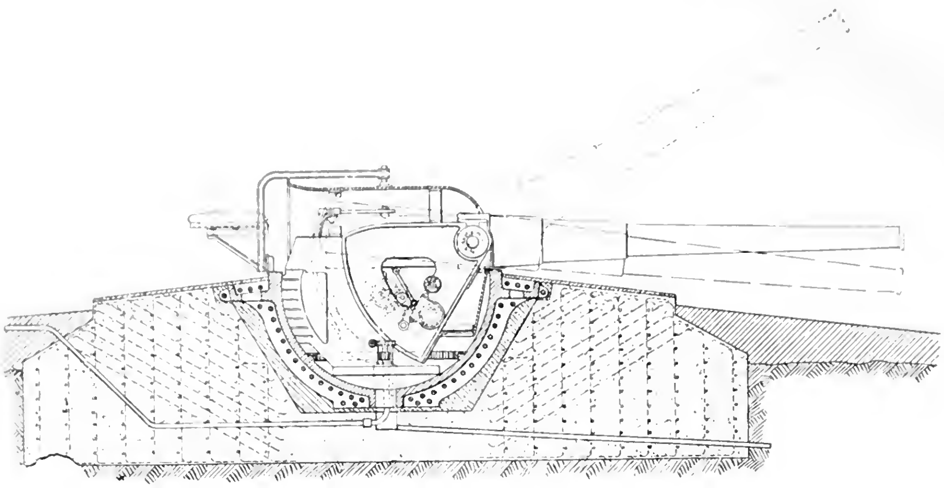


Fig. 3 Section of Coast-Defense Gun with Spherical Mount

HEAVY GUNS ON RAILWAY MOUNTS

We now come to the most important railway armament, i. e., the mounting of heavy guns upon railway cars. We may divide this equipment into two classes: First, guns of high power to be used against vessels at sea. These guns are necessarily fired from locations which have been carefully predetermined and to some extent prepared. They are never fired from main-line railway tracks. The second comprises guns of from 4.7-in. to 8-in. caliber and is useful to prevent landing or to check the enemy if he has made a landing.

In their operations in Belgium the Germans used large howitzers which were not originally mobile weapons. They were fired from previously prepared foundations. When placed upon such a foundation the fire of a gun is, of course, much more accurate than that of a mobile gun. The best foundation is of concrete, but a more quickly constructed foundation may be made of heavy timber bedded in clay, sand or cement. A foundation of this kind will stand a number of shots before it gets seriously out of level. These guns are transported, either assembled or in parts, upon flat cars. They are lifted off and placed upon their foundations by ordinary cranes and may thus be considered as a part of mobile armament.

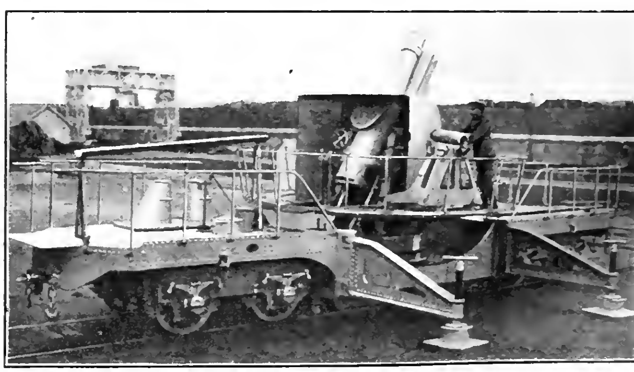
Fig. 4 shows a car of French design carrying a moderate sized howitzer. It is necessary to use outriggers in order to stabilize the car when the howitzer is fired. As depicted, on level ground this system works out very well. If the ground is not level, footings must be built up to receive the jack screws. There is provision under the car for locking to the track, so as to resist movement in a horizontal direction. The tendency is for the car to be lifted from the tracks. The center of action is the point of the jackscrew. Should the track shift there is, of course, a tendency to bend the screw, which may result in trouble if the screw is extended.

A railroad track will not resist a very great force applied transversely. About 30 per cent of the load on the track is a maximum. As the tendency is to lift the car when the gun is fired horizontally, the full weight of the car cannot be considered in making allowance for the resistance of the track.

SCHEMES FOR MEETING THE REQUIREMENTS OF MOBILE GUNS

We may now consider some of the schemes devised to meet the requirements of mobile guns.

In Fig. 5 the system of outriggers used on the French car just described is shown at (a). It will be seen that if it is fired from a location when the ground on one side of the track is sloping, a certain amount of blocking will be necessary. The overturning moment is A/B; the center of action is at C. Another arrangement is shown at (b); the outriggers are nearly on a level with the car platform and are supported by struts or jackscrews which are free to move about the centers C, C'. The overturning moment is A/B. The entire side thrust must be provided for on the track. The tendency to bend the jacks is eliminated. If the ground beside the track is low, the jacks are lengthened, no blocking being required. At (c) is shown a system of blocking the car upon the railroad ties. The base B is short, but if the car is heavy, a good-



Illustrated London News.

Fig. 4 French Car Carrying Howitzer

sized gun may be fired from a car blocked in this way. It is certainly very desirable to work within the limits of the roadbed, as we are then fairly certain of the conditions we shall find, and know that we can fire the gun from any point along the road without previous preparation.

When we fire a gun horizontally, the center of action may be kept low, but when high-angle fire is required, we find some difficulties. The trunnions must be placed higher, not only to allow for the actual swing of the gun, as shown at (d) in Fig. 5, but to allow for the recoil as shown at (e). This increases the overturning moment when the gun is fired horizontally.

This principle of double recoil is important in mobile armament. The car is blocked, as shown at (c) in Fig. 5. A car blocked in this manner will stand a very great force applied downward. Its horizontal stability is, however, much less. The principle of double recoil involves the use of one recoil system parallel to the axis of the gun: this system offers heavy resistance, the movement being quite short. The carriage is free to recoil in a nearly horizontal direction upon a long slide. The resistance to the horizontal recoil is not great enough to affect the stability of the car. This principle was used in some of the older types of carriages in which the recoil along the slide was inadequate and the carriage was allowed to recoil horizontally, being checked by a friction brake or a "brake cylinder."

It has been found convenient to develop several formulæ for determining approximately the working strains and distances of recoil which will govern the mounting of a gun for double recoil.

For free recoil of the gun,

$$V = \frac{v\,p + k\,w}{M} \quad \ldots\ldots\ldots\ldots\ldots\ldots [1]$$

Where V = velocity of recoil of gun if unchecked
v = muzzle velocity of projectile
p = weight of projectile
w = weight of powder charge
M = weight of gun.

For smokeless powder k may be taken at from 4000 to 4700. For double recoil the formulæ are:

$$A = P\cos\phi - R \quad \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

$$z = \frac{VAM}{PN + AM} \quad \ldots\ldots\ldots\ldots\ldots\ldots [3]$$

$$y = \frac{x^2}{2g}\left(\frac{N}{A} + \frac{M+N}{R}\right) \quad \ldots\ldots\ldots\ldots [4]$$

$$x = \frac{Mv^2 - (M+N)x^2}{2gP} \quad \ldots\ldots\ldots\ldots\ldots [5]$$

where N = weight of carriage or car
P = resistance of gun recoil system
R = resistance of carriage recoil system
A = accelerating force acting on carriage
ϕ = angle of elevation of gun
x = velocity of combined recoil
y = distance carriage recoils
z = distance gun recoils on its slide.

When a gun is fired, the gun and projectile move in opposite directions, in accordance with Newton's third law of motion, their relative velocities being inversely as their masses. We have also to take into consideration the effect of the powder. The gases leave the gun at a velocity much higher than the projectile. All problems in gun recoil begin with the theoretic velocity of free recoil.

Formula [1] is used to find the value of V, and k is a constant which has to be determined for each kind of powder.

Formula [3] expresses the velocity of combined recoil, that is, the velocity reached when the gun and carriage are moving together.

The other formulæ are for determining the length of the recoil of the carriage when checked by a known resistance and the length of recoil of the gun in its slide. They are not accurate, as they are based upon the supposition that the resistances are constant, but they give results sufficiently accurate for preliminary calculation.

As applied to the problem of mounting guns upon railroad cars in accordance with the system of double recoil, just explained, the formulæ are used as follows:

The resistance of the first recoil system P must be such that when the gun is fired at the highest allowable elevation, the vertical component of the reactive force will be within the bearing capacity of the car and roadbed. The resistance may be made great, for the reason that the car may be solidly blocked upon the road, and will withstand a considerable vertical load. A is the horizontal component of the force P,

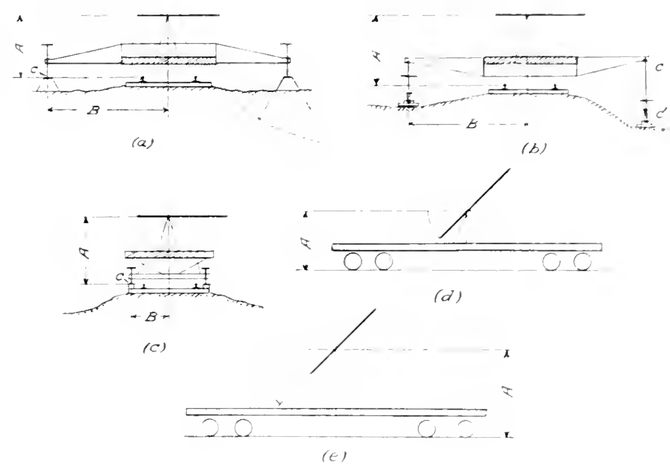


Fig. 5 Diagrams Showing Methods of Stabilizing

which tends to impart motion to the carriage and is found by Formula [2].

It is obvious that the resistance R must not be great. It must be so small that it will neither overturn the car nor shift the roadbed or other anchorage. It appears to me to be easier to provide a long horizontal recoil than a special anchorage.

Having determined these conditions, we find that after the gun is fired the velocity of the gun recoil is checked and a certain velocity is imparted to the carriage. The force P being great as compared with R, a point is soon reached when the gun and carriage are moving with equal velocity. From this point they may be treated, for practical purposes, as a single mass in motion. The gun will, of course, have some further motion on its slide, but this will be negligible as compared with the long horizontal recoil of the carriage.

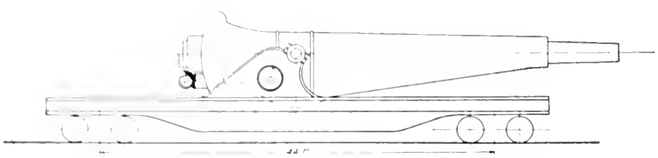
The weights of the car, gun and carriage being known, and the values of P and R determined with reference to conditions of strength and stability, the length of horizontal recoil for which allowance must be made is easily determined by Formula [4], which gives the value of y.

It has been proposed to mount heavy naval guns upon specially designed cars, and to provide at suitable points concrete foundations with locking devices, to engage the coöperating members on the cars, thus providing stable bases from which to fire the guns. The objection to the system is the initial cost and the difficulties met in securing the sites for the perma-

ment foundations and in maintaining them; also the fact that these sites will be mapped and known to the enemy.

Another system contemplates firing guns from a car moving on a curved track. The gun has a slight traverse on the car, but the main traverse in azimuth is secured by moving the car on the track. The gun being fired, the car recoils along the track. This is very objectionable for the reason that the gun has to be re-aimed after every shot. Thus you lose the advantage of a good shot. I do not think the system would be of value against a moving target.

Fig. 6 shows a gun of rather peculiar design mounted upon a railway car the trucks of which are arranged so that they can be completely turned under the car. This gun is fired from a track shown below. When being made ready for action, the front truck of the car is switched on to the curved track. The switch is then thrown so that the rear truck passes on to the straight part of the track. Traversing gears are provided



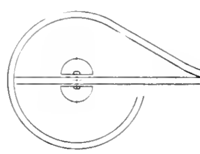


Fig. 6 Gun with Special Recoil Device Mounted on Railroad Car, and Circular Track for Traversing the Car

on the trucks so that the car may be worked forward until the rear truck is at the center of the system. Here an anchorage is provided of sufficient strength to sustain the reaction due to the recoil. The forward truck is traversed on the curved track about the center. The car is thus made to serve as a turntable. The gun fires from a fixed position. When the gun is elevated the breech swings down through an opening provided in the car platform. This arrangement brings the axis of the gun low for horizontal fire.

The laws of action and reaction are fixed, and it may be reasoned that no way can be found to lessen the shock of recoil excepting by making the recoil long. The case shown about this gun does, however, contain a mechanism—which, for obvious reasons, I am not free to explain—which does, to a great extent, lessen the shock of recoil, and the gun does not move back from the position shown when it is fired. The normal energy of recoil of a 14-in. gun is over 3,000,000 ft-lb. —enough to crush any ordinary railroad car or to lift it over a good-sized building. With the mechanism I have spoken of, the thrust upon the anchorage is only about 80,000 lb.

The first gun mounted upon a railway truck was mounted in the United States. This was done by the First Connecticut Artillery during the civil war. It was an old-time mortar, mounted on a truck. Five shots were fired from this gun before the truck collapsed. After that it was carried about on a flat car and fired from fixed platforms. Originally it was fired from a curved track.

[The paper from which this article is briefed was delivered prior to the entrance of the United States into the war. Although the work of mobile defense may for the time be set aside in consequence of the more pressing business of attacking the enemy, it is a work which must be carried out in the long run, and should be carried out so far as possible even during our present military exertion in order that no future emergency may find us unprepared.—The Author.]

War is a vast country-wide engineering enterprise. Theoretically speaking, an all-wise and powerful board of experts should determine where each man should be posted in the great war chain of fighters, for it is obvious that all specially trained men, and particularly all technically trained men, should keep at the posts where their training is needed. It was an inevitable mistake made by our allies at an earlier stage in the war which led many young physicians, engineers, mechanics and valuable specialists to rush as volunteers for the front. The technically trained men should be kept at their profession unless there happens to be a superfluity of them. The junior men in colleges, and particularly in technical or medical colleges, will probably serve their country better by working hard at their educational preparation than by abandoning their college work before their training is completed.—*The Electrical World.*

What is turning out to be a great storehouse of ammunition and explosives is being prepared by the Bethlehem Steel Company in New Jersey between Mays Landing, in Atlantic County, and Petersburgh, in Cape May County. This stretch of territory is more than forty miles long, stretching from north to south some five miles in width, on an average. It will afford ample space for testing good guns as well as for the storing of explosives and ammunition. More than 1000 men have been at work for a month in erecting the buildings, and the company is constructing its own railroad over the long stretch of territory, and the Government has given authority to build a new bridge across the Tuckahoe River. During the last ten days more than 150 freight carloads of ammunition have been brought into the grounds and stored. No strangers are admitted to the territory, which is surrounded by high barbed-wire fences, and the whole distance is patrolled by a company of soldiers to prevent trespassing. (Philadelphia *Public Ledger,* June 6, 1917, p. 7.)

Contracts have been let for the construction of a wind-tunnel building at Throop College of Technology, where researches in aerodynamics will be carried on. Here interesting and valuable experiments with airplanes will be conducted under the direction of Dr. H. Bateman, recently arrived in Pasadena from Johns Hopkins to take up this line of work, in which Throop College is one of the pioneers. The work takes on added significance from the recent announcement by the War Department of the plan to send an army of aviators abroad.

Dr. Bateman, who will have charge of the work, is a mathematical physicist, and his immediate investigations will relate to the stability of airplanes during flight, with which study the mathematical study relating to aeronautics is chiefly concerned. This aeronautics laboratory has been designed in consultation with Government experts in Washington and experts of the Curtiss Company in Buffalo, and the wind tunnel and apparatus to be used in connection with it represent the latest ideas in laboratory study of the science of aviation. (*Christian Science Monitor,* July 14, 1917, p. 8)

PROBLEMS IN WASTE DISPOSAL

By HENRY A. ALLEN, CHICAGO, ILL.

Member of the Society

Though the questions of disposal of wastes have been under consideration for many years, it is comparatively recently that such have been submitted to careful engineering study and analysis.

The main factors to be considered in the disposal of municipal wastes are sanitation and discommodity—the first as affecting the health of the individual and of the general public, the second as affecting the individual or public in the matters of inconvenience, unsightliness and offensiveness.

Cost. This factor is put last because it is assumed that any legislative body, appreciating the necessity of a function, will provide funds for the actuation of that function.

Often conveniences are demanded by individuals or the public, in utter disregard of the fact that such can not be had without commensurate expenditure of funds.

Economy in public works does not mean the apparent saving in moneys by the non-execution of a desired or required public improvement (so to speak, municipal deferred

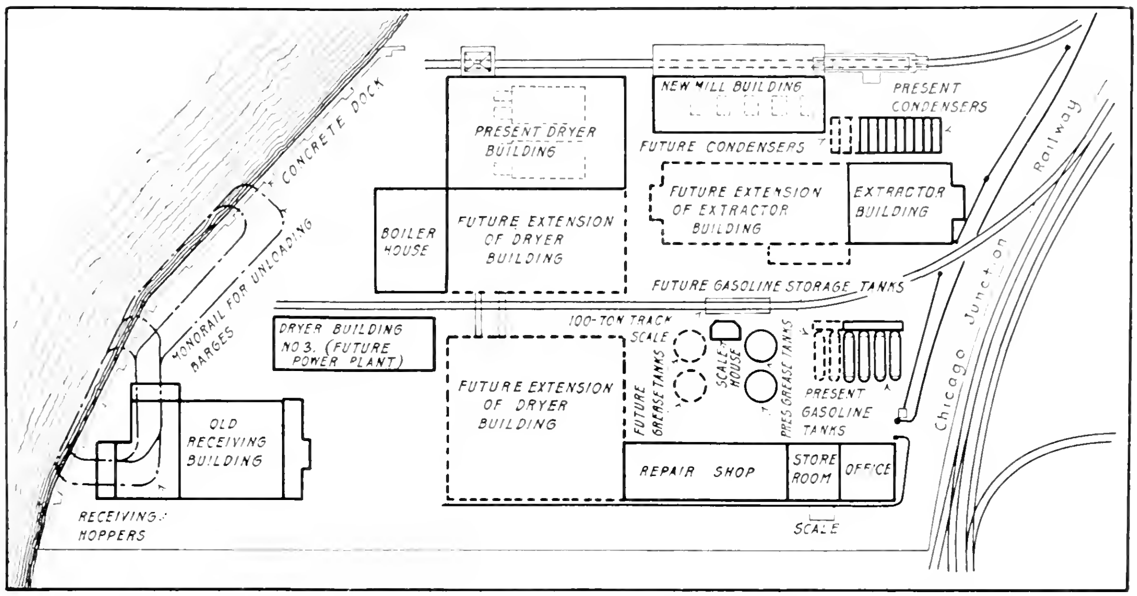


Fig. 1 Chicago Municipal Reduction Plant with Contemplated Extensions

In designing for a municipality, it is my opinion that the work should proceed along the following general divisions stated in the order of their importance:

FACTORS TO BE CONSIDERED IN WASTE DISPOSAL

Service. Service requires that the apparatus and structures shall at all times be able to perform the duties imposed. In the case of waste disposal it means at all times required ability to collect, transport and dispose of in a convenient and sanitary manner all wastes produced.

Discommodity. Discommodity or inconvenience relates to handling in a manner least disagreeable to, and entailing minimum effort on the part of, the individual or public.

Attractiveness. Attractiveness in structures is desirable as its tendency is to make less acute any actual or imaginary odium attached to a plant, whereas neglect tends to magnify such.

Economy of Operation. Economy of operation refers to the accomplishment of the work required in a most direct and inexpensive manner, having in view the obtaining of the greatest net monetary returns compatible with good sanitary and inoffensive operation.

maintenance), but making each dollar appropriated go farthest in the execution of a necessary or desired public improvement.

Obviously, it is to the engineering professions that the public must turn if it is desired to have solved, in a logical and practical manner, the various intricate problems of municipal waste disposal.

THE MUNICIPAL WASTE SITUATION IN CHICAGO

As the municipal waste situation in Chicago is typical of similar situations in many other cities of the United States, the following brief account may be instructive:

On August 30, 1906, the city of Chicago entered into a contract with the Chicago Reduction Co. for the disposal of the city's garbage.

The laws of the state of Illinois permit contracts to be entered into at any time of the year relative to the disposal of garbage, provided the duration of such does not exceed five years.

Owing to change in the system of disposal, at the end of two years a new contract was entered into for a period of five years ending August 31, 1913, which provided for a payment by the city of \$47,500 per annum to the contractor.

During this period it was claimed by the Chicago Reduction Co. that the city did not live up to its contract, and by the

Abstract of paper presented at a meeting of the Chicago Section of The American Society of Mechanical Engineers, January 19, 1917.

ity that the company did not operate its plant in a sanitary and inoffensive manner, as contemplated by its contract with the city.

Much dissatisfaction having arisen in regard to the manner of operation of the plant during the latter part of the term of contract, many individuals and civic associations began agitation for improvement of conditions, which finally resulted in an appraisal of the plant being ordered. A board of appraisers was appointed, consisting of H. M. Byllesby & Co., represented by Mr. Harold Almert, myself, appointed by His Honor the Mayor, City of Chicago, and Mr. Leonard Metcalf, selected by the two appraisers of the contending parties.

There was practically an agreement by all appraisers as to reproduction cost new; but a great difference in the question of physical depreciation, the city's appraiser estimating 41 per cent at the end of the five-year period, Byllesby & Co. 14 per cent, and the third appraiser a mean proportional of 24 per cent. The final fair values arrived at were approximately as follows:

City's appraiser	$226,000
Company's appraiser	762,000
Third appraiser	492,000

The company's appraiser agreed to the value of the third appraiser, but, as the city's appraiser considered this juggling, he withdrew.

After the disagreement of the appraisers, the city having

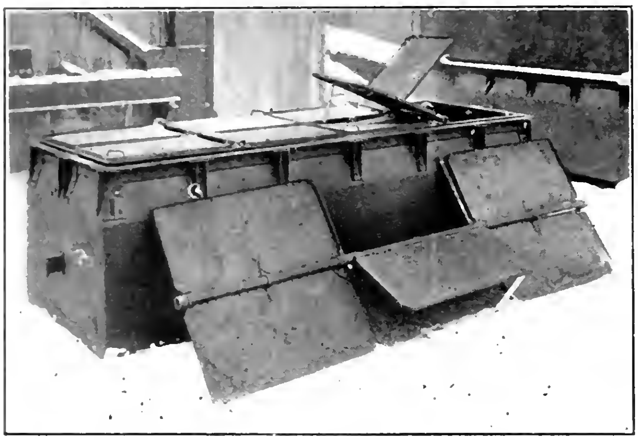


FIG. 2 GARBAGE BOX USED IN CHICAGO
(Length, 12 ft.; width, 4 ft.; depth, 32 in.)

no place to dispose of its garbage, I was asked to erect in two weeks' time a temporary garbage plant capable of handling a maximum of 500 tons a day until the city could make other arrangements. This work was accomplished, and, while not entirely inoffensive in operation, served well its purpose until the purchase of the plant of the Chicago Reduction Co. by the city.

Condemnation proceedings were commenced shortly after the appraisal of the property, but before they were completed, early in 1914, the company made a proposition to the city to sell its plant, including real estate, good will, etc., for the sum of $275,000. I previously advised against the purchase of this plant by the city, appreciating that rehabilitating an old plant and adding new structures while operating would result in high cost, and that when completed the plant would not be as well arranged and equipped as would be the case in a new plant constructed on a clear piece of ground.

Owing to the difficulty of securing a suitable location for a new plant, however, it was decided by the city to purchase the plant at the price offered—$275,000. In my original appraisal I estimated the worth of the plant to the city as the value of the land, plus salvage or scrap value, plus value of supplies on hand, plus an amount that may be termed the "value of temporary utility" or "availability for temporary use value," making a total of approximately $226,000. As this was in October and there were available approximately seven months before the hot weather of the following summer, I estimated the "temporary utility value of the plant" at approximately $80,000. When the offer from the Chicago Reduction Co. to sell was made, there remained practically but three months before the hot weather, too short a time to construct a new plant, hence I estimated an increase of $25,000 in "temporary utility value." As the cost to the city of condemnation proceedings would undoubtedly have been not less than $25,000, and in view of the fact that the property so obtained could be used for no other purpose than that for which condemned, I advised, all conditions being considered, that the company's offer be accepted.

It was during the bad weather of February 1914 that instructions were issued to start the work of rehabilitating the old reduction plant purchased from the Chicago Reduction Co. This necessitated the work of design and construction being carried on at the same time and working night and day. By June the plant was in condition to, and did, handle all the garbage of the city of Chicago in a practically inoffensive manner.

One of the greatest difficulties in disposal problems is the location of loading stations and plants, or, more strictly, the being permitted to locate such. While the citizens appreciate the necessity for disposal and attendant plants, they prefer such situated in their neighbors' back yards and offer strenuous objections when their own are under consideration. Hence, locations are too often required decided by political expediency rather than by good engineering judgment.

It is well to state here that the women of Chicago, through their various organizations, have played a most prominent part in bringing about the solution of the city's waste question, especially as regards garbage. These organizations are of invaluable assistance in educating householders to properly separate and take care of household wastes.

In my opinion, the city of Chicago has approached this great question in a most broad-minded and businesslike way, appropriating requisite funds to enable investigations, studies and experiments to be made, to the end that a foundation can be laid for the solutions of the various problems—not alone for today, but for years to come.

SELECTION OF A GARBAGE-COLLECTION UNIT

Having been selected chief of the technical staff, created on the recommendation of the city's Waste Commission, the necessary engineering and working forces, including waste investigators, were organized and systematic studies begun. At the same time, work on the design and construction of the municipal reduction plant, 95th Street incinerator, Bridewell crematory, and collecting and handling equipment was being carried on. To facilitate this work it seemed to me that somewhere along the line from the production of waste to the point of final disposal a unit should be selected. The most difficult phase of the entire problem is getting the garbage from the kitchen to the collecting unit.

It was for this reason that the garbage box was selected. The larger the capacity of this unit, other things being equal, the less the cost of collecting and handling. Study showed that

a six-cubic-yard box when filled became too heavy for a two-horse team, except on the very best of paved streets. As but 13 per cent of our alleys are paved and 62 per cent of our streets, this prohibited such a unit being used throughout the city. So, taking all in consideration, the unit adopted appears to be the most satisfactory. This consists of a box 12 ft. long, 4 ft. wide, and 32 in. high, as shown in Fig. 1.

Two such boxes can be loaded abreast, three in length and two vertically, making twelve boxes per specially designed railway car. One-half this number can be loaded on a specially designed street car. The net loads of garbage contained will be approximately 34 and 17 tons, respectively.

By adopting a standard collecting unit, hoisting equipment, including cranes, runways and slings; hauling equipment, including wagons and tractors; transporting equipment, including railway and electric cars, steam and tow barges, become standards for loading and disposal stations for various wastes.

The studies so far conducted indicate that it may be considered an axiom that that system handling an offensive substance which exposes the least or fewest surfaces to contact with such substance is the most sanitary, least offensive and, in general, commercially the best.

TABLE 1 COST OF GARBAGE DISPOSAL IN CHICAGO FOR FIVE YEARS PREVIOUS TO ACQUISITION OF GARBAGE PLANT BY THE CITY

Year Ended September 30	Amount Paid by City	Number of Tons Delivered	Cost Per Ton
1909	$47,500	89,957	$0 528
1910	47,500	97,087	0 489
1911	47,500	115,364	0.411
1912	47,500	118,225	0.401
1913	47,500	144,343	0.329
Totals.....	$237,500	564,976	$0 420

TABLE 2 AVERAGE NET COST PER TON TO THE CITY OF CHICAGO FOR HANDLING GARBAGE AT THE MUNICIPAL GARBAGE PLANT FROM TIME OF ACQUISITION TO SEPTEMBER 30, 1916

Year	Expense of Operation	Revenue	Net Cost of Operation	Garbage Tonnage Received	Net Cost Per Ton
1914......	$154,684.48	$ 96,585.06	$ 58,099.42	75,599¾	$0.768
1915......	278,570.35	183,196.83	95,373.52	150,874¾	0.632
1916......	432,721.86	410,512.28[1]	22,209.58	137,920½	0.161
Totals..	$865,976.69	$690,294.17	$175,682.52	364,395	$0.482

[1] During the year 1916 the extractor plant was in operation but from the first of June, and the mill house was not in full operation until the latter part of June. From January 1 to the time of starting the extractor plant, the city received only $3.27 a ton for commercially dried garbage, which is green garbage dried down to 10 per cent moisture.

The capacity of the old mill house was not sufficient to handle all garbage degreased, necessitating the storage of approximately 14,000 tons on the property north of the plant, thereby greatly increasing the cost of production of tankage.

TABLE 3 ESTIMATED PROFIT IN HANDLING GARBAGE AT THE CHICAGO MUNICIPAL PLANT DURING 1917

Cost of Operation	Revenue[1]	Net Revenue	Garbage Tonnage	Net Profit Per Ton
$477,000	$603,000	$126,000	145,000	$0.869

[1] Price of grease taken at 5 cents per pound and tankage at $5.00 per ton, both figures much below the present market prices.

COST FIGURES ON GARBAGE DISPOSAL

It is entirely feasible to construct a reduction plant or an incinerator to operate in a sanitary and inoffensive manner. To lay down a fixed set of rules, however, is not permissible, as the waste problems of each city must be considered as separate and distinct. Generally it costs money to incinerate, whereas money can be made by reduction, as will be seen from Tables 1 to 3.

SYSTEMS OF GARBAGE REDUCTION

Briefly, the following may be considered the present methods or systems of garbage reduction: Cooking process (Arnold and Edgerton), Cobwell system, chemical process, and drying process (Mertz and Simons).

In the cooking process the raw garbage is fed into large tanks called digesters, holding several tons of garbage each. These tanks are then closed and the contents subjected for several hours directly to a steam pressure varying between 40 and 80 lb. per sq. in., the tendency being to break down the cellular structures by boiling.

When the digestion is completed the emulsion of grease and tank liquors is drawn off. The solid matter generally is fed to a press where the main portion of the entrained oil and liquors is forced out, leaving a tankage containing 40 to 50 per cent of moisture. The tank liquors and grease obtained from the cooking and pressing process are passed through a series of settling tanks or basins in which the grease is separated gravimetrically and drawn off or skimmed from the top.

The tank liquors, which contain considerable fertilizer value, are treated in a multiple-effect evaporator to thicken before mixing with the degreased tankage.

The tankage after pressing is properly dried and subjected in a percolator to the action of a grease solvent which absorbs the remaining grease. The saturated solvent is distilled off and condensed, leaving the grease, the solvent being ready to use again. The degreased tankage and liquor, called "stickwater," are mixed, dried, milled and shipped.

There are several successful reduction plants employing this process, among them being the municipally owned and operated plant of the city of Columbus, Ohio, and privately operated plants at Pittsburgh and Philadelphia.

In the Cobwell system the green garbage is fed into a tub-shaped digester tank of several tons capacity, provided with a steam jacket or interior heating coils, and subjected to the direct action of a grease solvent at a temperature under 200 deg. fahr. Dehydration takes place for several hours, during which time the vapors are drawn off and condensed. These vapors consist principally of moisture and a portion of entrained solvent. After condensation the solvent is separated from the water and is ready for use again, the water generally being wasted.

During this operation a large proportion of the grease is dissolved in the solvent and the cellular structures for the most part broken down. The saturated solvent is then drawn off.

The tankage remaining in the digester is subjected to one or more washings of grease solvent, for the purpose of obtaining the greatest permissible amount of grease. The solvent with the dissolved grease is then drawn off and live steam introduced, as in the case of most percolator processes, to drive off as much of the remaining solvent as possible, to minimize loss. The tankage is then subjected to drying under vacuum by heat supplied from the steam jacket or coils.

When the moisture content has been reduced to less than 10 per cent, the contained tankage is removed, ground, screened and shipped.

It will be noted in this process that a large portion of the reduction is done in the one tank or digester.

Some of the latest municipal installations employ this system, among which are those in New Bedford and Los Angeles. The city of New York is endeavoring to build a plant, equipped with this process, of 2000 tons capacity of green garbage per 24 hours, estimated to cost approximately two and one-half million dollars. New York is having the common difficulty of securing a suitable location for the plant, owing to the objection of property owners near sites deemed suitable.

The chemical process proposed by Dr. Hirsch has not been demonstrated with the required exactitude to enable competent engineering judgment to be passed upon it. It consists of a treatment tank containing several tons of green garbage, the garbage being subjected to the action of certain chemicals which convert the cellulose into dextrin, or dextrose, depending upon the temperature employed and the time. Personally, I have great hope that such a system may be evolved.

Dr. Morgan claims to have a process by which he produces alcohol directly from garbage. The experiments so far made by him have not yet, I am informed, been sufficiently conclusive to enable an engineering report to be made.

In the three systems above described it will be noted that the green garbage is fed into tanks, which are then closed and the contents exposed to treatment.

GARBAGE-REDUCTION PROCESS USED IN CHICAGO

The fourth process mentioned is the dryer process and is the system in use at the municipal reduction plant in Chicago. In this process the garbage is generally first run through a crusher to smash open cans of condemned foodstuffs and to break up other large material to permit of more efficient drying. The material from the crusher is then fed into dryers, its moisture content being reduced to 10 per cent or less. From the dryers it is fed into percolators where it is subjected to the action of a grease solvent. The grease-saturated solvent is then drawn off and the solvent distilled off and condensed for repeated use, the grease being treated and stored ready for shipment. Steam is then turned on to drive off any residual solvent, after which the tankage, which contains about 26 per cent moisture, is withdrawn and then put through final dryers and dried to about 6 to 8 per cent moisture. It is then screened, milled and screened and stored ready for shipment.

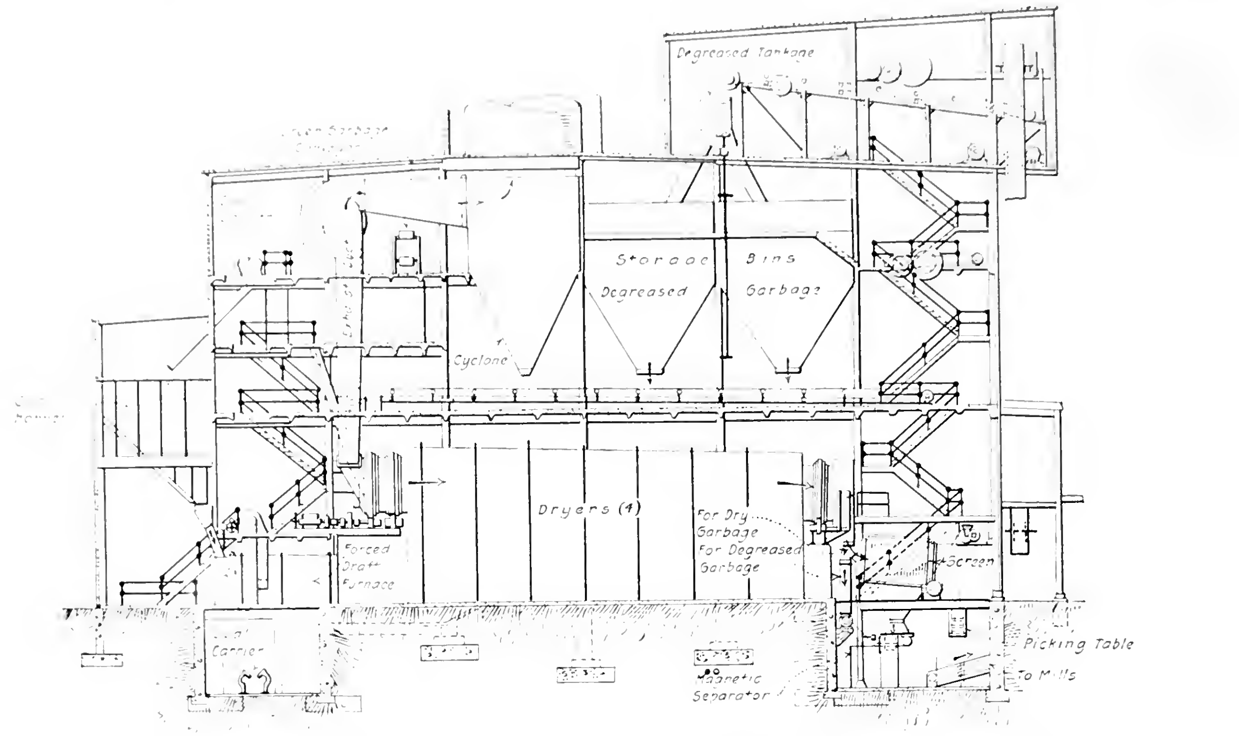


FIG. 3 LONGITUDINAL SECTION OF DRYER BUILDING, CHICAGO MUNICIPAL REDUCTION PLANT

This system was one of the first employed, but in most cases has been replaced by the cooking process or its latest modification—the Cobwell system. My investigation convinced me that one great cause of offense at the plant of the Chicago Reduction Co. was due to the use of direct-heat dryers and the consequent burning or carbonizing of certain greases and materials such as hair and flesh. This scorching action not only was the cause of offense, but also, I believed, the cause of loss in the amount and value of the by-products. The result was the installation of the more costly direct-indirect-heat dryers.

As predicted, when using the indirect-heat dryers not only has the necessity for scrubbing practically been eliminated, but the tankage and grease produced are better, with consequent increased values. The garbage is dried from 75 per cent moisture to 10 per cent or less in one cylinder.

The principal aim in designing this plant was to eliminate offense; therefore, not being content with the results thus attained, I thought it advisable to provide each dryer with a petticoat stack. This stack permits commingling of outside air with the gases escaping from the dryer, therefore cooling and throwing down a certain amount of moisture (which carries with it considerable very fine suspended matter) and in addition causing dilution.

The stacks are provided with suitable sprays, for use in case of any possible emergency due to delayed collection in hot weather or accidental fire or overloading. It will be noted that each dryer is arranged in the newly designed dryer building as a practically complete unit, having its own cyclone and petticoat stack.

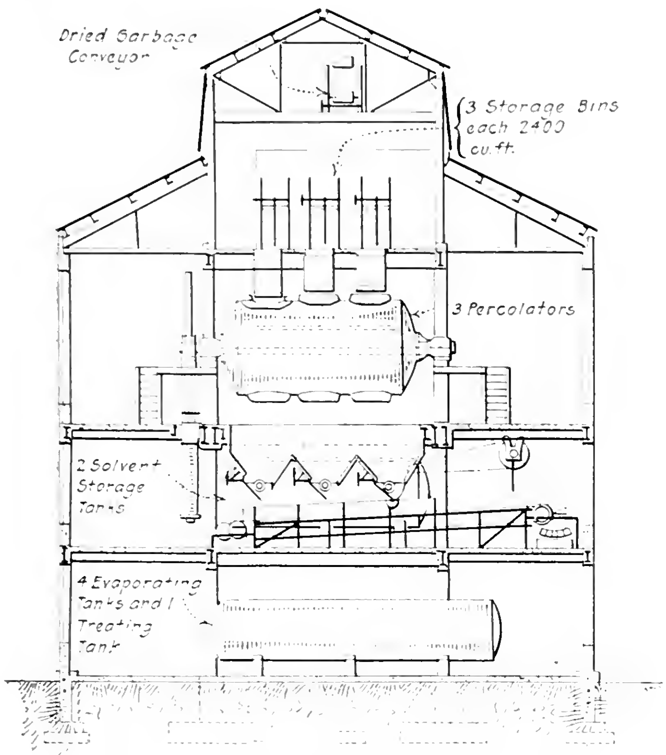


FIG. 4 CROSS-SECTION OF EXTRACTOR BUILDING

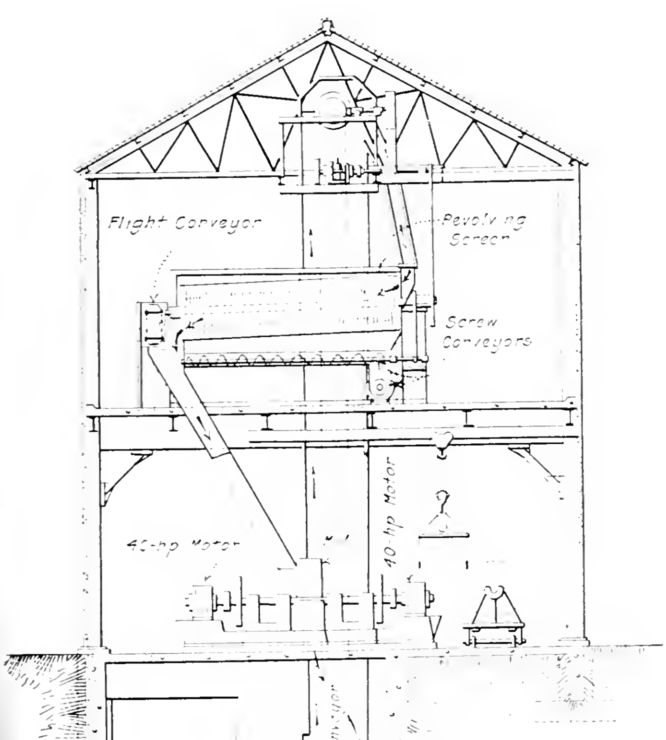


FIG. 5 CROSS-SECTION OF MILL BUILDING

BY-PRODUCTS FROM GARBAGE

An interesting as well as an economically important phase of the garbage-disposal situation are the many products derivable and derived from garbage, as indicated in Table 4. The kind and number of by-products produced, however, are matters to be determined by commercial expediency.

TABLE 4 PRODUCTS DERIVABLE AND DERIVED FROM GARBAGE

- Garbage..
  - Moisture plus Volatile (75%)....
    - Ethyl alcohol
    - Methyl alcohol
    - Formic acid
    - Acetic acid
    - Citric acid
    - Malic acid
    - Essential oils
  - Solids (25%)..
    - Garbage Grease
      - Glycerine.....
        - Nitroglycerine
        - Soaps
        - Toilet articles
        - Confectionery
      - Stearic acid...
        - Candles
        - Soaps
        - Fluxes
      - Red oil.......
        - Automobile industry
        - Liquoring fat
        - Sulphonated oil
    - Tankage.......
      - Carbohydrates
        - Starches
        - Sugars
        - Gums
        - Dextrine
        - Alcohol
      - Proteins......
        - Stick
        - Ammonium sulphate
      - Inorganic salts
        - Potassium sulphate and other potassium salts
        - Acid phosphate
        - Bone phosphate of lime
      - Rags.......... Paper pulp
      - Tin cans......
        - Tin
        - Iron scrap
      - Miscellaneous.
        - Glass, crockery, metal (other than tin cans) sand, ashes and rubbish

I estimate the amount of garbage that will be delivered to the plant during the year 1917 at not less than 150,000 tons, from which should be obtained not less than 8,000,000 lb. of grease and 30,000 tons of tankage. The city of Chicago at present has a contract for the purchase of garbage grease at a price of 7.29 cents per lb. on a basis of 3 per cent unsaponifiable. total impurities not to exceed 6 per cent. The city has a contract for the purchase of garbage tankage at the sum of \$4.16 per ton. The price received for the grease is high. but that received for tankage is low. the present market value of garbage tankage exceeding \$7 per ton.

In the July issue of the *Proceedings of the Engineers' Club of Philadelphia,* D. Robert Yarnall and G. A. Binz review recent development in V-notch weir measurement. concluding with a description of an elaborate test of a standard Lea meter made at the University of Pennsylvania. The paper is abstracted from the proceedings of the meeting of the Philadelphia Section of the Am.Soc.M.E.. April 24. 1917.

COMBINED STRESSES

By A. Lewis Jenkins, Cincinnati, O.

Member of the Society

In the past few years much has been written regarding the applications of the formulæ for combined stresses. The discussions consist of theoretical and experimental analyses of the stress relations resulting from complexed loadings which produce more than one kind of simple stress, such as combined shear and tension; and most of these are endeavors to prove that the designer should base his calculations on the maximum existing shear stress regardless of the relative strengths of the materials in tension compression and shear.

This popularity and stimulated interest in the subject of combined stresses was induced by Guest, who in 1900 published the results of his tests on the strengths of soft steel, copper and brass tubing when subjected to bending and twisting. The main conclusion drawn from the results of these experiments was that they were in accordance with the previously established fact that soft steel and most ductile materials are weaker in shear than in tension. Recently several writers have extensively advocated the use of the maximum-shear-stress hypothesis until they have reached the limit of having suggested its application in the design of cast-iron members! One of the most recent handbooks for designers gives only Guest's formula for the design of shafting subjected to combined bending and twisting, without mentioning the fact that it is absurd to use it for anything but a soft, ductile material.

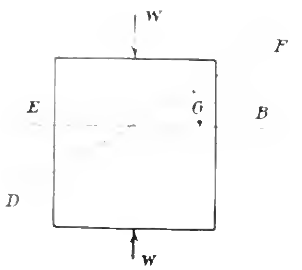


Fig. 1 Bar Subjected to Compressive Load

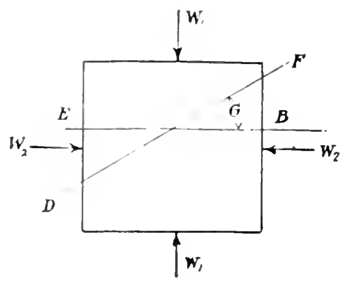


Fig. 2 Bar Subjected to Two Compressive Loads

There are six possible hypotheses upon which a formula for combined normal and shearing stresses may be based, namely, the maximum apparent and the maximum true or equivalent stresses in tension, compression and shear. Of these only the maximum apparent stresses in tension and shear and the equivalent tensile stress have been generally proposed for the design of shafts. Guest's formula is evidently not based on the apparent maximum shear stress as some writers have assumed.

Apparent and Equivalent Stresses Due to Loads That Produce Simple Tension and Compression Directly

Apparent Stresses in Normal and Oblique Planes. The bar shown in Fig. 1 is subjected to a compressive load W, and the simple compressive unit stress on the section EB is $C = W/A$ where A is the area of the cross-section through EB.

The area of the cross-section through DF, inclined at an angle G with EB, is $A/\cos G$; and the force normal to the plane DF is $W \cos G$; hence the apparent compressive unit stress acting normal to DF is

$$C' = \frac{W \cos G}{A/\cos G} = \frac{W \cos^2 G}{A} = C \cos^2 G$$

The component of W acting parallel to DF is $W \sin G$; hence, the apparent tangential or shear unit stress along DF is

$$S' = \frac{W \sin G}{A/\cos G} = \frac{W \sin G \times \cos G}{A} = \frac{C \sin 2G}{2}$$

The value of S' is a maximum when $G = 45$ deg., which means that the maximum apparent shear stress is along the plane making 45 deg. with the direction of the load and is equal to

$$S' = \frac{C}{2} = \frac{W}{2A} \qquad [1]$$

This indicates that the shear stress in a cast-iron cube is roughly equal to half the compressive stress when failure occurs.

The bar shown in Fig. 2 is subjected to two compressive loads W_1 and W_2 acting at right angles. Denoting the simple compresses unit stresses by C_1 and C_2 respectively, the apparent compressive unit stress on the plane DF is equal to

$$C' = C_1 \cos^2 G + C_2 \sin^2 G \qquad [2]$$

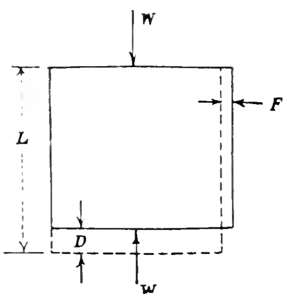


Fig. 3 Deformation of Loaded Bar

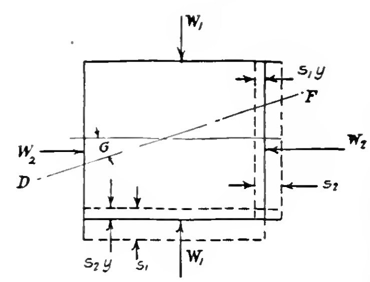


Fig. 4 Direct Compressive Unit Strain on Bar

and the apparent unit shear stress on DF is

$$S' = \frac{C_1}{2} \sin 2G - \frac{C_2}{2} \sin 2G$$

which is a maximum when $G = 45$ deg. and equal to

$$S' = \tfrac{1}{2}(C_1 - C_2) \qquad [3]$$

If W_1 and W_2 were reversed, they would produce tension instead of compression, and the apparent tensile unit stress on DF would be

$$T' = T_1 \cos^2 G + T_2 \sin^2 G$$

where $T_1 = W_1/A_1$ and $T_2 = W_2/A_2$. The maximum apparent shearing unit stress is a maximum when $G = 45$ deg. and is equal to

$$S' = \tfrac{1}{2}(T_1 - T_2)$$

If W_1 produced direct compression and W_2 direct tension, the apparent unit stresses would be

Presented at a meeting of the Cincinnati Section of The American Society of Mechanical Engineers, February 15, 1917.

$$C' = C_1 \cos^2 G - T_2 \sin^2 G$$
$$T' = T_2 \sin^2 G - C_1 \cos^2 G$$

and the maximum apparent shearing stress is

$$S' = \tfrac{1}{2}(C_1 + T_2).$$

It is seen from equation [2] that the greatest apparent compressive unit stress for the loading shown in Fig. 2 is either $C_1 = W_1/A_1$ or $C_2 = W_2/A_2$, depending upon the relative values of the loads and respective areas, the compressive stress normal to W_1 being independent of the load W_2 or the unit stress C_2.

Equivalent Stresses in Normal and Oblique Planes. The above method of determining the effect of combined stresses employs the ordinary methods of statics, and the results are known as apparent stresses. The method is based on the conception that unit stress is an internal resisting force acting on a unit area, and is found by dividing the load by the area.

A better conception of stress assumes that it is that property of a material which resists deformation of strain, and its intensity is measured by the product, Es, where E is the modulus of elasticity and s the unit strain or deformation produced in a unit of length.

In Fig. 3 the load W deforms the bar of unit area an amount equal to D and the unit deformation in the direction of W is $s = D/L$, where L is the length of the bar, and the unit compressive stress is $C = Es$.

Although there is a slight decrease in the volume in this case, due to the load W, the lateral dimension, which is equal to unity, is increased an amount equal to F. The ratio $F/(D/L) = F/s = y$ for a unit block is a constant for a given material, and is known as Poisson's ratio of lateral contraction. For any size block having a lateral dimension in the direction of F equal to L', then $y = (F/L') \div (D/L)$.

In Fig. 4, W_1 produces a direct compressive unit strain in its direction equal to $s_1 = C_1/E$ and a lateral unit strain (extension) equal to $s_1 y$.

The total unit strain in the direction of W_1 is

$$s_1 - s_2 y = \frac{C_1}{E} - \frac{C_2 y}{E}$$

The equivalent stress, or the single simple stress that will produce an equivalent strain in the direction of W_1 equal to that actually produced in that direction by the combined action of W_1 and W_2, is C_{e_1}. Hence

$$\frac{C_{e_1}}{E} = \frac{C_1}{E} - \frac{C_2 y}{E}$$

and $C_{e_1} = C_1 - C_2 y$.

Similarly the equivalent stress in the direction of W_2 is

$$C_{e_2} = C_2 - C_1 y$$

The equivalent compressive stress on the section DF is

$$C_e = C_{e_1} \cos^2 G + C_{e_2} \sin^2 G$$

and the maximum equivalent shear stress is

$$S_e = \tfrac{1}{2}(C_{e_1} - C_{e_2}) = \tfrac{1}{2}(C_{e_1} - C_{e_2} y - C_{e_1} - C_{e_2} y) =$$
$$\frac{1+y}{2}(C_1 - C_2) \ldots\ldots\ldots\ldots\ldots\ldots [4]$$

In general, the equivalent normal stresses (compression and tension), produced by simple compressive and tensile stresses acting in three directions perpendicular to one another, as shown in Fig. 5, are when all are tension.

$$T_{e_1} = T_1 - T_2 y - T_3 y$$
$$T_{e_2} = T_2 - T_1 y - T_3 y$$
$$T_{e_3} = T_3 - T_1 y - T_2 y$$

If any of the stresses should be compression instead of tension, its sign in the above equations should be changed.

The equivalent shearing stresses are:

$S_e = \tfrac{1}{2}(T_{e_1} - T_{e_2})$ in the plane of S_1 and S_2

$S_e = \tfrac{1}{2}(T_{e_2} - T_{e_3})$ in the plane of S_2 and S_3, etc.

MAXIMUM APPARENT AND EQUIVALENT STRESSES DUE TO COMBINED NORMAL AND SHEAR STRESSES

In machine construction many parts are required to resist both a single normal stress (tension or compression) and a simple shear stress. Cases where a machine element is subjected to more than one normal stress, together with one or more shear stresses, are quite rare; but there are many examples of a single normal stress being combined with a single shear stress, as in shafts being subjected to bending and twisting, propeller shafts, webs of beams, girders and machine frames, lathe beds, planer and boring-mill rails, spindles of milling machines, drilling machines and saws, bolts, screws for transmitting power, and numerous other machine parts.

Let the rectangle in Fig. 6 represent a small elementary area subjected to both a simple tensile stress T and a simple shear stress S, such as exists on the tension side of a shaft subjected to bending and twisting or in the web of a beam subjected to bending. On the compression side of a shaft or beam the normal stress is compression, or negative, and is denoted by C as shown in Fig. 7.

The normal stresses T and C may be produced by loads causing tension, compression or by any of their combinations, and

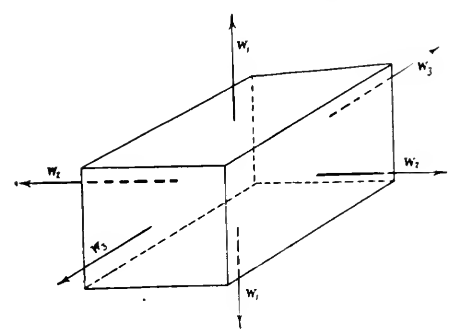


FIG. 5 LOADS IN THREE DIRECTIONS

the shear stress S may be produced by torsion or any other shearing action, such as vertical and horizontal shear in beams.

There are two ways in which the combined effect of these simple stresses may be expressed, namely,

1 By employing the ordinary methods of statics, in which case the results are known as apparent stresses

2 By applying the elastic theory, which states that the stress depends entirely upon the deformation or strain in the body. The results of this method, which is merely a refinement of the other, are called equivalent stresses.

The derivation of the formulæ for finding these stresses may be found in most textbooks on the strength of materials.

Maximum Apparent Normal Stresses. By resolving the stresses T, C and S perpendicular and parallel to any line such as AB in Fig. 6, the apparent shear stress along AB and the apparent compressive stress perpendicular to it may be found. Similarly, the tensile stress on FD may be found. When $\tan 2G = -2S/T$, the normal stresses are a maximum, which gives for the maximum apparent tensile stress

$$T' = \frac{T}{2} + \frac{1}{2}\sqrt{4S^2 + T^2} \ldots\ldots\ldots\ldots [5]$$

and for the maximum apparent compressive stress acting at right angles to it

$$C' = \frac{T}{2} - \frac{1}{2}\sqrt{4S^2 + T^2} \ldots\ldots\ldots\ldots [6]$$

Similarly, in Fig. 7 the maximum apparent tensile stress is

$$T' = \frac{C}{2} - \frac{1}{2}\sqrt{4S^2 + T^2} \ldots\ldots\ldots\ldots [7]$$

and the maximum apparent compressive stress is

$$C'' = \frac{C}{2} + \frac{1}{2}\sqrt{4S^2 + T^2} \dots\dots\dots\dots\dots [8]$$

From these equations it is seen that if a body is subjected to both a simple tension and a simple shear stress, the maximum apparent tensile stress is greater than the maximum apparent compressive stress by an amount equal to

$$T'' - C'' = \sqrt{4S^2 + T^2}.$$

In the case of a circular shaft subjected to bending and twisting, the stresses due to bending are T on the tension side and C on the compression side, and since these are numerically equal, the values of T' and C' are also equal.

Rankine held that the yielding of a material subjected to combined stresses depends entirely upon the maximum apparent normal stress, and was independent of the apparent shear and other stresses which may act at right angles to it. He also made no distinction as to the relative strengths of material in simple tension, compression and shear.

Maximum Apparent Shear Stress. The apparent shear

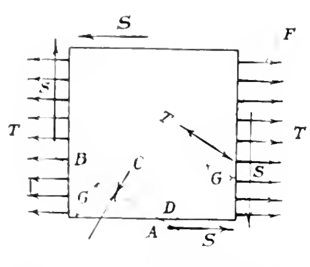


FIG. 6 SMALL ELEMENTARY AREA IN SIMPLE TENSION AND SHEAR

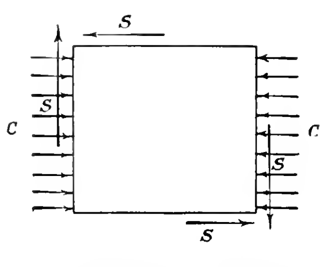


FIG. 7 NORMAL STRESS ON COMPRESSIVE SIDE

stress acting along AB in Fig. 6 becomes a maximum when $\cot G = 2S/T$ and is equal to

$$S' = \tfrac{1}{2}\sqrt{4S^2 + T^2} \dots\dots\dots\dots\dots [9]$$

and for Fig. 7

$$S' = -\tfrac{1}{2}\sqrt{4S^2 + C^2} \dots\dots\dots\dots\dots [10]$$

These formulæ have recently become popular on account of some writers having suggested their use in preference to any others, and by so doing they have made the same claims for them as Rankine made for the maximum normal stress formulæ, and again the relative strength of the material has been neglected.

Maximum Equivalent Normal Stresses. Any point on the surface of an area subjected to the simple stresses T and S is acted upon by an apparent tensile and an apparent compressive stress having directions at right angles to each other. In the planes of maximum stress these stresses become T' and C' and they produce a deformation or strain equal to

$$\frac{T'}{E} - \frac{C'y}{E}$$

The equivalent stress, namely, that single tensile stress which would produce a deformation equal to that actually produced by T' and C' is

$$T_e = T' - C'y$$

and the equivalent compressive stress is

$$C_e = C' - T'y$$

By substituting the values of T' and C',

$$T_e = \frac{1-y}{2} T + \frac{1+y}{2}\sqrt{4S^2 + T^2} \dots\dots\dots [11]$$

and

$$C_e = \frac{1-y}{2} T - \frac{1+y}{2}\sqrt{4S^2 + T^2} \dots\dots\dots [12]$$

In Fig. 7 the equivalent tensile stress is

$$T_e = \frac{1-y}{2} C - \frac{1+y}{2}\sqrt{4S^2 + T^2} \dots\dots\dots [13]$$

and the equivalent compressive stress is

$$C_e = \frac{1-y}{2} C + \frac{1+y}{2}\sqrt{4S^2 + T^2} \dots\dots\dots [14]$$

It should be noted that according to equation [11], $T_e = (1+y)S$ when $T = 0$; and $T_e = T$ when $S = 0$.

The theory that these equations should be applied to problems in combined stresses is due to Saint Venant, and is based on the assumption that the yield point of a material does not depend upon the apparent stress or stresses in any given direction, but upon the deformation or strain. It is sometimes known as the "maximum strain theory." This theory also neglects the relative strengths of the material.

Equivalent Shear Stress. The equivalent shear stress is

$$S_e = \frac{1}{2}(T_e - C_e)$$

and by substituting for the case shown in Fig. 6, gives

$$S_e = \frac{1+y}{2}\sqrt{4S^2 + T^2} \dots\dots\dots\dots\dots [15]$$

and for Fig. 7,

$$S_e = -\frac{1+y}{2}\sqrt{4S^2 + C^2} \dots\dots\dots\dots\dots [16]$$

In equation [15] it should be noted that $S_e = (1+y)S$ when $T = 0$; and $S_e = \frac{(1+y)}{2}T$ when $S = 0$.

The quantity $1+y$ is the ratio of the modulus of elasticity in tension to the modulus of elasticity in shear (modulus of rigidity).

This indicates that the true stress in a circular shaft subjected to a torsional moment M_t, is

$$S_e = \frac{5.1\,M_t}{(1+y)D^3}$$

and the true shear produced by a direct or purely tension or compression load is

$$S_e = \frac{(1+y)}{2}T \text{ instead of } \tfrac{1}{2}T$$

and $C_e = \frac{(1+y)C}{2}$ instead of $\frac{1}{2}C$.

Although these formulæ are given in Merriman's Mechanics of Materials in the form $S_e = \frac{(T_e - C_e)}{2}$, they have not been mentioned in the numerous discussions on combined stresses occuring in engineering periodicals.

RELATIVE STRENGTHS OF MATERIALS

Hard or brittle steels and cast iron fail in tension when subjected to torsional load or a tension load, and in shear when subjected to compression. Soft steels and other ductile materials fail in shear when subjected to either a tension or compression load or a torsional moment.

A hard-steel or cast-iron beam of T cross-section will fail in tension even though the flange is on the tension side. It is practically impossible to design a cast-iron beam that will fail on the compression side, and if the facilities for testing the strengths of materials were limited to a bending test, not even a conception of the compressive resistance of cast iron could

be determined. Neither can the shearing strength of a rectangular or a round bar made of brittle steel be determined from a bending test, for the simple reason that the tensile stress reaches the ultimate strength of the material before either the compressive or shear stresses become ultimate.

A torsion test of a round bar is extensively used in determining the shearing strengths of materials because pure torsion produces a shear stress that is greater than the normal stresses. The apparent normal and equivalent stresses produced are at least equal to the shear stress, and if the material is stronger in shear than in tension, it will fail in tension along a helical surface making an angle of about 45 deg. with the surface of the bar. Such a test is by no means a measure of the shearing strength of a brittle material such as cast iron.

When a highly finished soft-steel bar is subjected to tension, a series of lines inclined to the axis at about 45 deg. are readily noticeable after the elastic limit has been reached. These are known as "Lüder's lines," and are in the direction of the maximum shear stress. They indicate that the elastic shearing resistance and not the elastic tensile stress determines the yield point. Soft-steel bars actually fail in shear with a cup-shaped fracture that is somewhat modified by the flow of the metal during contraction.

It is known that brittle materials do not suffer an appreciable lateral contraction before failing in tension. They are stronger in shear than in tension, and the yield point of a hardened-steel bar almost coincides with the ultimate strength, it being elastic under almost any load within its ultimate strength. These facts suggest that the yield point and elastic limit might be wholly dependent upon the shear and not upon the tension- or compression-resisting properties of the material. In the light of the present knowledge of the effect of hardening steels, it is entirely possible that the actual ultimate tensile stress is not increased by hardening and the apparent increase in tensile strength is caused by the increased shearing resistance due to the treatment.

In view of these facts, it seems quite probable that the tension test of a soft-steel bar does not reveal its true tensile strength, yield point or elastic limit with any greater degree of accuracy than a torsion test reveals the shearing strength of hard steel or cast iron. It would be very interesting to know the tensile strength of a bar loaded in such a way as to eliminate the shearing stresses and thereby forcing its failure to occur in tension.

The term *compressive strength* is merely used to denote the unit compressive stress in a body subjected to a compressive load when the shearing stresses and friction can no longer resist rupture.

It is easy to see that a bar may be ruptured in tension by the fractured surfaces separating normally or in shear by the fractured surfaces sliding upon each other, producing tangential separation; but in the case of a short bar of metal or stone subjected to compression, the direct effect of the load is to press the material together instead of producing separation.

Very soft materials, when subjected to compression, flow laterally and do not separate; whereas brittle materials fail in shear before they will flow, and some steels develop cracks parallel to the direction of the load after the material has suffered considerable lateral extension, showing that the separation is caused by tension. It is difficult to acquire an abstract conception of ultimate compressive strength, and no means are available by which even the elastic compressive strength may be shown to be dependent upon any property other than the elastic strength in shear.

SELECTION OF FORMULA FOR A GIVEN MATERIAL AND LOADING.

A body subjected to a complex loading will fail when the stress in any direction at any point reaches the ultimate resistance of the material in that direction at that point.

Conceive of a chain consisting of three or more elements of special design—one link so designed that the maximum stress is tension, another in which the compressive stress is much higher than the tension or shear, and the third element having its minimum resistance in shear. The links are so proportioned that a load on the chain will produce a tension, compression and shear stress in the respective links that is numerically the same for all. How would the chain fail? If made of cast iron it would fail in tension, of glass it would fail in compression, and of soft steel it would fail in shear. It is obviously absurd to say that such a chain constructed of hard steel or cast iron would fail in shear; yet that is in accord with the idea that some discussions on combined stresses were intended to convey.

According to Hancock, the numerical values of the stress at the yield point and at the elastic limit are practically equal. It has also been observed that a material usually fails ultimately in the same manner in which it first yields; hence the yield points or elastic strengths of a material may be used as a criterion of its relative ultimate strengths.

Let Q = yield point in shear
P = yield point in tension
F_s = factor of safety in shear = Q/S_e
F_t = factor of safety in tension = P/T_e

In order to have equal factors of safety against yielding in tension and shear

$$F_t = F_s \text{ and } \frac{F_t}{F_s} = 1$$

substituting,

$$\frac{P/T_e}{Q/S_e} = 1$$

$$\frac{P}{Q} = \frac{T_e}{S_e} = \frac{(1-y)\quad T/S}{(1+y)\sqrt{(4-T^2/S^2)}} + 1 \ldots\ldots\ldots [17]$$

If the right-hand side of this equation is greater than the left the factor of safety in tension is less than the factor of safety in shear, and yielding will occur first in tension; which shows that the equivalent-normal-stress formula should be used. If the left-hand member is the greater, yielding will occur first in shear; showing that the formula for equivalent shear stress should be used.

If the value for Q is obtained by a torsion test it is more accurate to use

$$\frac{P}{Q} = \frac{T_e}{S_e} = \frac{(1-y)\quad T/S}{\sqrt{4+T^2/S^2}} + 1 + y \ldots\ldots\ldots\ldots\ldots [18]$$

These formulæ are for determining whether a body made of a given material and subjected to a given shear and a given tensile stress is weaker in shear than in tension and enable the designer to select the proper formula.

Similar formulæ may be written for compression and shear or compression and tension.

FORMULAE FOR THE DESIGN OF SHAFTS SUBJECTED TO BENDING AND TWISTING

Let M_b = external bending moment
M_t = external twisting moment
M_{be} = equivalent bending moment which would produce the same normal stress as M_b and M_t

M_{te} = equivalent twisting moment that would produce the same shear stress as M_b and M_t

I = rectangular moment of inertia

J = polar moment of inertia

c = distance from the neutral axis to the extreme fiber, or radius of a round shaft

Z_r = rectangular modulus of section, I/c; for round section $D^3/10.2$

Z_p = polar modulus of section $J/c = 2I/c = D^3/5.1$ for round section

D = diameter of shaft

P = unit tensile stress at yield point

Q = unit shearing stress at yield point

T = working stress in tension

S = working stress in shear.

Then

$M_b = TI/c$ and $M_t = SJ/c$

Maximum Normal-Stress Theory. According to the maximum normal tress theory the stress producing yielding is

$$T' = \frac{T}{2} + \frac{1}{2}\sqrt{4S^2 + T^2} \quad \ldots\ldots\ldots\ldots [19]$$

By multiplying this equation through by I/c and remembering that $J/c = 2I/c$, it becomes

$$T'I/c = TI/2c + \frac{1}{2}\sqrt{S^2J^2/c^2 + T^2I^2/c^2}$$

by substitution, the equivalent bending moment is

$$M_{be} = \frac{1}{2}(M_b + \sqrt{M_b^2 + M_t^2}) \ldots\ldots\ldots [20]$$

and consequently the stress is

$$T = \frac{5.1}{D^3}(M_b + \sqrt{M_b^2 + M_t^2}) \ldots\ldots\ldots [21]$$

The form frequently given in text books is due to Rankine, who wrote it in terms of the equivalent twisting moment: namely:

$$M_{te} = M_b + \sqrt{M_b^2 + M_t^2} \ldots\ldots\ldots\ldots [22]$$

from which the shearing stress is

$$S' = \frac{5.1}{D^3}(M_b + \sqrt{M_b^2 + M_t^2}) \ldots\ldots\ldots [23]$$

which is the same value as given for the tensile stress above. This is due to the substitution of M_{te} for $T'J/c$ in the derivation of the latter formula. If the tensile stress at the yield point due to bending is the same as shearing stress at the yield point due to torsion, T' might be substituted for S'; but as a matter of fact, the ratio P/Q is not unity. The requirement for equal factors of safety in shear and in tension was found to be $T' = PS'/Q$. Hence, Rankine's equation should be written

$$M_{te} = \frac{Q}{2P}(M_b + \sqrt{M_b^2 + M_t^2}) \ldots\ldots\ldots [24]$$

for the general case.

Maximum-Strain or Maximum-Equivalent-Normal-Stress Theory. According to Saint Venant's theory the stress producing yielding is

$$T_e = \frac{(1-y)}{2}T + \frac{(1+y)}{2}\sqrt{4S^2 + T^2} \ldots\ldots\ldots\ldots [25]$$

By the same method used in the preceding case it is found that

$$M_{be} = \frac{(1-y)}{2}M_b + \frac{(1+y)}{2}\sqrt{M_b^2 + M_t^2} \ldots\ldots\ldots [26]$$

and

$$M_{te} = \frac{Q}{P}[(1-y)M_b + (1+y)\sqrt{M_b^2 + M_t^2}] \ldots\ldots [27]$$

The formula used by the French engineers is

$$M_{be} = 0.375\,M_b + 0.625\sqrt{M_b^2 + M_t^2} \ldots\ldots\ldots\ldots [28]$$

and was derived by Grashof, who used 0.25 for the value of y.

The formula due to Bach and much used in Germany is

$$M_{be} = 0.35\,M_b + 0.65\sqrt{M_b^2 + M_t^2} \ldots\ldots\ldots\ldots [29]$$

the value of y being taken equal to 0.3.

Maximum-Apparent-Shear-Stress Theory. It has been shown that the maximum apparent shear stress is

$$S' = \frac{1}{2}\sqrt{4S^2 + T^2} \ldots\ldots\ldots\ldots [30]$$

By multiplying through by J/c and substituting, it is found that

$$M_{te} = \sqrt{M_b^2 + M_t^2} \ldots\ldots\ldots\ldots [31]$$

and

$$M_{be} = \frac{P}{2Q}\sqrt{M_b^2 + M_t^2} \ldots\ldots\ldots\ldots [32]$$

Equivalent-Shear-Stress Theory. From the equation for equivalent shear stress

$$S_e = \frac{(1+y)}{2}\sqrt{4S^2 + T^2} \ldots\ldots\ldots [33]$$

The equivalent twisting and bending moments are

$$M_{te} = (1+y)\sqrt{M_b^2 + M_t^2} \ldots\ldots\ldots\ldots [34]$$

and

$$M_{be} = \frac{P}{2Q}(1+y)\sqrt{M_b^2 + M_t^2} \ldots\ldots\ldots\ldots [35]$$

Maximum Compressive Strength. The fact that practically all materials used in machine construction are equally as strong or stronger in compression than in shear or tension eliminates the compressive strength as a criterion in design. Glass has the distinction of having a greater resistance in tension than in compression and if its physical properties were definitely known it is quite probable that the maximum-compressive-stress theory would be found applicable.

Guest's Formula. The formula deduced by Guest from his experiments is written

$$M_{be} = \sqrt{M_b^2 + M_t^2} \ldots\ldots\ldots\ldots [36]$$

whereas the maximum apparent shear stress gives

$$M_{te} = \sqrt{M_b^2 + M_t^2}.$$

In order to determine the diameter of shaft the former is equated with $TD^3/32$ and the latter with $5D^3/16$, which causes Guest's formula to give a stress twice that of the maximum, apparent-shear-stress formula.

The expression given by Guest could be obtained from equation [32] if $P/Q = 2$ or from equation [35] when

$$P\frac{(1+y)}{2Q} = 1$$

By assuming $y = 0.3$ this expression reduces to $P/Q = 1.57$.

Guest did not give the values of P/Q and y for the materials used in his experiments. The values of P/Q given by Hancock[1] are as follows:

	P	Q	P/Q
Steel Tubing	21,000	10,500	2.000
Nickel Steel	76,500	38,000	2.013
Mild Carbon Steel	47,000	30,500	1.546
Steel (Scoble)	64,600	29,170	2.214
Carbon Steel	55,500	24,400	1.454
Rivet Steel	38,900	23,400	1.662
Nickel Steel	56,000	35,000	1.555
Steel Tubing	17,000	11,500	1.478
Steel Tubing	28,000	16,000	1.750
Steel Tubing	20,000	12,000	1.666

[1] Proceedings A.S.T.M., Vol. viii, 1908.

It is seen from the results in this table that the value of $P/Q = 1.54$ corresponds to that given for mild carbon steel; and the values for steel tubing, the material used by Guest, vary from 1.47 to 2.00. These results apparently favor the two shearing-stress theories about equally well; but by accepting the elastic theory it is preferable to assume that the value 1.54 is the proper one to use, which means that the equivalent-shear-stress theory is the more accurate of the two and should be used for soft or ductile materials. There is nothing in Guest's results to show which of these theories he used. His formula is empirical and the data on the elastic limits and ratios of lateral contraction are lacking.

Selection of Formula. For the design of shafts made of hard or brittle materials such as cast iron or hard steel the Grashof formula

$$M_{be} = \frac{3M_b}{8} + \frac{5}{8}\sqrt{M_b^2 + M_t^2}$$

should be used.

For the design of shafts made of soft or ductile materials such as very mild steels the equivalent-shear-stress formula

$$M_{te} = (1 + y)\sqrt{M_b^2 + M_t^2} = 1.3\sqrt{M_b^2 + M_t^2}$$

should be used.

When the equation

$$\frac{P}{Q} = \frac{(1 - y)\,M_b}{(1 + y)\sqrt{M_b^2 + M_t^2}} + 1$$

is satisfied both of the above equations give the same result and either may be used. When the right-hand side of the equation is the greater, use the equivalent-normal-stress formula, and when less use the equivalent-shear-stress formula.

CONCLUSION

The equivalent stresses are a refinement over the apparent stresses and both theoretical and experimental results show that the former is the more accurate. The equivalent-stress formulæ are written as follows:

Equivalent tensile stresses

$$T_e = \frac{(1 - y)}{2}\,T + \frac{(1 + y)}{2}\sqrt{4S^2 + T^2}$$

$$T_e = \frac{(1 - y)}{2}\,C - \frac{(1 + y)}{2}\sqrt{4S^2 + C^2}$$

Equivalent compressive stresses are

$$C_e = \frac{(1 - y)}{2}\,C + \frac{(1 + y)}{2}\sqrt{4S^2 + C^2}$$

$$C_e = \frac{(1 - y)}{2}\,T - \frac{(1 + y)}{2}\sqrt{4S^2 + T^2}$$

Equivalent shear stresses are

$$S_e = \frac{(1 + y)}{2}\sqrt{4S^2 + T^2}$$

$$S_e = \frac{(1 + y)}{2}\sqrt{4S^2 + C^2}$$

The tensile-stress formulae should be used when P/Q is less: and the shear-stress formulae should be used when P/Q is greater than

$$\frac{(1 - y)\,T}{(1 + y)\sqrt{4S^2 + T^2}} + 1$$

if the material fails in torsion with a helical-shaped fracture. the equivalent-normal-stress formula should be used, and if in torsion it fails in a plane perpendicular to the axis, the equivalent-shear-stress formula should be used.

If a material fails in tension with a decided cup-shaped fracture, the equivalent-shear-stress formula should be used; whereas failure perpendicular to the axis of the tension specimen indicates that the equivalent-normal-stress formula is preferable.

The Association of Iron and Steel Electrical Engineers will hold its eleventh annual convention at Philadelphia, Pa., Sept. 10-14, with headquarters at the Bellevue-Stratford Hotel. The day of Sept. 12 will be devoted entirely to a patriotic program, with addresses by army and navy engineers on vital subjects concerning our industries.

At Harvard University three prizes, amounting to $200, known as The Nelson Prizes in Plumbing, have just been awarded for the best papers on subjects having to do with the theory or practice of plumbing. A new contest similar to the one just completed but involving a larger sum of money is planned. to be offered this coming year. It is probable that a fellowship will be also offered by Harvard. and engineering graduates who have knowledge and ability to handle problems dealing with sanitation should be especially interested.

The annual convention of the American Institute of Electrical Engineers, which was to have been held at Hot Springs. Va., was postponed on account of many conditions arising from the war. and in its place a special two-day convention was held in the Engineering Societies Building, June 27 and 28.

Topics of the professional sessions included high-tension cables, high-tension insulators, use of electricity in mines, and economical combinations of water-power and steam plants. A paper on the last subject described a method for determining the economical limits in steam and water-power developments.

In his presidential address. President H. W. Buck pointed out that, although engineering has been one of the most important factors in the development of our civilization, nevertheless the engineer has had a difficult struggle to begin to attain the recognition due him. However, the particular training that the engineer acquires in the pursuit of his profession particularly fits him to fill every position in our political and economical affairs, and in the future he is destined to occupy more and more positions of public trust.

Mr. E. W. Rice, Jr., president-elect for the coming year, addressed the meeting on Modern Warfare a Question of Engineering. He said in substance that although it is important that we have an army at the front, the most effective work can be done in the shop and office at home by bending forth every effort toward supplying the army with all the modern appliances of warfare to make it most efficient, and not to wait for the miracle that will never appear. He expressed his belief that the submarine problem will be solved by the combined efforts of engineers and scientists, that we should build ships and the best kind of ships, and that all shipping should be used to the best advantage: that it is not so much a question of the number of ships as it is a case of keeping them in use, which means that our docks must be equipped by the most modern apparatus for loading and unloading the vessels so as to keep them in service.

C. O. Mailloux announced that recruiting for a corps of electrical engineers and electrical workers to go to France would soon begin, to build up the electrical systems in that country. This corps will be similar to the body of railway engineers that was recently organized in this country to build up the transportation systems in France.

CONTRIBUTED DISCUSSIONS OF SPRING MEETING PAPERS

SUBSEQUENT to the publication of the account of the Spring Meeting in the July issue of THE JOURNAL, five contributions have been received which should be appended to this account. Prof. R. Pohakoff, of the Technical Institute of Moscow, Russia, contributes a statement of the Technical Bureau of the Russian Artillery Commission in discussion of Mr. E. F. Walsh's paper on The Importance of Intelligent Inspection in Munitions Manufacture; also a more complete discussion of Mr. A. L. De Leeuw's paper on A Foundation for Machine Tool Design and Construction. Mr. Victor B. Phillips, author of the paper on Relation of Efficiency to Capacity in the Boiler Room, now in active service, forwards the closure to the discussion of his paper. Mr. Charles Meier replies to Mr. Carl G. Barth's discussion of his paper on Metal Planers and Methods of Production, and Mr. Barth answers Mr. Meier's reply.

DISCUSSION OF PAPER ON A FOUNDATION FOR MACHINE TOOL DESIGN AND CONSTRUCTION

TO THE EDITOR:

In Par. 32 of his paper, Mr. De Leeuw refers to a tool which he shows in his Fig. 4, mentioning that this tool broke down very soon after the surface of the hollow began to show scratches. I do not know what was the plan of the tool, whether it had a round edge or not, but the scratches might have been attributed to the following reason:

If you take the ordinary round-edge tool (Fig. 1) with the ordinary angles of front rake, side rake and clearance, you will find by a very simple mathematical analysis that when the front rake is less than the side rake—as it usually is—the cutting angle changes from point to point of the edge. I assume herewith that the chip and all its elements go off the bar at a right angle to the cutting edge at the respective point. It will have one value at the plane *ab* (i.e., at the plane of the front rake), a lesser value at the plane *bc* (side rake), and intermediate values at points *de*, etc.; and if you lay off the respective values of the cutting angles at the corresponding different points *a, d, e, c*, of the cutting edge, then these values would change like the curve a', d', m', c' (Fig. 2). In other words, the angles will first decrease, then go up a little, then decrease again until they reach the lesser value cc', corresponding to the plane *bc*. These angles, with an ordinary round-edge tool and the ordinary usually accepted angles of side and front rake, therefore change in a curve with some peak points in it.

If you will assume that the chip consists of elementary chips, each element going off the bar at right angles to the cutting edge, then these different elementary chips have to descend on inclined planes with changing angles, and necessarily one elementary chip is either retarded or accelerated in its downward movement by its adjoining chip; and this retardation or acceleration necessarily must create inner friction and cause the different scratches on the hollow of the tool, every single scratch being the mark left by the elementary chip.

If the scratch to which Mr. De Leeuw referred can be attributed to the reasons just cited, then, in my judgment, the following remedy could be suggested to avoid these scratches and prolong the life of the tool:

All the cutting angles must be equal at all points of the cutting edge, starting at the *ab* plane and terminating at the plane *bc*; and in order to achieve this end, the quadrant *adec* should not be a plane but a quadrant of a circle drilled out by a drill with its center point at *b* and having a radius *ab* equal to *bc* and its cylindrical body projecting in the line *adc*. In this way all the cutting angles would be equal all the way through from *a* to *c* just as in the case of a straight-edge tool.

Of course, this calls for another way of preparing the turning tool altogether, both with regard to machining and grinding, but this can be very easily arranged. In fact, I introduced such a tool in the Laboratory of Technology at the Technical Institute, Moscow, Russia, some two and a half years ago, and have also designed some grinding attachments to grind the hollow produced by the drill.

I started to make some experiments with a tool so designed, but had to discontinue them on account of being sent over to this country in connection with the war. I hope, however, to resume the experiments in the near future, and shall be glad to report to your Society the results obtained.

I also made some dynamometer tests with such a tool, but these tests are, too, in an unfinished condition as yet.

Referring to the circular tool of Mr. De Leeuw, Par. 35, I believe that he originated this tool about two and a half years ago. I do not know how much experimenting has been done with this tool in this country, but I may mention that as soon as I read about it in the *American Machinist*, where it was originally described, I prepared a tool along the same lines with the object of making some experiments, but, as already stated, I had to leave for the United States and therefore could not make them.

However, I published an article in a Russian technical magazine describing the construction of this tool, and, based upon this description, a few tools have been prepared in the Ijev Rifle Works, in the Ural mountains. When I visited these works in 1915 I was shown the results of their experiments, which proved to be very satisfactory, both with regard to speed and life of the tool. I have sent these facts to the Russian magazine, *Vestnik Ingenerov*, for publication.

Referring to Mr. De Leeuw's Suggested Lines of Experimentation, I fully agree with what the author says, but I can easily see some objections from the so-called practical viewpoint of shop men. Mr. De Leeuw suggests that these experiments should be made at low speeds, and whatever the results of such experiments should be, the ordinary shop man will probably say, "That's all right—it may be all right in theory, but how about the practical side, where the results of such experiments are quite different?" They will doubt if the results of such experiments can be fully applied to practice.

In connection with this I may mention that very few experimental data have been published along the line of cutting with fine cuts, although a little has been done.

Edward Herbert, of Manchester, England, has been working along such lines for some time, and has invented a special machine for taking very fine cuts from a hollow tube. He has published some of the results of his experiments and they are very interesting, especially with reference to the cut, as they show that a finishing tool fails quite differently from an ordinary roughing tool.

In the roughing cut, when you increase the speed, leaving all other conditions equal, the time of the endurance of the tool decreases, something like curve *ab*, Fig. 3, in which the

abscissæ represent the speed and the ordinates the endurance time. In the case of the finishing tool, however, the endurance curve is something like the curve *abcd*, Fig. 4, with some peaks in it, which means that when you increase the speed of the finishing cut the endurance time may increase up to a certain limit, and then will start to decrease with a further increase in

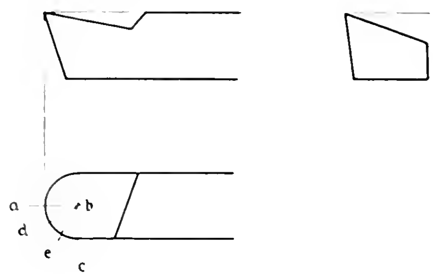


FIG. 1 ROUND-EDGE TOOL

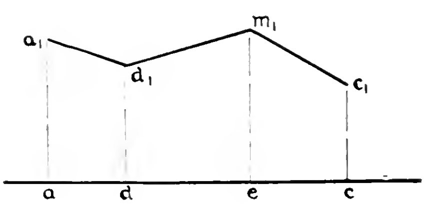


FIG. 2 VALUES OF CUTTING ANGLES

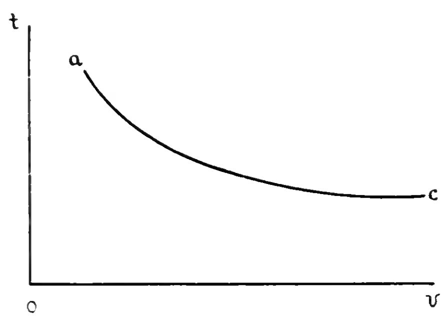


FIG. 3 ENDURANCE TIME OF TOOL IN ROUGHING CUT

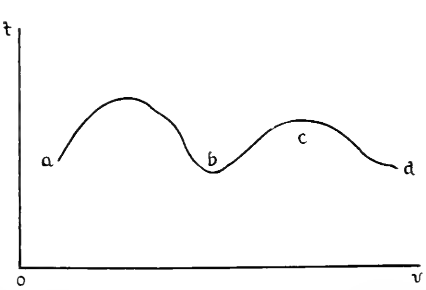


FIG. 4 ENDURANCE TIME OF TOOL IN FINISHING CUT

the cutting speed. If the cutting speed continues to increase, the endurance time may go up again. From this one can draw the conclusion that there is probably a certain speed which is the most profitable for working so far as endurance of the tool (and, as experiments show, also the appearance of the machined surface) is concerned.

When Mr. Herbert presented his paper on this subject some three or four years ago, he met with the same objections to which I have just referred, i.e., that these experiments may be of much theoretical value but are very doubtful so far as practical results are concerned.

In order to meet these objections to a certain extent, I made some experiments on finishing cuts, but in a quite practical way, and under conditions absolutely identical with those prevailing in ordinary shop practice. It would perhaps be out of place to go into too many details of these experiments at this time, especially as I have already presented them in a paper before the Institution of Mechanical Engineers, in Manchester, an extract of which was published in the *American Machinist* some ten months ago.

Suffice it here to say that these practical experiments fully confirmed the results of Mr. Herbert's experiments made under conditions different from shop practice.

Therefore, I can most assuredly say to shop men that practice and theory go hand in hand together, and if the theoretical experiments are conducted on the right lines, they are sure to yield valuable practical results.

R. POLIAKOFF.

New York, N. Y.

AUTHOR'S CLOSURE TO DISCUSSION OF PAPER ON RELATION OF EFFICIENCY TO CAPACITY IN THE BOILER ROOM

TO THE EDITOR:

In their discussions both Mr. Barrus and Mr. Reinicker are unwilling to attach any accuracy to tests of eight hours' duration. The author understands fully the validity of objections to eight-hour tests and the tests in question were conducted with these objections in mind. They could not have been conducted otherwise. As regards the degree of accuracy of the efficiencies obtained, it may be said that the closely accurate determination of efficiency was throughout of secondary importance. None of the data sought nor conclusions reached is impaired by an inaccuracy of, say, 3 per cent in the overall efficiency. The overall efficiency is the only quantity that the employment of the short test can bring into question. It will be noted that differences in efficiency by virtue of differences in fuel-bed thickness are far in excess of any possible inaccuracy in the values of efficiency. Furthermore, all other observations and the conclusions drawn therefrom are in no way subject to the criticism of the short duration. It is quite conceivable that the curvature or slope of some of the lines on the furnace and boiler unit operation charts may be appreciably in error. These charts were presented, however, to illustrate certain general principles, and are believed to be of sufficient accuracy to serve this purpose. The entire part of the paper relating to the boiler as a heat absorber is, of course, not subject to the above criticisms.

The reason for the short tests was the impossibility of operating for a longer period at the heavy overload. It will be noted that the coal used was very high in sulphur. The resultant difficulties with clinker building out from the bridge wall prevented continuing these tests over eight hours. The eight-hour test was adopted for this investigation only after considerable experimentation. It was found that very small changes in the fuel supply could be readily observed in their effect upon the fuel-bed thickness. In considering the accuracy of the tests it must be remembered that firing conditions were kept very constant. Every effort was made to this end. Under such conditions objections to the eight-hour test are minimized. In view of the observed fact that cutting off the fuel supply for five minutes produced an easily observed change in the fuel bed, the author feels justified in claiming

an accuracy of efficiency figures within a 3 per cent limit of variation.

Mr. Spitzglass speaks of the author's failure to study the relation between efficiency and capacity. The author would say here that, assuming the possession of complete data on the operating characteristics of a steam boiler, the study of the above relation must necessarily be a prolonged affair. It involves the loading conditions of the plant, prices of coal and labor, cost of equipment and of land and other conditions affecting power costs. Manifestly it could not be so much as touched upon in the present paper. All that the author hoped to do was to establish the importance of the relation of efficiency to capacity in the boiler as the prime basis of the investigation which has been presented.

Mr. Spitzglass also questions the ability of the fireman "to observe air velocities, draft-gage readings, gas analysis and the flue temperatures," or to interpret such readings. As regards flue-gas analyses, the author fully agrees with Mr. Spitzglass, and takes great pains in the paper to point out how the conditions of combustion may otherwise be easily and simply indicated. As regards the observing of air velocities, the author believes that the air meter, an illustration of which is shown in the paper, may be read as easily as any other form of meter. Concerning the use of instruments in general, the practice of the best plants throughout the country is a sufficient answer. The author heartily subscribes to the value of the steam-flow meter as mentioned by Mr. Spitzglass.

The author wishes to correct the impression that may have been gained that he ever had in mind the use by the fireman of charts such as have been presented in this paper. He would, however, propose the use of scales on the various instruments, having the numbers so arranged as to correspond when operating conditions are proper; e.g., all numbers indicating 5 when No. 5 load is to be carried. Such a system would be readily intelligible to the fireman.

Messrs. Alpern and Reinicker both call into question the matter of air-pressure drops through the tuyeres and fuel bed (i.e., sum of pressure in air boxes of stoker and draft in combustion chamber). Clearly this drop is a function of the amount of air forced through the fuel bed, the areas of air openings in the grates, and the thickness and resistance of the fuel bed. The criticisms seem to assume ability on the part of the operator to regulate this pressure drop independently of load. Such cannot be the case, since any increase in air pressure with a given condition of fuel bed will simply result in a greater combustion rate and will not change proportionately the ratio of air to coal burned. This ratio may be regulated only by regulation of the fuel-bed resistance.

Mr. Alpern speaks of "some operating faults of the tests." The author has nowhere indicated that the air supply to the extension grates was kept continuously at the maximum, nor does Mr. Alpern's discussion indicate to him any faults in operation. The point is that at heavy overloads it is obviously necessary to increase the combustion rates on all parts of the grate surface. This necessity applies to the extension grates as well. The author does not believe that the maximum supply of air to these grates is sufficient for prolonged overloads in the stoker under discussion. Mr. Alpern's statement regarding the relation of air pressures to the different fuel-bed thicknesses is not in accord with the data given in the paper. The author certainly agrees with Mr. Alpern that "the heavy-fuel-bed condition was an unnatural one."

In answer to Mr. Reinicker's statement that the furnace drafts were too high, the author would say that in the particular setting tested, lesser drafts could not be used without driving some gas out of the setting near the top of the first pass and without endangering dump-grate bars. The author fully agrees with Mr. Reinicker as regards the limitations placed upon both capacity and efficiency by high furnace temperatures. Difficulties from clinker and destruction of the refractory lining are perhaps the greatest single barrier operating against heavy overloading. Mr. Reinicker's statement regarding the unimportance of radiation and convection as *losses* and his criticism based thereon have no bearing on the paper under discussion. The author treated radiation and convection as the modes of heat transmission from the furnace to the boiler, and at no point considered their bearing upon the incidental losses from the setting.

In the first paragraph of his discussion, William Kent has put in a few words and in admirable form the idea that has been in the mind of the author for some years, and which led to the preparation of this paper.

Victor B. Phillips.

Ft. Leavenworth, Kan.

DISCUSSION OF PAPER ON METAL PLANERS AND METHODS OF PRODUCTION

To the Editor:

Regarding Mr. Barth's statement in his discussion that the time consumed in stopping and reversing the planer and table must be independent of the length of the stroke and can be considered equal to the time it would take the table to travel an imaginary addition to its actual stroke, I think this is where the misunderstanding comes in. I take it Mr. Barth believes a constant can be found which would be correct for all lengths of strokes. This is impossible owing to the variable quantities governing the different belt conditions; for instance, on long strokes, where the reversals are less frequent, the pulleys do not heat up and the belt slips less than it does on short strokes. It is a positive fact that if a planer is run for any length of time on short strokes (especially with cast-iron pulleys) the belt conditions are continually changing, owing to the slipping of the belts and the heating of the pulleys and the air which seems to get between the belt and the pulley. This condition becomes a great deal more aggravated on short strokes than it does on long strokes, and even at times I have seen it get to a point where the belts would smoke terribly. Anyone who has stood and watched such a performance and observed the variation in the length of stroke will admit that no practical constant can be found which will be correct for all conditions and for all the lengths of strokes.

As to the imaginary length of a perfect stroke, why try to determine on this imaginary quantity when the actual quantity can be so easily figured? Knowing the cutting and return speed and assuming there is no loss at either end, we have the actual ideal condition, which is the theoretical number of strokes I referred to in Table 1.

In making our aluminum pulleys, we aim to get as close to this theoretical or ideal stroke as possible, and just how near we have approached this condition is represented by the efficiency column, from which it can be seen that no one constant can be found to cover all lengths of strokes which would be correct; because what would be correct for the average long strokes would not be correct for the shorter strokes. A graphical diagram, such as is shown in Mr. Barth's Fig. 1, could not be determined, therefore, as the values of *a* would be variable for different-length strokes.

I cannot see that Mr. Barth's contentions are at all well founded, and I believe if he will carefully analyze the prac-

tical side of these points, he will agree with me that I am correct in what I have said.

Charles Meier.

Cincinnati, Ohio.

To the Editor:

I appreciate fully what Mr. Meier says in regard to the absurdity of my contentions about a constant imaginary over-run for very short strokes, but as I never allow any planer to run on such absurdly short strokes, it did not occur to me to qualify my statement, as I have now done in correcting my discussion. However, I can assure him that I have too often demonstrated that my contention is correct for all practical purposes, to admit that there is any misunderstanding about this matter, on my part. Besides, the accompanying plot, Fig. 1, of his experiments clearly shows that his shortest stroke did not adversely influence the effective pull of the belt, which, in fact, indicates a higher effective pull on the shortest stroke, both for the cast-iron pulleys and the aluminum, provided any reliance can be placed on his experimental figures in

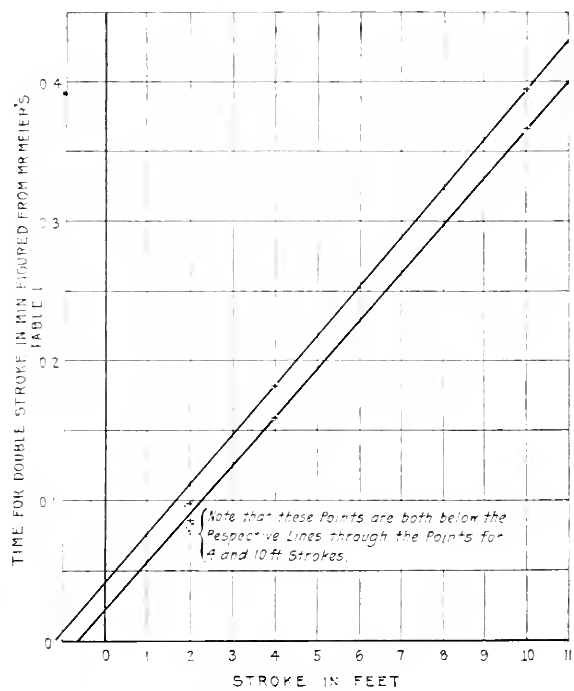


Fig. 1 Plot of Mr. Meier's Experiments

Table 1. I may say, in this connection, that I certainly cannot approve of Mr. Meier's way of figuring the theoretical number of strokes from the theoretical speeds 40 and 90 ft. It savors too much of time studies that give nothing closer than 0.1 min. You can arrive at such matters by indirect methods only.

Regarding the power question, in Par. 11 of his paper, Mr. Meier makes the unqualified statement that the aluminum pulleys show a saving of 25 per cent in power, which, taken by itself, is very misleading, though of course he did not mean it that way. I therefore suggest that he rewrite it something like the following:

"11. Table 2 also shows, what we should expect to find, some reduction in the peak load on the motor during reversal, namely 25 per cent, with the aluminum pulleys as against the cast-iron pulleys.

Carl G. Barth.

Philadelphia, Pa.

The Society of Industrial Engineers, which was recently organized at Washington, D. C., consists of professional technical engineers, accountants, managing executives in commercial and industrial activities, technical writers, educators and students. It is planned to offer the services of the organization to the Government through Howard E. Coffin, chairman of the Advisory Committee, Council of National Defense, and through such committees as can use the services of industrial engineers. A bureau has been organized under the direction of the president of the society to list all the industrial specialists in the country who may be called upon to serve either as advisers or directors of efficiency work. D. C. Dent, of Chicago, is acting secretary of the organization.

Standard wrought-iron or steel pipe of any size up to and including 10-in. is with three exceptions larger in diameter internally than its specific designation would indicate. Ordinary 1-in. wrought-iron pipe, for example, when made to conform exactly to standard dimensions (which, however, is not always the case) has an internal diameter of 1.05 in., which is 1-20 in. over the nominal size.

On the other hand, extra strong pipe having a higher designation than ½-in. and up to 12-in. is smaller in diameter, with one exception, than the nominal size would indicate. Thus, extra strong 1-in. wrought-iron pipe is 0.95 in. diameter inside, which is 1-20 in. under the nominal size, while double extra strong 1-in. pipe has an actual internal diameter of only 0.60 in., or a little more than half the nominal value.—*Power*, July 17, 1917.

The Shipping Board has announced a call for engineers to serve on the great war fleet that is to be built. It is announced that in the next 18 months no less than 5000 engineers will be needed.

Engineering schools in terms beginning July 21 will be opened at the Massachusetts Institute of Technology, Cambridge, Mass.; at Stevens Institute, Hoboken, N. J.; at the Case School of Applied Science, Cleveland, Ohio; at the Armour Institute of Technology, Chicago, Ill.; at the University of Washington, Seattle, Wash.; and at Tulane University, New Orleans, La.

Each term will last one month, the expense of tutoring being borne by the Shipping Board. The Massachusetts Institute of Technology, it is said, can put through 150 students a month, and other institutions an average of 35 students. Marine engineers of all grades, oilers, water tenders, and stationary engineers are eligible for the classes. (*Christian Science Monitor*, June 23, 1917, p. 3.)

The Chemical News and Journal of Physical Science (vol. 15, no. 3003, June 15, 1917) announces a unique British invention, namely, a secret process for manufacturing rubber sponges.

In making certain rubber goods a "fault" was developed. Its cause was traced and out of it the artificial sponge gradually emerged.

Within the last five years, however, a similar product has been manufactured in America. It appears now that an English inventor, G. W. Leeson, has produced an artificial sponge which is claimed to be superior to those now on the market, as with or without soap it has not the slightest trace of roughness and, in addition, the new sponge retains its freshness for a long time.

WORK OF THE BOILER CODE COMMITTEE

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in THE JOURNAL, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee as approved by the Council on June 21, 1917, in Cases Nos. 150, 153-157 and 159-161 inclusive. In this report, as previously, the names of inquirers have been omitted.

CASE No. 150 (REOPENED)

Inquiry: Is it permissible under the rules of the Boiler Code to brace that portion of the head of an h.r.t. boiler below the tubes with diagonal braces, or must this portion of a boiler be braced with through stays?

Reply: Diagonal bracing is not permissible for that portion of the front head of an h.r.t. boiler which comes below the tubes, under Par. 218 of the Code, but it is permissible for the corresponding portion of the rear head.

CASE No. 153

Inquiry: Does the crowfoot brace illustrated in Fig. 7 meet with the requirements of Par. 223 and Table 4 of the Boiler Code?

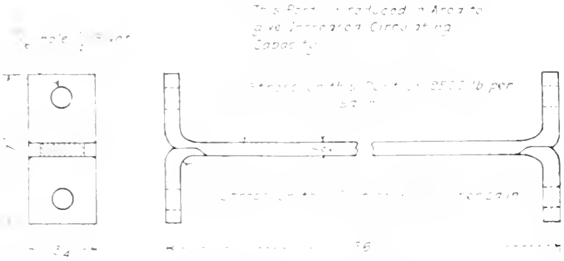


FIG. 7 PROPOSED SIDE BRACE FOR 150 LB. W. P.

Reply: The strength of each branch of the crowfoot in the design shown is difficult to compute. As the crowfeet vary so widely on different braces, it was the idea of the Boiler Code Committee in formulating this rule that the manufacturer would test each type of brace made to determine whether it meets the requirements or not, and the Committee suggests that the braces be tested to determine the relative strength of the body of the brace and of a crowfoot. According to the rule, the foot of the brace should be one-third stronger than the body of the brace. It, therefore, follows that if a test brace is made with the body one-third stronger than the brace to be used, the crowfoot of this test brace should be as strong as the body of the brace.

CASE No. 154

Inquiry: In the staying of a segment of a head, above the tubes, of an h.r.t. boiler in which a manhole is inserted, is there an allowance of 100 sq. in. under the rules of the Boiler Code, as is allowed by Par. 218 for manholes inserted in heads below the tubes?

Reply: Where a manhole is placed above the tubes in an h.r.t. boiler, no allowance shall be made as for the head surface that need not be braced, and the bracing of the head with such manhole opening should conform to that which would be used provided there was no manhole.

CASE No. 155

Inquiry: What is the application of the rules in Part I, Section 2, of the Boiler Code to the workmanship on steel plate heating boilers? Are punched rivet holes permissible, and also may cast iron mud rings and door frame rings be used?

Reply: The Code does not require the drilling of rivet holes for boilers for low pressure heating or hot water supply, except those that come under the power boiler rules as specified in Par. 335. This also applies for cast iron mud rings and door frame rings, where used.

CASE No. 156

Inquiry: *a* Will brass or bronze valves and fittings with flange ends in accord with the "1914 Brass Standard Flange Dimensions," when bolted to ferrous fittings as prescribed in Code Tables 15 and 16, comply with the purpose and intent of the Boiler Code Committee's reply in Case No. 101?

b Does the Boiler Code Committee approve the recommendation that the raised face be removed from a Table 16 fitting when it is bolted to a brass or bronze fitting?

c Does the Boiler Code Committee approve the recommendation that full face gaskets be used in a non-ferrous to non-ferrous or a non-ferrous to ferrous flange joint?

Reply: *a* The standardization of bronze fittings has been referred to a special committee of the Society. Until a report upon such standards is prepared and accepted by the Society, the Boiler Code Committee will abide by the decision in Case No. 101.

b All dimensions shall conform to the American Standard given in Tables 15 and 16 of the Appendix for the pressures therein specified, except that the face of the fitting to which it is attached shall be flat and without the raised face where brass or bronze composition fittings are used.

c It is the opinion of the Committee that full face gaskets should be used.

CASE No. 157

Inquiry: *a* Will cast iron, dove-tail lugs be permissible under Pars. 323 and 324 of the Boiler Code?

b In empire and economic type boilers, where the pads on the cross braces form a reinforcement to the side sheets, what coefficient should be used under Par. 199 of the Boiler Code?

c A ruling is desired covering Par. 254 of the Boiler Code, if no burrs are present.

Reply: *a* This inquiry is answered by Case No. 151.

b According to Par. 203, the value of C to be used should be 135.

c It is the opinion of the Boiler Code Committee that the plates should be separated to make sure there are no burrs.

CASE No. 158

(In the hands of the Committee)

CASE No. 159

Inquiry: If the material of which a dished head is formed is thicker than necessary under the rules of the Boiler Code

to sustain the pressure carried, is it necessary to flange a manhole opening, if inserted, to a depth of three times the thickness of the material used?

Reply: The intent of Par. 198 of the Code is that a manhole opening in a dished head shall be flanged to a depth of not less than three times the required thickness of the head, measured from the outside. If, therefore, the required thickness of material for a head is ½ in., the opening needs to be flanged to a depth of not less than 1½ in.

Case No. 160

Inquiry: Does Par. 316 of the Boiler Code allow the feed inlet to be located 3 in. from the bottom tube sheet of a small, vertical laundry boiler?

Reply: The Committee has decided that the requirement of Par. 316 does not apply to a small laundry boiler of the type you describe.

Case No. 161

Inquiry: Does Par. 218 of the Boiler Code prohibit the hexagonal or beehive arrangement of tubes used in the design of h.r.t. boiler shown in Fig. 8? The reply in Case No. 142

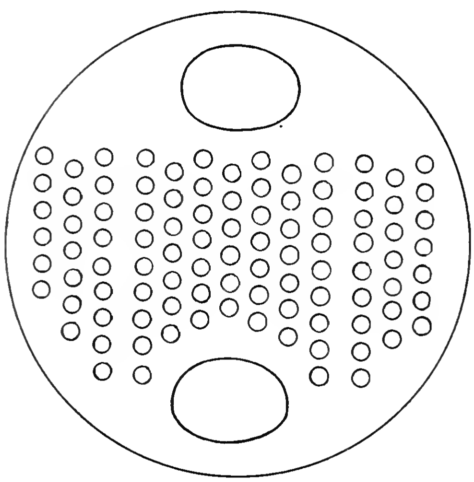


Fig. 8. Hexagonal Arrangement of Tubes in H.R.T. Boiler

is taken to apply to the usual tube layout, and does not seem to apply to the special tube layout, there shown.

Reply: The reply in Case No. 142 applies irrespective of the tube arrangement in an h.r.t. boiler.

Revision of Boiler Code

The Council of the Society has directed that the proposed changes in the Boiler Code be published in The Journal, with the request that any desired discussion on the proposed changes be mailed to the Boiler Code Committee for consideration. These proposed changes embody suggestions made at the meetings held at the Society headquarters, December 8 and 9, 1916, which were widely advertised as public meetings to which all those interested were invited to attend and participate in the discussions. Publishing the proposed changes will make it possible for any one to discuss the revisions before they are brought to the final form and presented to the Council of the Society for approval. All suggestions will be gratefully received and will be carefully considered by the entire Committee, and a full and free discussion is solicited.

A number of proposed revisions were published in the June issue of The Journal. There are other revisions which will be published later on with the request that they also be discussed.

PAGE 12

Par. 29a. Change Par. 29a to read as follows:

29 *Modifications in Elongation.* a For material over 11/16 in. in thickness, a deduction shall be made from the percentage of elongation in Par. 28a of four times the thickness in inches in excess of 11/16 in. to a minimum of 20 per cent.

Par. 30a. Change Par. 30a to read as follows:

30a Tension test specimens shall be taken longitudinally from the bottom of the finished rolled material, and bend test specimens shall be taken transversely from the middle of the top of the finished rolled material. The longitudinal test specimen shall be taken in the direction of the longitudinal axis of the ingot, and the transverse test specimen at right angles to that axis.[1]

Par. 30b. Change Par. 30b to read as follows:

30b The test specimen shall bend cold through 180 deg. without cracking on the outside of the bent portion, as follows: For material 1 in. or under in thickness, around a pin the diameter of which is equal to the thickness of the specimen; and for material over 1 in. in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen.

PAGE 13

Par. 33a. Change Par. 33a to read as follows:

33a *Number of Tests.* One tension and one bend test shall be made from each plate as rolled.

PAGE 81

Par. 335. Change heading which now reads "Boiler Materials" to "General."

A New Size of Boiler Stamp

When the A.S.M.E. Boiler Code was first issued early in 1915, stencil stamps conforming with the requirements of Par. 332 were prepared by the Society and offered to the public. The stamps were made ¾ in. in diameter and conformed generally with the exterior proportions of the Society emblem. They were widely distributed among boiler manufacturers and are now in extensive use in all parts of the country, seventy stamps in all having been issued up to the present time under the Boiler Code Committee's supervision.

In using a stamp of this size on plates ¼ in. thick or less, the rebound made it difficult to obtain a legible impression unless great skill was used in the stamping process. As a result of this difficulty, an inquiry concerning the matter was placed before the Committee. It was considered as Case No. 139 at the March 16 meeting, and treated as follows:

Case No. 139

Inquiry: Is it possible to secure a smaller A.S.M.E. boiler stamp than the present ¾-in. stamp that is furnished to meet the requirements of Par. 332 of the Boiler Code? It is difficult to stamp thin plates with the present ¾-in. stamp on account of the rebound.

Reply: A new stamp will be provided, ½-in. size, hammer

[1] Exceptions made for tension test specimens for plate which is rolled longitudinally with reference to position when used in a boiler shell. See Par. 190.

types [illegible] can be either used [illegible].

The Boiler Code Committee [illegible] nounce that a new [illegible] stamp [illegible] in the form of a hammer stamp, with the [illegible] emblem reduced to [illegible] in., as illustrated in Fig. 1. The reduced size of the emblem will greatly facilitate the stamping [illegible] thin plates, and where desired the impression may be obtained by using the stamp as a hammer instead of as a sledge in the usual manner.

Fig. 3 HAMMER STAMP FOR A.S.M.E. STANDARD BOILERS

Manufacturers desiring stamps are reminded that applications either for new or old size stamps must be accompanied by an affidavit made out on the form provided by the Committee and properly executed according to the following resolution approved by the Council:

> It is the opinion of the Committee that the official symbol or stamp is to be used to indicate that The American Society of Mechanical Engineers' rules have been compiled with in the construction of the boiler. The stamp shall be affixed by the manufacturer. Certification to be governed by law or contract.

The blank affidavit form may be obtained upon application to the Boiler Code Committee at the Society headquarters.

In an effort to coöperate in the solution of various problems of vital importance to the development of the French industries, the French Society of Civil Engineers decided to organize a Congress of Civil Engineering, which, in its idea, would constitute something like General Assizes of the Industry for the study of a program to be carried out after the war.

According to a preliminary announcement, the work of this congress will be divided into two groups and several sections.

The first group, embracing Sections 1 to 7, will be of a technical character and will be devoted to the following specialties: Section 1, public works and civil constructions; Section 2, transportation; Section 3, mechanical engineering, motors and machine tools; Section 4, mining and metallurgy; Section 5, industrial physics and chemistry; Section 6, industrial applications of electricity; Section 7, farm engineering and agricultural industries.

The second group, comprising three sections, will be devoted to economic problems and divided as follows: Section 8, rational organization of industrial works; Section 9, social hygiene, accident prevention, healthful work; Section 10, industrial legislation.

It is expected that the first part of the congress, i. e., the National Congress, will be held next November and will be opened to all interested in the economic and industrial future of France. The terms of admission have not yet been announced.

As regards the Inter-Allied Congress, for many reasons it is not expected that it can be organized until after the termination of the war. (Announcement in *Le Génie Civil*, vol. 70, no. 23, June 9, 1917, p. 373)

Tests of aeroplane engines will be made at a laboratory at the Bureau of Standards. At a recent meeting of a subcommittee on power plants of the National Advisory Committee for Aeronautics preparations were made for the development at the Bureau of Standards of a laboratory for testing aircraft engines under conditions of altitude and temperature similar to those encountered in flights at an altitude of 20,000 ft. or more. The laboratory and its experimental equipment will be organized under the auspices of the Advisory Committee, and the investigations will be directed by the subcommittee on power plants. (*The Automobile and Automotive Industries*, vol. 37, no. 2, July 12, 1917, p. 82)

The Autogenous Welding Committee of the American Society of Refrigerating Engineers has been appointed and consists of the following members: F. L. Fairbanks, Mem.Am.Soc. M.E., chairman; Llewellyn Williams, Mem.Am.Soc.M.E.; S. F. Jeter, Mem.Am.Soc.M.E.; P. A. E. Armstrong, metallurgical engineer, the North American Co.; Charles H. Bromley, associate editor *Power;* James C. McCabe, Mem.Am.Soc.M.E.; Theo. Vilter, president Vilter Manufacturing Co., Milwaukee, Wis.; Prof. Edward F. Miller, Mem.Am.Soc.M.E.; John E. Starr, Mem.Am.Soc.M.E., and Thomas Anderson, refrigerating inspector, City of Chicago.

The purpose of the committee is to assist in the development of the welding art and to make its application to pressure vessels as safe as the best knowledge of the subject can make it.

The government of the Union of South Africa has appointed an advisory board to deal with the development of the natural resources of the country. A special scientific and technical committee has been appointed to carry out scientific investigations. This committee consists of Mr. J. Burtt-Davy (botany and agriculture); Mr. L. Colquhoun (chemistry); Professor Young (geology); Professor John Orr, Mem. Am.Soc.M.E. (mechanical engineering); Mr. Bernard Price (electrical engineering); Professor Beattie (physics); Dr. Caldecott (metallurgy); Professor van der Riet (chemistry); Professor Malherbe (chemistry); Dr. L. Peringuey (president of the Royal Society of South Africa). The first step taken by the new committee has been to arrange for the preparation of fifty-two reports by leading experts, dealing with the available raw materials of South Africa suitable for manufacture or export. It is intended that these reports shall be published for the guidance of intending manufacturers and other business men.

In reply to a query from E. P. V. Ritter, of the Merchants and Manufacturers' Exchange, New York City, asking about the advisability of holding conventions during the war, the President has sent the following letter:

"In reply to your letter of June 4, allow me to say that I not only see no reason why commercial conventions should be omitted during the war, but should regret to see any instrumentality neglected which has proved serviceable in stimulating business and facilitating its processes. This is not only not a time to allow any slowing up of business, but is a time when every sensible process of stimulation should be used.

Cordially and sincerely yours,

(Signed) Woodrow Wilson."

(*Journal of Commerce*, June 18, 1917, p. 1.)

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

APART from the regular monthly departments, this issue of THE JOURNAL is practically devoted to the Sections of the Society, the Proceedings Section containing papers presented and discussed at Section Meetings, the publication of which will be continued in the next issue, and the Society Affairs Section containing reports of the year's activities received from the respective chairmen of Sections.

In reading these accounts of Sections work, members of the Society will become impressed with the increasing importance and tremendous possibilities of this activity of the Society, whereby we are able to bring the Society work in direct touch with eighty per cent of the whole membership.

Quoting from Vol. 31 of the Transactions, only eight years ago, during the presidency of Mr. Jesse M. Smith, "A meeting of members of the Society residing in St. Louis and vicinity was called by Wm. H. Bryan, member of the Meetings Committee. Prof. E. H. Ohle acted as secretary and about twenty engineers were present. This was the first local meeting of the Society to be held outside of New York City." Boston almost simultaneously held its first meeting. All the development of the Sections has come within the space of eight short years, and has now reached a magnitude that 112 local meetings were held during the season just closed.

The President, Dr. Hollis, proposes to further accentuate the national character of the Society by instituting the holding of Council meetings in various cities. The Council meeting for November will be held in Chicago. This will bring together a larger number of the officers of the Society than would ordinarily be brought in connection with one of the local meetings, it being planned to adjust the date of the Council meeting to the same day as that of the Chicago local meeting.

The President contemplates in the early fall a visit to the Coast. With this trip he will have attended meetings of the Society in all of the centers where we have established Sections.

The Committee on Sections also contemplate holding meetings next season in various cities where Sections meetings will be held. In this way an intimate knowledge will be gained of the requirements in different parts of the country. The first meetings will probably be held at St. Louis, Chicago and Detroit, during the month of October. By arranging meetings at these cities on consecutive days the committee will be able to visit several cities in one week with a saving in traveling expenses and the time of the members of the committee. These meetings will be arranged to fall on dates when the monthly meeting of the Section is being held, so that the members of the committee will not only have opportunity to meet the Executive Committee but also all members of the Section. In this way it is hoped that all Sections will be visited at least once every two years.

This will tend to bring all members into close association with the work the Society aims to accomplish through Section activities, and will also give the members opportunity to get first-hand information regarding matters of vital interest to them.

CALVIN W. RICE,
Secretary.

WHAT THE SECTIONS HAVE DONE THIS YEAR

A CLOSE association between the various local organizations of other societies representing the divisions of engineering practice and our own Sections has resulted in the holding of a large number of joint meetings during the season just closed. The largest of these meetings was that held in November 1916, when the Sections from Boston, New Haven, New York and Worcester and the Providence Engineering Society, affiliated with our Society, met with a number of engineering organizations in a visit to New London, Conn. There were over 1600 present on this occasion, and the event was described in detail in the December issue of THE JOURNAL.

The title of the Associated Technical Societies of Baltimore indicates that a plan of full coöperation of the engineering organizations has now been achieved in that city. In Buffalo our Section has coöperated with the Buffalo Engineering Society to the mutual benefit of both, while the Cincinnati Section is affiliated with the Engineers' Club of Cincinnati and takes charge of three or four of the joint meetings held each year. In Erie the Section has developed relations with the Engineers' Society of Northwestern Pennsylvania, and plans are being perfected whereby it will supply the speakers at two of the joint meetings of the season. Very cordial relations exist between the Minnesota Section and the other engineering societies of that state, and there have been joint meetings with the local branch of the American Institute of Electrical Engineers. The plan of affiliation of the Philadelphia Section with the Engineers' Club is working very successfully and Philadelphia is being pointed to as an example of coöperation of engineers. Joint meetings have been held during the year with The Franklin Institute and with the American Society of Heating and Ventilating Engineers. The meetings in Providence have been those of the Providence Engineering Society, affiliated with our Society. The Section meetings in New Orleans have been held jointly with the local branch of the American Society of Civil Engineers and the Louisiana Engineering Society. New Haven is organizing a Connecticut State Section to secure more complete coöperation, and a meeting of the Bridgeport branch of this Section has been held during the past month; the work in this state has developed a new field for Sections activities. In Atlanta the Section is coöperating with the Affiliated Technical Societies there. The Detroit Engineering Society and the local Section of our Society are working in complete harmony for the development of the profession in that busy center, and joint meetings are held by both organizations with the Detroit Branch of the Society of Automotive Engineers.

The reports from the various Sections of the year's work indicate more fully how this spirit of cooperation, of which the above are potent examples, is being developed. These reports show also how the Sections are joining with local branches of the other national societies in their meetings, and are thus carrying out in an equally effective way the work which the parent societies are endeavoring to do nationally.

THE SECTIONS AND THE SOCIETY

At the Annual Meeting in December the third Conference of Sections was held, when the official delegates of sixteen Sections and the representatives of five centers contemplating the establishment of Sections met with the Committee on Sections. One session was devoted to an "experience" meeting, at which each delegate reported the work of his Section during the past year and plans for the ensuing season. The conference led to a better understanding of the problems with which each Section has to deal and developed ways and means for their ultimate solution.

The Committee on Sections also held a luncheon and business meeting at the Spring Meeting in Cincinnati in May 1917, at which seventeen Sections were represented. That the coöperation of the Sections might be even more complete, it was urged at this meeting that there be an exchange of literature and notices of meetings between the Sections.

At the Spring Meeting, also, the Committee on Constitution and By-Laws presented an amendment to the constitution recommending that the Committee on Sections be made a Standing Committee of Administration of the Society and that it have a seat on the Council without vote.

A NEW DEVELOPMENT IN SECTION ORGANIZATION

The Connecticut members are developing a new method of section organization in the nature of a State Section, with branches at the important industrial centers of the state. Heretofore the requirements of the members of that locality were met by the activities of the New Haven Section. This Section has been holding two meetings annually for some time—one in the fall and the other in the spring. These meetings were held at Yale University, and through them the Society has grown in Connecticut to such an extent that a more comprehensive program has been found desirable. This movement has, in a measure, been prompted by a feeling on the part of the members in other localities of the state that it was unjust to continuously put upon the New Haven members and Yale University the burden of arranging the meetings, because all of the members of the Society in the state of Connecticut were always invited to the meetings of the New Haven Section.

The members of the New Haven Section have set an excellent example in coöperation by not only unselfishly stepping aside to make way for the State Section, but by taking a leading part in its development.

About three months ago a meeting was held in Bridgeport at which were present members of the Committee on Sections, Secretary Rice, a majority of the members of the New Haven Section, and a large number of members of the Society representing various parts of the state. At that meeting the following organization committee was appointed: H. B. Sargent, chairman, representing New Haven; C. K. Decherd, representing Meriden; Harry E. Harris, representing Bridgeport; S. F. Jeter, representing Hartford, and E. S. Sanderson, representing Waterbury.

A formal petition has now been submitted for the establishment of a Connecticut Section, with branches at New Haven, Bridgeport, Hartford, Meriden and Waterbury. Each branch will be governed by an Executive Committee of five members, the chairmen of the five branches composing the Executive Committee of the State Section.

The Bridgeport branch organization committee met on the evening of July 16 at the Algonquin Club, and tentatively selected the following officers: H. E. Harris, chairman; F. R. Pleasonton, vice-chairman; R. W. Ellingham, treasurer; E. L. Fletcher, secretary; C. W. Burges, chairman of Committee on Increase of Membership. The other proposed branches will soon organize, so that the whole scheme may be put into effective working order by the beginning of the new fiscal year, on October first.

NEW SECTIONS

New Sections have been established during the year at Baltimore, Erie, Indianapolis, New Orleans and Ontario, the headquarters of the last being at Toronto. This brings the total number of Sections up to twenty-one.

LOCAL ORGANIZATIONS

In several cities in which the number of members of the Society is not sufficient to organize a Section, the members meet together or with existing local organizations periodically. The accounts of these meetings have been published during the year with the regular Section reports.

The Committee on Sections is anxious to extend the benefits of the Society as rapidly and as far as possible. Obviously the initiative must be taken by the members themselves, and in those centers where the numbers and interest are sufficient to warrant meetings being undertaken.

The Society through the Committee on Sections is anxious to assist in the development of Sections work and makes appropriations to cover fixed expenses.

MEETINGS AND PAPERS

In the October 1916 issue an outline was given of the proposed Sections activities for the season. A report from each Section gave the number of meetings expected to be held, trips to be taken and entertainment features planned. As far as possible the papers which were to be presented were listed, thus giving a fairly complete program of the work laid out for the year.

To a large extent the programs in each city have been carried out as planned. In all 112 meetings have been held this season, and all have been reported in THE JOURNAL. Eleven of the papers presented locally have been published in THE JOURNAL.

THE SECTIONS AND VISITS OF OFFICERS

In the fall of 1916 President Jacobus and Secretary Rice made a tour of the Sections and of the centers where members were contemplating the formation of Sections. President Jacobus delivered an address in Buffalo on the relations existing between the parent Society and its Sections and on coöperation between the Sections and local engineering societies and clubs. The places visited were Meriden, Pittsburgh, Cleveland, Buffalo, St. Louis and Baltimore.

In January of this year President Hollis visited the Sections at Detroit, Chicago, Milwaukee, New Orleans, Birmingham and Atlanta. President Hollis's message to the Sections was service of the individual to society. In March Dr. Hollis made a

second tour which took him as far west as the Minnesota Section, whose headquarters are at Minneapolis-St. Paul. En route he visited the Sections at Buffalo, Chicago and Indianapolis, receiving a rousing welcome from all. His spirited address on Service to the Country in This Crisis brought forth enthusiastic responses. He has also spoken before the members of the Sections at Boston, New York, Philadelphia and Worcester, and the Providence Engineering Society.

In April Secretary Rice supplemented President Hollis's visits by a tour to the Sections at Cincinnati, Chicago and Milwaukee, and to Madison and Oklahoma City.

The President expects to make a trip to the Coast in the fall and visit the Sections there.

SECTIONS REPORTS FOR THE YEAR

At the close of the season's work the Sections have sent in reports to headquarters giving detailed accounts of their work. Some of these reports are published below and the remainder will be included in the next issue of The Journal.

The thanks of the Society are due to the Executive Committees of the Sections whose terms of office have just expired, for the personal time they have devoted and labor spent in continuing and fostering this very important activity of the Society. To maintain the full measure of coöperation and of amicable relations with other engineering societies which the Sections enjoy calls for the exercise of a great deal of tact and perseverance on the part of committee members, and the Society has cause for congratulation because of the fine spirit in which this work has been conceived and carried out during the past season.

Sections Reports

BALTIMORE

The Baltimore Section was organized at a meeting on October 19, 1916. President Jacobus and Secretary Rice attended the organization meeting.

In organizing the Section it was realized that its work could be made much more effective if the mechanical engineers could secure the coöperation of all the other engineers in the city. It was felt that a joint organization of engineers in Baltimore would tend towards greater interest in each particular section and also in matters of general engineering interest. Steps were therefore taken at the outset to bring about such a coöperative organization. Following a number of conferences the Associated Technical Societies of Baltimore was formed of all local technical societies and the local sections of the national engineering societies. Each local organization invites members of all sections of sister societies to all its meetings, except those of a strictly business character. It is hoped that later on this association may develop a close union and that the joint organization will be one of considerable influence.

The first year of the Section's activities has been marked with many meetings of interest with such subjects and speakers as Work of the Navy Experiment Station, by W. F. DeBaufre, Mem.Am.Soc.M.E.; Recovery and Use of By-Products from Coal Tar, by F. H. Wagner, Mem.Am.Soc.M.E.; Flow of Values Through an Industrial Plant, by Harrington Emerson, Mem.Am.Soc.M.E.; Safety First on the B & O, by J. T. Broderick, and Munitions and Preparedness, by Alten T. Miller.

The formation of a Section in this city has stimulated interest in the Society, as evidenced by the increased membership during the past year; it has also encouraged the formation of a Student Branch at Johns Hopkins University.

The outlook for next fall is most encouraging and it is anticipated that the four meetings already planned for next winter will prove of even greater interest to engineers than those of the past year.

C. C. Thomas,
Section Chairman.

BUFFALO

The Engineering Society of Buffalo was organized in 1912 from a group of members of the A. S. M. E., and by a sturdy growth it has absorbed the entire activities of the local Section. The *why* of the E. S. B. is "coöperation," the greatest force in the world today.

Today the society has a membership of over 500, comprising the various branches of professional engineering, mechanical, electrical, chemical and civil, all of which are splendidly represented. The society believes that the intermingling of engineers of somewhat different interests is broadening to all, and conducive to the greater effectiveness of the influence of engineers on questions affecting the general public welfare, as well as to the advancement of the profession nationally.

Every two weeks during the months of October to May, inclusive, meetings are called in the Hotel Statler, and the average attendance is about 200. Preceding each meeting a dinner is served to promote social intercourse of members and their guests.

Bulletins are prepared announcing all meetings, and for special meetings display posters are used. Return postal card notices of meetings are also forwarded to all members.

A practice is made of inviting the more prominent business men and heads of manufacturing establishments to the meetings.

Each year there has been an increase in interest and attendance at these meetings, but the season just closing has been marked by more ambitious programs and an even more enthusiastic attendance. In arranging the program for the year special attention was given to securing subjects of general rather than specific technical interest in order to stimulate enthusiastic support from the entire local membership. An analysis of the program shows that effort has been concentrated upon making the subjects as broad as possible, and also of special interest in Buffalo and its vicinity. A similar series is being planned for next season.

John Younger,
Section Chairman.

NEW YORK

Following out the plan inaugurated toward the close of the preceding year, the activities of this Section were carried out along three distinct lines: namely, the regular monthly meetings, at which papers or addresses were delivered; social evenings under the direction of the Entertainment Committee, and excursions arranged and conducted by the Excursion Committee. In each of these activities the Acquaintanceship Committee assisted, and informal suppers before the monthly meetings were also effective in getting the members better acquainted.

The regular meetings were divided between technical papers and those of a semi-popular nature, the latter this year being chiefly on military topics. The technical papers were The Development of the Poppet Valve Steam Engine, by Siegfried Rosenzweig; Standards of Business Success, by Earle Buckingham; Narrow Gage Motor Cars, by C. W. Hunt, and an address by Dr. Ira N. Hollis. Among the semi-technical were those on Explosives, by Charles L. Reese, of the E. I. Du Pont de Nemours Powder Co.; Submarines, by Mr. Charles H. Bedell of the Electric Boat Co.; Mobile Armaments, by Andrew M. Coyle, and an address by Commander E. P. Jessop, U. S. Navy.

The average attendance was about 300, with a notable increase of the younger members of the Section.

During the first half of the year the Excursion Committee, under the direction of its Chairman, carried out a number of interesting and instructive Saturday-afternoon excursions, the largest of which was the trip to the submarine base at New London, in conjunction with the Boston, Providence, New Haven and Worcester Sections; 700 members and guests of the New York Section journeyed by special train on this excursion. The committee also conducted the excursions at the Annual Meeting. Unfortunately the war condition has prevented carrying out the plans of this committee during the latter half of the year.

Among other activities of the Entertainment Committee may be mentioned an informal smoker held early in the season, and a dinner-dance at the Machinery Club in April, both of which were largely attended.

H. R. Cobleigh,
Section Chairman.

PRESENTATION OF THE JOHN FRITZ MEDAL

THE John Fritz Medal, awarded to Dr. Henry Marion Howe in January of this year for his "investigations in metallurgy, especially in the metallography of iron and steel," was presented to him in the Auditorium of the Engineering Societies Building, New York, on the evening of Thursday, May 10.

Mr. Ambrose Swasey, Chairman of the John Fritz Medal Board of Award this year, presided at the ceremonies, and addresses were delivered by Dr. Rossiter W. Raymond, Secretary Emeritus of the American Institute of Mining Engineers, and Dr. Ira N. Hollis, President of The American Society of Mechanical Engineers.

Prof. Albert Sauveur, Chairman of the Board at the time the award was made, presented the medal, and the ceremonies concluded with the response of Dr. Howe. A full account of the proceedings at the meeting is given below.

HENRY M. HOWE

MR. SWASEY WELCOMES THE FRIENDS AND MEMBERS OF THE ENGINEERING SOCIETIES

In welcoming the friends and members of the engineering societies, and in introducing the first speaker of the evening, Mr. Swasey said: "It is a happy privilege that we can meet here this evening to honor one of our number who has distinguished himself in the profession of engineering, and that we may call to mind that splendid, noble character for whom the medal to be presented this night was named, and for whom it was established, and also call to mind the number who have received the medal as the years have gone on.

"I am sure we can but feel that this has been an elevating influence, a broadening influence, and that today, because of the John Fritz Medal, the engineering profession in this country occupies a higher plane and has a broader horizon than ever before. It has brought the different sections of the engineering societies together in a more coöperative way than has been in the years before, and I am sure that we all rejoice that these medals are awarded as we go along through life. I would that dear Mr. Fritz could take a part in and know of the work that is being undertaken in his behalf and in his name, in which he was so much interested.

"I remember one day we went down to the studio of the sculptor and he was extremely interested in the model for the medal which is to be presented this evening. He took much interest in every detail, not only as to the obverse, but as to the reverse side of the medal. In many ways he was identified with this work, and it is a great pleasure to think of him, of his sweet ways, and of the interest, not only as a great engineer, but of the great broad man he was in every respect, and I may say that we appreciate the noble works of those who have received the medal since his day, and we are glad to have one of the medalists with us here this evening in addition to the one who is to be the recipient of the medal that is bestowed this evening.

"I am sure you will be interested to have me read the names of those who have received the medals from time to time:

"The first was John Fritz, then came Lord Kelvin, George Westinghouse, Alexander Graham Bell, Thomas Alva Edison, Charles Talbot Porter, Alfred Noble, Sir William Henry White, Robert Wilson Hunt, John Edson Sweet, James Douglas, Elihu Thomson, and this evening Henry Marion Howe.

"This certainly is a splendid list of members and a great honor roll. Many have passed on, have ended their work here, and others are still going on with the work, but the names and the memories of those who have passed away still abide with us, and now this evening as we take up the ceremonies of presentation of the medal, I am going to first call upon one who needs no introduction, because you all know him because of the splendid work that he has done, for what he has accomplished for the engineering profession. We all have a deep affection for him, and therefore I am going to simply present to you Dr. Raymond."

DR. RAYMOND PRESENTS A FITTING TESTIMONIAL TO THE ACHIEVEMENTS OF PROFESSOR HOWE

Dr. Raymond, with his intimate knowledge of the life and the work of Professor Howe, delivered a very interesting and forceful address which is reproduced in full below:

"The genesis of a new science or branch of science is in this wise: First there is the invention of some new means or method of investigation, such as the chemical laboratory, the telescope, the microscope, or the spectroscope, followed at once by an innumerable host of startling, confusing, mostly qualitative observations. Such an invention reveals to mankind a dazzling but vague new world, the very existence of which was scarcely suspected before, and the indefinite outlines of which inspire poetic generalizations, and vast hypotheses—beautiful if true—beautiful, indeed, irrespective of their truth.

"Then comes the long period, less thrilling yet not less meritorious and even more important, during which the means and methods of observation are rendered more precise, and the recognition of differences more minute. At the same time, the older data are revised, corrected, and assorted—many,

probably most, of them, being rejected. This is the stage of preparation of the raw material of the science; and it is characterized in every science by the accumulation of a well-nigh intolerable burden of distinctly separated facts. But this burden must be patiently borne, and the separate units of which it is composed must be delimited, measured and weighed, in order that the mathematical, that is, the quantitative, character may be impressed upon them. Illustrations of this principle will occur to all who have followed the growth of any science.

"General Myer, the creator of our U. S. Weather Bureau, once told me that when he began to organize that service at Washington, he found in the garret of the Smithsonian Institution tons of old papers containing 'weather observations' contributed by public-spirited citizens all over the country who had heroically got out of bed at certain hours to read their thermometers, rain gages and weathercocks and anemometers. But nobody had tested or standardized their apparatus, and nobody guaranteed its freedom from accidental aberration or mischievous meddling.

"I have heard also of a great German mineralogist, who made many thousand measurements of crystals, and based upon their varying angles some beautiful hypotheses. But after his death, another mineralogist tested his goniometer, and found in it defects which vitiated his observations.

"Such are the pseudo-materials of science, which must be got out of the way before safe induction can begin. But even really scientific data may present, during the stage of verification and inchoate arrangement, an overwhelming complexity, which threatens to smother a new science in its cradle. Take, for instance, the condition of biology before Wallace and Darwin. Everybody was furiously busy detecting differences, and founding upon them the definitions of new species; and the mere catalogues of species were beyond the student's comprehensive grasp. We all remember the universal sigh of relief with which the scientific world, welcoming the Darwinian hypothesis as its new guide, began to study similarities and relationships instead of differences, and saw the incalculable multitude of individual species group themselves in a grand order, illuminated by a new law.

This emergence of a general formula from a chaos of equations marks the final stage in the genesis of a science. That is not the end, but only the beginning, of its history. It must still grow by accretion, subdivide by fissile separation, and establish its relations to other sciences. And at every step the operations of observation, verification, criticism, analysis and synthesis must be repeated, just as the embryo rehearses in miniature the history of a species.

"It follows that the stages of development which I have indicated, though they may seem, on the large scale, to follow one another, really go on *pari passu*. There is no time at which any one of them ceases. Yet with regard to a single and limited branch of scientific inquiry, their existence and succession may be clearly discerned.

"It is my difficult but honorable and welcome task to set before you an outline of the work of a master who has contributed mightily to all these phases in the growth of the new science of metallography; as a discoverer and observer, as an industrious compiler, and as the builder of a noble edifice out of the materials thus gathered and prepared.

"It is not my purpose to give a complete biographical and bibliographical statement. But I must say here at least so much as will indicate the peculiarly fitting endowment and environment by which this life and its work were determined and perfected.

"Henry Marion Howe was born March 2, 1848, at Boston, Mass. His father was Dr. Samuel G. Howe, famous for his service to Greece in her war for independence (from 1824 to 1830) and later for his labors in the instruction of the blind. His mother was Julia Ward Howe, author of the Battle Hymn of the Republic, and leader in many reforms. He was of good stock on both sides, making him heir to intellectual keenness and refinement, the capacity for both enthusiasm and perseverance, a passion for the pursuit of knowledge, and a gift of clear and felicitous statement.

"This inheritance was improved by a liberal education. No matter how vehemently the business or scientific value of a 'college course' may be controverted, I notice that, without exception, the successful men who have had such a course are glad they had it, and those who have not wish they had. We may be sure that Professor Howe's easy command of his field in technical literature owes much to the circumstance that he was graduated in 1865 from the famous Boston Latin School, and, four years later, received his degree as Bachelor of Arts from Harvard College. Thus equipped, he entered the Massachusetts Institute of Technology, which gave him in 1871 the degree of Graduate in the Department of Geology and Mining Engineering—a cumbrous title for which the institution substituted, a few years later, that of Bachelor of Science. And Harvard made him Master of Arts in 1872, and Doctor of Laws in 1905.

"But upon this basis of wide and liberal culture it was necessary to his future achievements that he should lay another foundation of acquaintance with practice; and this he did during the next dozen years, as a student in the steel works at Troy, manager of works at Pittsburgh, and designer and builder of the works of the Orford Nickel and Copper Co. at Capleton and Eustis in the province of Quebec, and at Bergen Point, N. J. His experience in the metallurgy of copper bore legitimate fruit in the publication at a later period of his first book, Copper-Smelting; but before this appeared (in 1885) he had already become known through his technical papers as an acute observer and reasoner, by no means averse to friendly controversy.

"Since it is my present duty to offer not so much a symmetrical and complete account of Professor Howe's activities as a description of the particular labors in recognition of which he receives today from his brother engineers the John Fritz gold medal, I shall pass lightly over the general features of his career, merely observing that from 1883 to 1897 he resided at Boston, and, besides his private practice as a consulting metallurgist and expert witness in metallurgical patent suits, was lecturer on metallurgy at the Massachusetts Institute of Technology; that in 1897 he was called to the professorship of metallurgy in Columbia University, from which position he retired in 1913 with the title of Professor Emeritus; and that for the last ten years he has declined as far as practicable all professional business, in order to devote himself exclusively to the completion of what had clearly become the great scientific mission of his life. To this end, he has maintained at his own expense a special laboratory of research.

"It gives me pleasure to fancy, whether or no the fancy be also fact, that I remember the beginning of that mission, forty-odd years ago. In 1871, the first year of the existence of the American Institute of Mining Engineers, Mr. Howe, then just graduated from the Massachusetts Institute of Technology, became a member of the new organization. His two earliest contributions to its Transactions, Blast-Furnace Economy, in Vol. III, and Thoughts on the Thermic Curves of

Blast Furnaces in Vol. V, indicated already that he was making a scientific study of practice. But between the dates of these papers a famous controversy was inaugurated in the forum of the Institute by the brilliant paper of Alexander L. Holley, *primus inter pares*, entitled What Is Steel? In this controversy, eminent metallurgists like Wedding, chemists like Prime, and expert captains of industry like Metcalf, vigorously took part; but of all the knights in the tourney, none rode a straighter course or laid in rest a sharper lance than Howe, whose paper on The Nomenclature of Iron ardently advocated a scientific as distinguished from a commercial nomenclature. To tell the truth, the battle had a commercial origin. The real question at issue was not, What *is* steel? but, What may fairly be called steel at the custom house? And the technical reputation of the Institute was invoked by one party in favor of a convenient, practical, industrial classification which would relieve importers from the expensive refinements of science.

"Well, there was even an international committee on the subject, and the committee made a report, and the report was not adopted by the Institute, except provisionally for optional use in its publications, because the Institute was wisely deemed to be an arena of discussions and not a tribunal of decisions. Never was a more fortunate position assumed, for the great question was left open, as it should be always. The tariff difficulty was adjusted somehow; the antagonists shook hands; the thunder of the captains of industry and the shoutings died away. But one man continued the inquiry fiercely in his own soul. Henry Marion Howe, before whom the dust of the controversy loomed like a giant Afrite still defying attack, devoted his life thenceforward to the mighty conundrum, What is steel? That he has spoken the last word—even his own last word—on the subject, no one would venture to say; but certain it is that he has brought us to a degree of knowledge the very existence of which was scarcely dreamed in 1876.

"It is curious that at that time he insisted upon the capacity of steel for hardening as an essential element in classification. For it was through this door—the study of the conditions and nature of the hardening process—that the advance was to be made into the wider field of knowledge. And the instrument of knowledge was to be the new science of metallography.

"That science, at least so far as it relates to iron and steel, may be said to have begun with the observations of Sorby on the microstructure of iron, reported in 1864 and 1868. Martens published independently in 1878. But already in 1868, Tschernoff had enunciated the chief laws which govern the metallography of iron. These were supplemented by the appearance in *Stahl und Eisen*, 1885, of Brinell's laws. All these creditable steps of progress were rendered more or less uncertain and incomplete by the imperfection of the apparatus and methods of precision, by consequent errors of observation, and by gaps in the data—though the aggregate quantity of material was already overwhelming. Then came in 1887 and subsequent years the remarkable investigations and intuitions of Floris Osmond, who discovered that metals frequently combine to form definite chemical compounds, and that these compounds frequently form solid solutions. He discovered also the thermal critical points of iron, and, interpreting these changes in the cooling curve as indications of some molecular change, propounded the brilliant hypothesis of the allotropy of iron which furnished the acceptable allotropic theory of the hardening of steel. To him, as Professor Sauveur remarks in his Biographical Notice of Osmond (Trans. A.I.M.E. xlv, p. 274), we owe likewise the discovery of austenite, the non-magnetic solid solution of iron and carbon existing above the thermal critical range, and the transition constituents, martensite, troostite and sorbite, marking as many distinct and important steps in the transformation, on cooling, of the solid solution austenite into the ferrite-cementite aggregate.

"This brings us to the date of Howe's first book on the subject; and the history of the new science, as I have already sketched it in general terms, is epitomized in the essays and books of Professor Howe from the appearance of his Metallurgy of Steel in 1888 to that of his Metallography of Steel and Cast Iron in 1916. The first of these books was an amazing accumulation of reported facts, tabulated, verified and explained as far as was then practicable. The last is an equally amazing array of facts, but now sifted, tested, logically arranged and luminously interpreted, exhibiting not uncomprehended differences, but significant similarities and relationships. The first was a heap, parts of which had been sorted; the last is an edifice. To produce the first required intelligent and inexhaustible industry and critical discernment. The second exhibits the creative genius of an architect. Between the two lies the history of a science, to every stage of which this builder has made some important contribution. Let me mention a few of these, under the heads of invention of improved methods; discovery of new facts; testing of data; and correlation and interpretation of observed phenomena. I shall not pretend to comprehensive completeness in this survey. I must be content with the exhibition of typical samples.

"One of the new methods invented by Professor Howe is that of determining the microstructural and other conditions which exist in steel at high temperatures by fixing those conditions through the process of quenching—a method which has been generally adopted, and by the use of which much clearer and more trustworthy results have been obtained than were formerly possible.

"Among his discoveries of new facts may be mentioned the isotropy of the effects of plastic deformation (announced in 1888, and supported in 1914); the possibility of effacing blowholes in soft steel by welding (1909); the relations of graphite flakes in cast iron, representing, not complete discontinuities of the metal, but only the filling by graphite of the interstices in ferrite skeletons; and the crystallography of the slip planes (Metallography of Steel and Cast-iron, p. 327).

"But this investigator kept himself acquainted with the discoveries of others. In 1893 he confirmed by rigorous experimental proof the brilliant hypothesis of Osmond that the transformations in steel represent the alternate acquisition and loss of hardening capacity.

"Under the head of testing and verifying data, I would name the rigorous analysis of the so-called Clapp-Griffiths process; the demonstration that the chief benefit of rolling and forging is due to the low finishing temperature rather than to the degree of mechanical reduction, as formerly believed; and the striking demonstration that the results of one of the most important investigations of the gas evolved from iron were wholly vitiated by the leakage of the apparatus. All these may be found in the Metallurgy of Steel, which contains also analyses of the conditions of dephosphorization, of the chemistry of the crucible process, and of the technique of Bessemer practice.

"In a remarkable paper on the structure of steel, contributed to the proceedings of the American Society for Testing Materials for 1911, Professor Howe collected into the

form of propositions or laws the observed relations of heat treatment to the microstructure and mechanical properties of steel. In that paper he enunciated twenty-three of these laws; and had he then ceased from his labors, his work would have followed him as an imperishable record indelibly carved upon the history of science. But he was destined to go still further during the five years which followed. His latest book, The Metallography of Steel and Cast-iron, published in 1916, occupies intellectually a higher plane than its predecessors, by which I mean that it commands a wider outlook, permitting grander generalizations, and the recognition, in due perspective, of causes, effects and relations. This book, in short, exhibits that simplification which I have described as following the stage of maximum complexity in the development of a science. Its very title, coupling steel with cast iron, expresses the maturer view which includes both in one continuous series, subject to the same laws—a significant conclusion of the controversy which began with the contention that steel was not cast iron. Not that the difference has been disproved but that a higher unity has been shown to embrace it. Such is indeed the normal end of controversy—'peace without victory' through agreement on a higher level.

"This book is not a textbook, repeating what is generally accepted already. Covering the field in which others have meritoriously labored, it propounds, suggests and prophesies new truth and new views of truth. It is a product of the two kinds of genius, the genius which consists in an infinite capacity for taking pains, and the genius which with happy intuition surveys, divines, coördinates and interprets the cosmos in the chaos.

"That my estimate of the work of our great American colleague, as summed up and set forth in this book, is not merely an expression of personal affection or patriotic pride, let me prove by one or two opinions from eminent authorities.

"I would quote first a few paragraphs translated from a review of the book by Professor Le Chatelier in the *Revue de Metallurgie* (Vol. xiii, No. 2, March-April, 1916):

> The new work of Mr. Howe is entirely original. It has nothing in common with the numerous treatises on metallography which have appeared during the last ten years. Whoever has read one of them has read them all. Here we have to do with the personal observations and views of the author. As he indicates in his preface, he has written this treatise, not to state the solidly established principles of a young science, but to cause the creators of that science themselves to think; to open before them new horizons. Hence he has not feared to announce theories sometimes a little hazardous. . . .
>
> This study will make an epoch in the history of the progress of science. It represents many years of uninterrupted research, but for a much longer period it will certainly be consulted by investigators with fruitful results.

"The following remarks are taken from a similar review by H. C. H. Carpenter, Professor of Metallurgy at the Royal School of Mines, South Kensington, England:

> It is quite safe to say that Professor Howe's book will at once take its place as an authoritative, and indeed, classical, exposition of the field of knowledge with which it deals. From whatever standpoint it is judged, it is a great book—great in its power, lucidity, balance, comprehensiveness, and preëminently scientific character.

"In a private letter, written with reference to the announcement that the John Fritz medal was to be conferred upon Professor Howe, the same distinguished author says that he believes no award could have given greater pleasure to the metallurgists of Great Britain, who look upon Professor Howe not merely as the *doyen* of metallographists in America but as their most distinguished representative; 'a worker whose single-mindedness in the pursuit of truth is an example to us all, and whose conscientiousness gives to his publications a character of their own.'

"Finally, I take the liberty of quoting from a private letter received by me from a no less eminent American, Prof. Albert Sauveur himself, who, as the President of the Board of Award, bestows this medal tonight:

> Professor Howe, in his recent masterly book on The Metallography of Steel and Cast-iron reviews exhaustively and examines critically, as he alone can do, every view at all worthy of recognition, dealing with the subject he covers. I believe that any responsible author who has ever expressed a reasonable opinion on any subject dealing with the metallography of iron and steel will find his views recorded and discussed in this book. Professor Howe then proceeds to weigh with great fairness and extraordinary intelligence and lucidity the arguments or evidence supporting the different views, and draws his conclusions accordingly. His method is that of a mathematician solving a problem in which each factor is given its proper value. In this way, Howe has rendered to metallurgists an inestimable service; and he alone could render it. Where most of us could see only chaos and obscurity, he is able to bring order, and to discover the light that, under his skillful manipulation, soon illuminates the darkest corners. . . .
>
> This, I think, is his greatest achievement—the marvellous coördination which he has brought into the science of metallography through his genius and his labor, tremendous in quantity, marvelous in lucidity. To him more than to any one else we owe the quick rejection of weak or ill-supported theories in favor of the survival of the fittest—a process so necessary to the advance of any branch of human knowledge.

"To these expressions of individual and representative opinion should be added the numerous formal honors bestowed upon Professor Howe by institutions and governments in many lands. England, France and Russia have each conferred three of these recognitions, while others have come from Germany and Sweden. And, last but by no means least to his patriotic heart, come two announcements, received since I began the preparation of this address, the one, of his election as a member of our National Academy of Sciences; the other, of his selection as one of the charter members enumerated in the proposed Act of Congress incorporating the American Academy of Engineers.

"Thus the applause of two continents attends the act of the John Fritz Medal Committee in selecting Henry Marion Howe as a recipient of that great honor. And the act has also another significance. It is a recognition on the part of engineers that the microscope and the test tube have become the tools of engineering. Indeed, when we remember that the strength of materials is the alphabet of every branch of engineering science represented by the givers of this medal, we must admit that the man who with microscope and test tube analyzes the causes and determines the conditions of that strength is among the greatest of engineers.

"While this testimonial is bestowed by engineers, I cannot forbear to utter my satisfaction that it is received by one who is more even than an engineer; whose many-sided patriotic and literary activity is typical of this age, in which engineers are, as St. Paul said of the Gentiles, 'no more strangers and foreigners, but fellow-citizens with the saints.' If we may say of him, as Johnson said of Goldsmith, '*non tetigit quod non adornavit*,' we may almost add, '*non est, quod non tetigit*.'

"And so we crown to-day with grateful pride, not only the leader, but also the comrade and friend!"

DR. HOLLIS EULOGIZES THE RECIPIENT OF THE MEDAL

Expressing his opinion that the spirit of the meeting should lead us to a new dedication of ourselves to the service of mankind, Dr. Hollis said: "It is not only a privilege, but also

an honor, to have a share in the award of the John Fritz Medal to Henry Marion Howe for his contributions to applied science. This medal as a recognition of achievement in applied science has completely justified itself if it has served no other purpose than to record in this admirable way the practical service to science. But it does more in calling attention to the great value of research. The popular conception of invention as a mere happy guess or thought has led many into a totally false conception of the method by which applied science has grown. As a matter of fact, practically all of our advancements have been the results of patient study and research, the work of developing a thought always being the harder and better part of it. In calling attention to the method by which Mr. Howe's great work has been accomplished, this meeting serves to educate and to clear the popular mind on the true value of scientific research and of the abstract study of all science. Not one of the recipients of the John Fritz Medal has earned his right to distinction by mere thought. Each one of them has worked, and worked steadily through his life, with some definite end in view, usually without much thought of the money side of his discovery. In this respect Mr. Howe is a worthy successor of all those who have preceded him on this honorable list. His work has been done quietly and modestly without the help from daily papers that has become so disturbing and, in some cases, so disastrous a part of the scientist's achievement in these later years. He is not only a fitting successor to all the men who have received the same honor, but he is also beyond all others of the same family as John Fritz. No professional man has ever earned lasting fame who has not obtained it through the high respect of those in his own profession. It is not the printing press and the public who make the reputation of a great man, but rather his companions in the profession who understand his work. Mr. Howe is thus singularly happy in the friends who have gathered around him tonight to rejoice with him. They will remember and understand well what he has done for the science of metals and for his country as well. As a teacher, a writer, and a scientist, his life is a speaking example of science wisely and unselfishly used in man's service. He has given and published freely his discoveries and his ideas on steel so that all his fellow citizens might benefit alike. There has been no touch of the baneful search for power through money. Without being an announced leader in scientific management, his work in teaching the industries the value of special steels, in adapting the means to the end, has been a great contribution to safety and efficiency.

"He has pointed out the path. Sometimes by simply indicating where the path enters the unknown, a teacher opens the way and leads others from traditional methods to new and better things. Life is made up of wandering pathways, and some great pathfinder stands at every parting. James Watt was at the beginning of modern industry, George Corliss at the first great departure in the economical use of steam, John Fritz lived to see his work culminate in the great Bethlehem Company. All the others on the list of medalists have found themselves at the beginning of an era in their subjects and now Henry Howe joins these immortals who have stood as the great teachers and pathfinders of mankind.

"Nothing that I can say here will add to his reputation. That is written in his books. This great meeting should, however, lead us to a new dedication of ourselves to the kind of service so much needed toward the rational life of man of this planet.

"Science has three aspects: first, to discover truth and follow it; second, to employ the forces and materials of nature for the good of all mankind; third, to set us into closer accord with the will of God.

"It is not necessary to dwell on these, except perhaps the last, which is the only pure science that we have. In these days of struggle for power, in these days when the white races are using their scientific knowledge to weaken one another, to destroy one another, it is well for us to search our hearts for those things in which science has been found wanting. At times we have made a god of it, with the thought that it alone has brought the human race out of darkness, that it has dispelled the shadow of superstition, and by promoting the well-being of man it has formed a true civilization. We sometimes forget that no civilization can continue to exist in an unbalanced condition. Science alone would make of this a hard, cold world, just as all intellectuality without heart tends to mere machinery. There are always two sides to a shield. Well-being and comfort without the spirit of self-sacrifice destroy rather than promote an enlightened civilization. It is well, therefore, on an occasion like this to give some thought to the religious side of life, and by religious I mean that kindly spirit brought into the world by Jesus Christ 1900 years ago. Nothing that the world has done or that science has produced is comparable with His one precept as the chief motive by which men can live. We may consider this great struggle going on in Europe, into which we ourselves are plunging, as the greatest thing that ever happened in this world, and yet it is insignificant by the side of that appealing life that ended on the cross so many centuries ago. 'Love thy neighbor as thyself' is the best inheritance of the race, as it is the chief hope of the future. Science is valuable only in so far as it vitalizes and strengthens that one principle, because we care nothing for new inventions, we care nothing for the comfort of men, and we care still less for the possible support of a greater population, if the soul be dead. Only so far as science promotes true democracy (not political democracy) and that love of men which will make wars impossible and eventually turn the lawyers into farmers is it worth while. In 1900 years it has done something toward making possible Christ's reign on earth. The famine areas of the earth have been reduced by the development of transportation and the communication by telegraph. Where there is a shortage of crops, we can quickly rush aid and supplies, and the world is generally willing to give a small percentage of its gain. It has remained for science to develop the most effective method of destroying the whole yield of a harvest, and plunge it into the bottom of the sea, so that it is only just to say that the human race has developed no international conscience. The organization for relief is still in its infancy, and there is only enough Christianity left to provide help more or less spasmodically. Another direction in which science has promoted Christianity is in preventive medicine, and in hospitals that have been established for all kinds of infectious and inherited diseases.

"But, after all, we have just touched the fringes of a real civilization, in which righteousness will be the guiding principle for nations, as well as for men. When the best minds are devoting themselves to the invention and construction of machinery and chemicals for killing men on a great scale, we are very far from loving our neighbors as ourselves. Science has therefore done as much to enslave as to emancipate, and we have not yet learned that its votaries are worshipping only half of the truth. Unless the engineer and those who profit through his work can be brought to realize that everything produced through science is held in trust for humanity, we shall make no progress. Our country will be plunged more and more into that

lethargic, luxurious state which can be cured only by the shedding of blood. Already we feel in this war a certain impulse of regeneration, and we need it. Our country has been called 'dollar mad' by Europe. Almost everything is judged from the one single basis of money. A book is good only if it sells. Fortunately there is one place into which this surrender has not penetrated: that is the teaching profession, and Mr. Howe's life well illustrates the kind of altruism that will bring us a happy regeneration, and a more lasting peace than we shall ever get through the blood of war. A better democracy must come through science. Men must learn to be ashamed to accumulate wealth through invention. No privilege by birth and no inheritance through the patent office should stain our democracy. No king can love his neighbor as himself, no great land owner who has the peasant on his farm can ever feel that the creature who toils is exactly like himself. This great war then is a war against false doctrine. Its end must be that greater democracy which teaches men unselfish service to one another, without which the race is not worthy to remain, and without which it ought to disappear. Only so far as science strengthens righteousness will it contribute to the great task before us as a free people.

"We see some signs in our country of a true enlightenment. The wealthy desire to give. Our privately owned colleges and schools are supported in large part by generous men who believe that their wealth is a public trust. It is only a gleam of light, however, for the percentage of giving is extremely small, and our problem will not be solved until we attain that enlightenment which makes it a duty for every man to give. We must think of invention and science and wealth as the mere instruments through which the individual is enabled to benefit the race. It is important that we should consider this whole question now, because the treaty of peace that must eventually come will ask for an answer. Science and Christianity must join hands to find some means by which the problem of a larger life can be solved between nations, as between individuals.

"Our profession has an ethical purpose, and it will fail if it does not see clearly that its place is not with science alone. Under various names it has been the one great constructive profession since reason began to develop in the creatures on this earth. Its history is practically the history of the human race. The political struggles have but recorded the advance of science in one form or another. To us as a profession, therefore, is confided the great task of enabling men to live on this planet under the theory that the highest happiness is attained through love, rather than through force. Organization is a science, as important as the machine. Life itself is the greatest of sciences. We must contribute our share.

"My chief reason for dwelling on the moral aspect of science, especially on that side of it which promotes the practical application, is that Mr. Howe's career well illustrates the motive that must always lie behind the engineer's work, if our profession is to live and to be found worthy."

PROFESSOR SAUVEUR THEN PRESENTS THE MEDAL. ADDRESS OF PROFESSOR SAUVEUR

Professor Sauveur made a brief introductory allusion to the municipal reception of the French mission, at that moment taking place at the Public Library. He thought it a happy coincidence, in view of Professor Howe's early, earnest and persistent advocacy in public and private of the cause of the Entente Allies. Then, turning to the subject of the evening, he continued: "After what you have heard there can be no doubt left—if any doubt ever existed—in anyone's mind as to the wisdom and discrimination exercised by the John Fritz Medal Board of Award in selecting its medalist for 1917.

"There is nothing that I could add to what has been so ably—yea, so brilliantly—told by Dr. Raymond. To me, however, as Chairman of this Board at the time the award was made, is assigned the delightful duty of actually presenting the John Fritz Medal to Professor Howe.

"Henry Marion Howe, son of an illustrious father and of an illustrious mother,

Lover of justice and of humanity,

Public servant and public benefactor,

Master of the English language,

Loyal and devoted friend,

Untiring and unselfish worker in an important field of science,

Stimulating teacher, inspiring investigator and generous collaborator, hundreds have been guided by the light radiating from your pen, encouraged by your kind words, dazzled it is true, but also stirred to further and more vigorous efforts by the heights you reach,

Voyager in realms but dimly perceived by your fellow-workers,

Lone explorer of fields destined to yield rich harvest to future generations,

Man of genius, honored and loved the world over,

By authority of the Board of Award, I now place in your hands the John Fritz Medal."

REPLY OF PROFESSOR HOWE

"It is not to me but to the bright unbodied image which you have created, to the foster child of your chivalry and your leniency, that these more than generous words apply, that this noble memorial is due. I thank you from the bottom of my heart on his behalf, while on my own I thank you as warmly for his acquaintance, for the hope that it may kindle into an inspiring friendship, letting me 'grapple him to my soul with hooks of steel,' and above all for this incitement to further and vigorous striving, holding with Ulysses that

> 'Old age hath yet his honor and his toil;
> ————————something ere the end,
> 'Some work of noble note may yet be done.'

"To prolong thanks is so thankless that I might well now hold my peace were it not for the world crisis, ever in our consciousness. This so presses for our best thought that attention to other matters suggests fiddling while Rome burns. For Rome truly is in flames. We are as a family in a burning home. Democracy itself is at stake.

"This conflagration should arouse Americans all the more because it is a necessary and integral part of the train of events which our forefathers started when those

> 'embattled farmers stood,
> And fired the shot heard around the world.'

"In that shot was stored the whole process of the liberation of man, including today's tragedy, as surely as the history of the oak, its growth, its majesty, and its fall, are stored in the acorn. The example of our freedom not only incited the more plastic peoples to democratization as in France and Britain, but also started a process of selection leading straight to this death grapple between democracy and autocracy. For by selection those most impatient of despotic control, those of greatest initiative, in short the most independent from all other

lands, emigrated to us and to the other democracies induced by our example, leaving as a residuum the less independent, the more docile.

"The democratizing impulse of our example, aided as it was in France by hunger and by outraged manhood, and in England by royal fatuity, was irresistible. But in Prussia it was so far weakened by material comfort created by the skill and craft of her kings that it failed, and in failing exaggerated this process of selection.

"That failure found the Teutons without those influences which in France and Great Britain temper the selection by emigration, the inborn domesticity of the French, and the closeness of the ties between Britain and her colonies, which leads great numbers of her sons to send their children back to school, and to return to the motherland later in life when their adventurousness has spent itself, thus restoring to the nation much of its more adventurous blood which the dreams of youth send abroad. Because Germany was intensely autocratic and without hope of democratization, she lost by emigration not only the most adventurous and independent, but even a vast number of those of intermediate independence, to our great gain. Thus the mean docility of the residuum was exaggerated. Because Germany lacked colonies these emigrants identified themselves with the countries to which they went, and renounced allegiance to their land of birth, so that the submissiveness of those left at home was undiluted by the return in later life of the more independent stock.

"It is this exaggerated docility, resulting thus irresistibly from the selection started by our liberation, that has led to this terrible struggle. For it has enabled the Hohenzollerns and Hapsburgs, through their Nietzsches and their Treitschkes, through a cunningly devised state education appealing to all the baser motives, to ensnare the Teutons, drunk with vanity and new riches, in the intellectual slavery implied by their adopting the monstrous doctrine that might makes right, with all its sickening corollaries, its frightfulness, its foulness, and its treachery,

> 'hideous as the deeds
> Which you can scarce hide from men's revolted eyes.'

"It is this docility, with the resultant intellectual enslavement, that has enabled these autocrats to weld their people into a mass so coherent, so blindly unquestioning, as to strike with an initial force wholly disproportionate to their numbers when compared with those of democracies, whose units, however strong individually, cohere but feebly in every-day life because of their individualism.

"It is this frightfulness, it is this depth of depravity and cruelty engrafted on all Teutonia through this same process, that has added incalculably to the danger that autocracy will win, by frightening into neutrality or even into ill-concealed coöperation Germany's small neighbors who are our natural allies. Such a victory, leaving the Hohenzollerns and Hapsburgs still in power, could at best be followed by a truce between two armed camps, autocracy and democracy, during which the world would be putting all its available energies into arming for a renewal of fighting.

"Slow as we have been to understand that this struggle is something more than the latest of the European wrangles 'whose obscure sources do not interest us,' once we let our eyes be opened, once we saw that a great moral principle was at stake, we resolved that as it was we who had begun the extirpation of autocracy, so we must share in carrying this work to its triumphant end, not because any other course might well leave us to fight Teutonia singlehanded but because we are determined that 'government of the people, by the people, for the people shall not perish from the earth.'

"Our efforts should be quickened by the thoughts that though the means of creating men cannot in the nature of the case be hastened, those of destroying men can be accelerated to an indefinite degree by the applications of science. The very qualities which have enabled man to better himself at a rapidly accelerating rate by his inventions, the steam engine, anesthesia, the sewing machine, the motor car, the telegraph, the telephone, and wireless telegraphy, are capable of being used to increase at an equally accelerating rate the means of slaying him. From the enormous increase in the powers of human destruction in the few decades since Sedan we get but a first foretaste of what man is inherently capable of inventing. We are indeed shocked at the new and higher order of destructiveness of this war, but our imagination fairly reels in trying to conceive the still higher order of ruin of future wars, should autocracy stay in the saddle. Those against whom this enhanced destruction, this annihilation, would be launched would not be the savage and uncivilized but the very flower of the race, those who threaten autocracy most. Because man cannot deprive his fellows of these powers of invention, he can prevent his own annihilation only by curbing autocracy, that form of government which evolves naturally through human destruction, or better by destroying it and replacing it with democracy, which evolves naturally through human betterment.

"Our problem at the end of the war will be to prevent future wars, to prevent the actual employment of the enormously enhanced destructive powers sure to evolve, to force the nations to keep the peace as we have forced individuals. To say that we are inherently incapable of preventing our own annihilation; that because the less developed past did not learn to prevent its little wars, killing their tens of thousands, the more developed future must ever remain impotent to prevent its wars with their far higher order of havoc, killing their millions, is to betray a fatalism, a pessimism as unworthy of Americans as it is foreign to our nature. To me it seems an insult to the mothers who bore us, nay, to the God who made us."

Volume 38 of Transactions

The thirty-eighth annual volume of TRANSACTIONS of The American Society of Mechanical Engineers is now off the press and will shortly be placed in the hands of the membership. The volume records the affairs of the Society during the year 1916, and includes the annual report of the Council, giving a résumé of the activities of standing and special committees, and a calendar of the 103 general and local meetings held during this period. It also contains, under 46 titles, all the papers and discussions presented at the Spring Meeting, held in New Orleans in April 1916, and at the Annual Meeting, held in New York in December 1916. The papers deal with industrial management, the appraisal and valuation of industrial property, power-plant equipment and operation, the measurement of flow of air, natural gas, steam and water, drainage pumping, hoisting and handling machinery, balancing, vibration in mill buildings, machine-tool standardization, gas producers, steam and electric locomotives, electric boiler-joint welding, etc. A Code of Safety Standards for Cranes, prepared by the Sub-Committee on Protection of Industrial Workers, is presented. Credit for these papers should be given to the Committee on Meetings, its Sub-Committees, and the Sections Committees, through whom they were secured.

Standardization of Machine-Screw Nuts

On June 8, our Society and the Society of Automotive Engineers received a request from the Navy Department to consider the standardization of machine-screw nuts. This request was embodied in the following letter from Naval Constructor D. W. Taylor:

NAVY DEPARTMENT

BUREAU OF CONSTRUCTION AND REPAIR
WASHINGTON, D. C.

Mr. Calvin W. Rice, Secretary,
The American Society of Mechanical Engineers,
29 West 39th Street, New York City.

Dear Sir:

The Bureau's attention has recently been directed to the fact that paragraph 8 of Navy Department specifications 42S5b specifies dimensions of machine-screw nuts which prohibit the supply of such material by other than a limited number of manufacturers. Upon investigating the question, the Bureau has been impressed with the fact that there are apparently no standardized widths and thicknesses; brass and iron, hexagon and square nuts supplied by different manufacturers vary considerably in such dimensions for the same nut number. Seven manufacturers of this material have furnished the Bureau dimensions of the nuts they make; these requirements have been tabulated in the blueprints attached hereto. The last column in each of the blueprints contains the sizes as at present appearing in paragraph 8 of Navy Department specifications 42S5b.

It would appear that it would be desirable for The American Society of Mechanical Engineers or the Society of Automotive Engineers to undertake to standardize the dimensions of machine-screw nuts, if such work, in fact, has not already been inaugurated. It is felt that the elements involved in the investigation, such as any desirable relation of the width or outside diameter of nuts to the diameter of washers, the relation between the thicknesses of nuts and the usual commercial thicknesses as rolled of sheet brass or sheet steel, etc., can better be handled by you or a similar national society than by the Bureau. A letter similar to this is, therefore, being addressed to the Society of Automotive Engineers.

The Bureau desires to express its interest in the problem, its willingness to coöperate in any way practicable, and would appreciate your comments relative to the question at issue.

Respectfully,
(*Signed*) D. W. Taylor,
Chief Constructor, U. S. N.,
Chief of Bureau.

After conference with the Society of Automotive Engineers, the Society accepted the duty and addressed the following reply to the Navy Department, and President Hollis appointed E. H. Ehrman, E. Burdsall and Charles Glover as a committee to coöperate with the S. A. E. Committee, consisting of E. H. Ehrman, chairman; Clarence Carson, E. S. Crawford, J. E. Diamond, W. H. Nolls, Berne Nadell, H. H. Newson and E. E. Sweet.

Rear-Admiral D. W. Taylor, Chief Constructor, U. S. N.,
Chief of the Bureau of Construction and Repair,
Washington, D. C.

Dear Sir:

We accept cheerfully the request to standardize machine-screw nuts, and will immediately appoint a committee and coöperate with the Society of Automotive Engineers.

Yours truly,
(*Signed*) Calvin W. Rice,
Secretary.

The Navy Department acknowledged the offer of the two societies in the following letter:

NAVY DEPARTMENT

BUREAU OF CONSTRUCTION AND REPAIR
WASHINGTON, D. C.

The American Society of Mechanical Engineers,
29 West 39th Street, New York City.

Gentlemen:

The Bureau is pleased to note from The American Society of Mechanical Engineers' letter of the 9th instant, and the Society of Automotive Engineers' telegrams of the 11th and 12th instant, that the suggestion offered in the Bureau's letter that work be inaugurated in the standardization of dimensions of machine-screw nuts has been adopted. It is furthermore noted that The American Society of Mechanical Engineers and the Society of Automotive Engineers are coöperating in this problem. The Bureau is gratified indeed at the prompt response accorded the question in hand.

You will be communicated with at a later date relative to the Bureau's representative in connection with the subject at issue. It is felt that the question to be investigated is of interest not alone to this Bureau, but also to one, and possibly two, other Bureaus concerned with the suggestion that representatives be nominated to coöperate with The American Society of Mechanical Engineers and the Society of Automotive Engineers. The Bureau also feels that it will be highly desirable to have representatives of the Army and the Bureau of Standards on the Committee; it would be better, however, to have your organizations communicate with those branches of the Government direct as to any representatives which each branch might desire to nominate.

Respectfully,
(*Signed*) B. Stocker, *Acting*
Chief Constructor, U. S. N.,
Chief of Bureau.

The joint committee met in Washington on June 23, and the Navy Department was represented by Naval Constructor J. A. Furer, U. S. N.; the Bureau of Standards was represented by Mr. L. A. Fischer, and the Aircraft Engineering Board by Mr. C. B. King.

At this first meeting a table of proposed machine-screw nut dimensions was formulated to be sent to all manufacturers of such nuts for their criticism and suggestions.

The Bureau of Ordnance of the Navy Department has nominated W. W. Smyth as its representative on this committee.

Engineering Council

At the organization meeting of the Engineering Council, held in the rooms of The American Society of Mechanical Engineers, on June 27, the following officers were elected: President, I. N. Hollis; vice-presidents, H. W. Buck, George F. Swain; secretary, Calvert Townley. Executive Committee: Those named, with J. Parke Channing and D. S. Jacobus.

The council discussed at length ways and means by which the founder societies through the council may be of use to the nation. The unanimous desire to help the Government in the prosecution of this war resulted in a resolution instructing the executive committee to coöperate with the Government in procuring the services of engineers, also in the appointment of a committee of three, consisting of Messrs. H. W. Buck, A. M. Greene, Jr., and Edmund B. Kirby, to consider the best means of utilizing the inventive ability of members of the founder societies.

The secretary was instructed to inform all Government bureaus that might be interested of the organization of the Engineering Council and of its desire to be of assistance.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER SEPTEMBER 10, 1917

THE American Society of Mechanical Engineers is an organization for mutual service of over 8100 engineers and associates coöperating with engineers. The membership of the Society comprises Honorary Members, Members, Associates, Associate Members and Juniors, all elected by ballot of the Council. Application for membership is made on a regular form furnished by the Secretary which provides for a statement of the standing and professional experience of the applicant and requires references from voting members personally acquainted with the applicant. The requirements for admission to the various grades will be furnished upon request.

Below is the list of candidates who have filed applications for membership since the date of the last issue of THE JOURNAL. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate-Member or Junior, and those in the third under Junior grade only. Applications for change of grading are also posted.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by September 10, 1917, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about October 15, 1917.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be somewhat slower than under normal conditions. The first step in the consideration of an application is taken by the Membership Committee, and this committee is composed of busy men, with fewer opportunities to meet together in these strenuous times.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

Colorado

AKERLOW, CARL G. W., Engineer in Charge of Drafting and Designing, Colorado Iron Works Co., Denver

Connecticut

BREUL, FRED G., Owner and Manager, Private Manufacturing Business, Design and Construction Automatic Machinery, Bridgeport

DOYLE, BARTHOLOMEW M., Chief Engineer, Housatonic Power Co., Waterbury

District of Columbia

EICKHOFF, THEODORE H., Research in Ordnance Work, Washington

Indiana

HAMILTON, WILLIAM E., Efficiency Engineer, Premier Motor Corp., Indianapolis

Massachusetts

AFFLECK, BERTRAM L., Prevocational Instructor, City of Boston, School Department.

JUDGE, FRANKLIN, General Superintendent, Greenfield Tap & Die Corp., Greenfield

MACOMBER, CARLTON H., With General Electric Co., Lynn

POWELL, ALBERT M., Consulting Engineer, Powell Machine Co., Worcester

WHIPPLE, GEORGE F., Compiler "Catalogue Studies," Boston

Michigan

KREIDLER, DANA W., Chief Engineer, Carburetor Division, Detroit Lubricator Co., Detroit

PERRY, THOMAS D., Secretary, Grand Rapids Veneer Works, Grand Rapids

Mississippi

DROSS, PHILLIPP, Vice-President and General Manager, The Marty Foundry Co., Inc., Meridian

New Jersey

ACKERMAN, ALBERT A. JR., Chief Draftsman, The Singer Manufacturing Co., Elizabethport

HAGELTHORN, THOMAS, 436 Highland Avenue, Arlington

New York

COLLINS, EDGAR F., Engineer Industrial Heating, General Electric Co., Schenectady

DIAMANT, SIDNEY, President, De Mant Tool & Machine Co., New York

McCOY, WILLIAM T., Tool Department Head, Savage Arms Co., Utica

WILLIAMS, CHARLES S., Sales Engineer, American District Steam Co., North Tonawanda

Ohio

CAMM, JOHN A., Vice-President, The Cleveland Milling Machine Co., Cleveland

DOAN, JAMES B., President, The American Tool Works Co., Cincinnati

WESCHE, BJARNE A., Owner, B. A. Wesche Electric Co., Cincinnati

Pennsylvania

GLYNN, CHARLES V., Mechanical Engineer, Hershey Chocolate Co., Hershey

McBRIDE, JOHN J., Chief Export Inspection Bureau, American Car & Foundry Co., Berwick

Washington

WITHERSPOON, WILLIAM O., Designing Engineer, Washington Portland Cement Co., Concrete

West Virginia

JENKINS, EDWIN M., Mechanical Engineer, Virginian Railway Co., Princeton

Wisconsin

BREED, PRESTON H., formerly with National Brake & Electric Co., Milwaukee

KELLER, WILLIAM H., President and General Manager, Keller Pneumatic Tool Co., Fond Du Lac

Philippine Islands

STANTON, ROBERT B., JR., Manager Mechanical Engineering Department, Frank L. Strong Machinery Co., Manila

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

Connecticut

RATZKOFF, SILAS M., Production Superintendent, Gun Department, Winchester Repeating Arms Co., New Haven

New Jersey

McWILLIAMS, WILLIAM W., Assistant General Manager, Aeromarine Plane & Motor Co., Keyport

New York

HORN, HARRY P., Draftsman, General Acoustic Co., Jamaica, L. I.

ROBERTS, MORTIMER J., Sales Engineer, Air Reduction Co., New York

Ohio

ESTABROOK, CHARLES B., Manager, The Safety Ladder Co., Dayton

SPEAR, WALTER A., Test Engineer, Cincinnati Milling Machine Co., Cincinnati

Pennsylvania

LYONS, KARL M., Production Manager, Clarendon Refining Co., Clarendon

Vermont
BEAL, HENRY S., Manager of Cost Department, Jones & Lamson Machine Co., Springfield
Washington
GOFF, CLIFFORD, Machinist, U. S. Navy Yard, Puget Sound, Bremerton

FOR CONSIDERATION AS JUNIOR

Connecticut
ENGLEHART, RUSSELL J., With Winchester Repeating Arms Co., New Haven
PRYOR, WILLARD L., Assistant to Superintendent, Singer Manufacturing Co., Bridgeport
Illinois
ATZENHOFFER, ARTHUR H., Mechanical Engineer, Western Electric Co., Chicago
CLIFFORD, CHARLES H., JR., Industrial Engineer, Cooley & Marvin Co., Chicago
Kentucky
GRAY, HENRY C., Graduate Rose Polytechnic Institute, 1917, Resident Louisville
Maryland
MICHEL, RUDOLPH, Draftsman, Baltimore Oil Engine Co., Baltimore
TYSER, LEO, Superintendent Heating Division, Terminal Freezing & Heating Co., Baltimore
Massachusetts
BOLTON, WRIGHT JR., Master Mechanic, Acushnet Mills Corp., New Bedford
ELIN, MICHAEL B., Engineer, New England Westinghouse Co., Chicopee Falls
KNIGHT, EARL R., Assistant to the Superintendent on Production Work, Washburn Shops, Worcester Polytechnic Institute, Worcester
WARNER, EDWARD P., Assistant in Aeronautical Engineering, Massachusetts Institute of Technology, Cambridge
Michigan
OTIS, J. HAWLEY, Student, Mechanical Engineering, University of Michigan, Ann Arbor
Missouri
CHOCKLEY, FRED W., Chief Draftsman, Henrici Kent & Lowry Eng. Co., Kansas City
RENKEN, HARRY J., Traveling Representative Railroad Department, Fairbanks, Morse & Co., St. Louis
New Jersey
HARMON, WILLIAM C., JR., With Calco Chemical Co., Bound Brook
New York
FRIEDKIN, GEORGE, Mechanical and Radio Engineer Superintendent, Dubilier Condenser Co., Inc., New York
MACNABB, CLIFTON E., Sales Engineer, Worthington Pump & Machinery Corp., New York
PLONSKER, MAURICE J., Machine Designer, Lidgerwood Manufacturing Co., Brooklyn
SPERRY, SAMUEL E., JR., Draftsman, Interborough Rapid Transit Co., New York
THOMAS, OSCAR A., Ordnance Department, Inspector, New York Arsenal, Governors Island, New York
Ohio
BROCKMAN, BERNARD N., Special Representative, The R. K. Le Blond Machine Tool Co., Cincinnati
GIEBEL, ROBERT L., Production Engineer, Cincinnati Milling Machine Co., Cincinnati
MONAGHAN, WALTER I., Sales Engineer, Armstrong Cork & Insulation Co., Cincinnati
SOLLER, WALTER, Fellow Mechanical Engineer, University of Cincinnati, Cincinnati
Pennsylvania
CONNELL, F. VAN BUREN, Assistant Superintendent, The Baldwin Locomotive Works, Philadelphia

APPLICATION FOR CHANGE OF GRADING

PROMOTION FROM JUNIOR

Michigan
EMSWILER, JOHN E., Professor of Mechanical Engineering, University of Michigan, Ann Arbor
New York
HUESTIS, BRONSON L., Draftsman, Westinghouse Church Kerr & Co., New York
ROBERT, MONTAGUE H., Chief Engineer, Air Reduction Co., New York

SUMMARY

New applications	63
Applications for change of grading:	
Promotion from Junior	3
Total	66

NECROLOGY

FRANK FIRMSTONE

Frank Firmstone was born in Glendon, Pa., on August 29, 1846, and received his early education at the Phillips School, Easton, Pa. From there he went to the Saunders Military Academy in Philadelphia, and in 1865 was graduated from the Polytechnic College of Pennsylvania as a mining engineer.

His first position was with his father in the Glendon Co., and he was associated with this firm for 21 years. Upon the death of his father in 1875 he became general manager of the company. He resigned in 1887 and soon after became associated with the Cranberry Iron & Coal Co., Cranberry, N. C. He was president of this company for a number of years and was a director of all its subsidiary companies until the time of his death.

He was a recognized authority on engineering matters, and contributed valuable papers on blast-furnace practice to the American Institute of Mining Engineers.

Mr. Firmstone was a member of the American Institute of Mining Engineers, the American Society of Civil Engineers, the American Society for Testing Materials, the American Forestry Association, and the Engineers' Club of New York.

He became a member of the Society in 1880. He died on June 27, 1917.

JAMES JOHNSON PEARD

James J. Peard was born in New York City on July 25, 1849, and was educated in the public schools of Hartford, Conn. He left school to enter the employ of Colt's Patent Fire Arms manufacturing Co., where he learned his trade.

In 1873 he went to Providence where he worked with the Providence Tool Co. and afterward with the Brown & Sharpe Manufacturing Co. In 1876 he became a contractor in the employ of the Remington Arms Co., Ilion, N. Y., and after remaining there five years returned to the Colt company at Hartford. In the employ of this firm he gradually worked up until he became assistant superintendent in 1888 and superintendent in 1902. He retained the latter position until 1911, when he retired because of ill health.

For twelve years Mr. Peard was a member of the Board of Education of Hartford, serving as its secretary and president. He was a member of the Colt Mutual Benefit Association, which he organized and of which he was president until 1914. He was the inventor of many improvements in the products of the Colt company and was a recognized authority on firearms.

He became a member of the Society in 1891. He died on July 3, 1917.

WALTER BEVERLY PEARSON

Walter B. Pearson was born in Madison, Wis., on Dec. 2, 1861. He spent his boyhood in Wisconsin and obtained his education there, completing it with two years spent in the University of Wisconsin, where he specialized in mechanics. Upon leaving the University he went to Cleveland, where he took a position with the Warner & Swasey Co.

He left this firm to become assistant superintendent of the

Prospect Machine and Engine Co., Cleveland, resigning in June 1888, [illegible] a position with the Kummer Engine Co. in Chicago, Illinois [illegible]. Later he worked in the same capacity for [illegible] & Co. [illegible] for the Ball Engine Co., both of Chicago.

In [illegible] he organized the Pearson Machine Co., [illegible] special machinery of his own invention and [illegible] in producing and selling machine-screw products manufactured on the Pearson automatic screw machines.

In 1900 the Pearson Machine Co. was acquired by the Standard Screw Co., and in 1901 Mr. Pearson became a director of the latter company and was made vice-president. In 1904 he was elected president. Under his able management the company grew in strength and importance, acquiring in this process a number of the smaller machine-screw companies.

Mr. Pearson was a member of many clubs and societies, including the Engineers' Club of New York and the Chicago Engineers' Club.

He became a member of the Society in 1886. He died in Chicago on May 19, 1917.

EMPLOYMENT BULLETIN

The Secretary considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping anyone desiring engineering services. The Society acts only as a clearing house in these matters.

POSITIONS AVAILABLE

In forwarding applications, stamps should be enclosed for transmittal to advertisers; applications for non-members should be accompanied by a letter of reference or introduction from a member, such reference letter to be filed with the Society. Copy for notices must be in hand by the 15th of the month.

ENGINEER, technical graduate preferred, experienced in the design of open feedwater heaters, softeners, etc. Good position to right person. Write fully, giving details of experience and references. 102.

INDUSTRIAL ENGINEER—COST ACCOUNTANT. A well-established firm can offer exceptional opportunities for effective and interesting work to engineering graduates who have had substantial experience with modern industrial accounting, with special reference to manufacturing costs. In reply state age, education, experience, present and expected salary. 431.

ELECTRICAL ENGINEER possessing extensive experience with electrolytic plants for producing oxygen and hydrogen, wanted by New York concern. 811.

HIGH-GRADE MAN having a technical training desired by company with factory in western Maryland in the capacity of assistant designer and works manager. Duties to assist in designing special machinery and developing ideas; analyze machine operations, prescribe equipment and devise means to effect speedy and economical production; superintend the manufacturing of such machinery. Requires the ability of a thoroughly practical master mechanic with original ideas as to methods, a knowledge of modern shop practice, familiarity with the design and application of time-saving fixtures, executive ability and diplomacy necessary to successfully direct a manufacturing plant. No question of salary if the right man applies. State full particulars and technical experience with the assurance that such information will be held as confidential and no investigation will be made with present employer prior to conference. 958.

DESIGNERS. Men experienced in steam-engine and turbine work preferred. 967.

DRAFTSMEN, technical graduates, familiar with design of power-station installations, steam piping and a fair amount of structural work. State age and experience. Location Brooklyn. 990.

DRAFTSMEN AND DESIGNERS. Expeerienced men with some knowledge of valves and fittings; good future with large concern. State experience in full, salary expected and references. Confidential. 1002.

DESIGNER, familiar with pumps, blowers, heating and ventilating systems, for concern in Rochester, N. Y. 1008.

YOUNG DRAFTSMAN required immediately by manufacturer of power-plant specialties. Must be technical graduate and have had shop experience. One familiar with feedwater heaters preferred. Exceptional opportunities to acquire knowledge of design and production. Rapid advancement. Location Pennsylvania. 1013.

DRAFTSMAN. Young engineer, preferably a technical graduate with about a year's practical experience, who could work into a good position. Salary, $25 to start. Location New York. 1080.

DRAFTSMEN desired by firm manufacturing railroad specialties. Location New York State. 1084.

YOUNG ENGINEERING SALESMAN, not over 28 years of age, on application of steam specialties. 1089.

OPERATING CHIEF ENGINEER in charge of paper mill—man thoroughly familiar with boiler plants who is capable of making study of furnace conditions and tests. Salary $2500 to $3000. Location New Haven, Conn. 1129.

ESTIMATING ENGINEER. Prefer to secure a man of such age as not to be likely to be drafted for military service. Position requires a fairly comprehensive knowledge of construction work, a thorough knowledge of pumping machinery, piping and preferably concrete work, also qualifications that will enable a man to estimate on more or less complicated special machinery. Location New Jersey. 1130.

DRAFTSMEN experienced in ordnance work, particularly small arms and machine guns, or experienced in complicated automatic machinery. 1131.

COMBUSTION ENGINEER. Duties primarily those of efficiency work in the burning of fuel and generation of power, also in the use of power in the various departments of plant. Power plant is of 4000 hp. capacity, with extensive distributing system for air, steam and electricity. Excellent opening for a man interested in steam power-plant work. State fully qualifications, training and experience. Location New Jersey. 1133.

GRADUATE MECHANICAL ENGINEER with knowledge of centrifugal machinery—preferably fans, pumps and compressors—and also thoroughly familiar with their design and methods of testing same. Apply by letter. Location New York. 1140.

RECENT MECHANICAL ENGINEERING GRADUATES. Must have initiative and capacity for plenty of hard work in design, construction and operation of gasoline plants for large independent oil company. Location Oklahoma. Expenses paid. 1141.

MASTER MECHANICS, ASSISTANTS, INSPECTORS, ETC., in the construction and operation of a large shipyard. The organization must be completed as soon as possible. Location Pennsylvania. 1146.

SUPERINTENDENT OF CONSTRUCTION for mechanical equipment, including power plant, of hospital and medical college in Peking, China, for group of 14 buildings. Work will be installed by day labor and clients desire capable executive to act as superintendent for installation of such equipment. 1147.

1917 GRADUATE IN MECHANICAL OR ELECTRICAL ENGINEEERING for drafting and estimating work in connection with blast furnaces and mines. Location East Tennessee. 1152.

DRAFTSMAN for steel company. Position will be interesting, as there is a lot of new work started. Location New York State. 1153.

DRAFTSMAN. Work includes a wide range of designing machinery for roofing manufacture, conveying, foundations and plant layout. Location Perth Amboy, N. J. 1154.

DESIGNER, between 25 and 35 years of age, with mechanical and electrical engineering knowledge and sufficient shop experience to enable him to design apparatus so that it can be economically manufactured. Some pneumatic engineering experience desired, but not absolutely necessary. Work: improvement of present product in regard to increasing the quality of finished article. Design of new products now in process of development. Salary $1200 to $3000, depending entirely upon the man and his ability. Location Hoboken, N. J. 1155.

DRAFTSMAN on agricultural machinery for positions in either Porto Rico or Santo Domingo. Write fully stating age, experience, salary required and whether married or single. 1156.

SHOP SUPERINTENDENT for machine shop manufacturing planers, lathes, etc., and employing 200 to 300 men. Confidential. 1158.

GENERAL FACTORY EXECUTIVE. High-grade mechanical engineer wanted for position of works superintendent having direct charge of all power and maintenance work in a factory of over two thousand employees. Applicant must be able to show that he has made good previously in a similar position and must have pronounced executive and machine-designing ability. A desire to work harmoniously with organization a prime qualification. In first letter state age, salary and complete record of experience. Location, New York district. Permanent position for a real man. 1162.

COMPETENT MAN, about 35 years old, to take hold of maintenance and machine repairs and general shop economies. Prefer one who has had technical education and enough shop experience to understand the operation of all machine tools, and who has a full appreciation of the value of time in an operation without going into any efficiency work. Opportunity for advancement and eventually an executive position. 1166.

SALESMAN for mechanical apparatus. Salary depends on man. 1167.

DRAFTSMAN experienced in laying out dies. Permanent position. State previous experience and salary expected. Location New Jersey. 1170.

SALES ENGINEER for Spain desired by export house. Must be an experienced man who has actually sold machinery in that country. Must be competent to develop efficient sales organization, appoint sub-agents, etc. A substantial profit share will be paid in addition to salary, exceptional opportunity. Address applications in Spanish or English. 1172.

SALES ENGINEER for France desired by export house. Must be an experienced man who has actually sold machinery in that country. Must be competent to develop efficient sales organization, appoint sub-agents, etc. A substantial profit share will be paid in addition to salary, therefore an exceptional opportunity. Address application in French or English. 1173.

MECHANICAL ENGINEER familiar with general machinery in woodworking and machine shops to take charge of drafting room. Concern at present planning ship ways, and the work for this particular engineer will be the laying out of the woodworking shop and the machine shop, as well as derricks, cranes, etc. Location Pennsylvania. 1175.

INSPECTOR. Energetic, capable young man as inspector in plant manufacturing small machinery and machine parts. Should have had experience as a machinist. State initial salary expected, age, experience and qualifications. Good opportunity for advancement. Location New Jersey. 1183.

ENGINEER in drafting and engineering department. Able man with technical training wanted, familiar with structural work and machine design; conveying-machinery experience will be of advantage. Splendid future for right man. State fully particulars of education, experience, age, salary expected, etc. All letters regarded as confidential. 1185.

SALES ENGINEERS. Men of at least 24 years of age, with college education or its equivalent, who have had mechanical training and shop experience in the sales department of a prominent manufacturer of pneumatic machinery. Good opportunity for the right man. Give references, experience and salary expected. 1187.

DRAFTSMAN with sufficient experience to enable him to take charge of the making and checking of detail drawings in a drawing room employing two or three men. State qualifications and past experience fully. Large part of the work will consist of routine calculations. Applicants must be possessed of technical training. Salary about $150 per month. Location New York State. 1189.

FACTORY EXECUTIVE, technically trained, about 30 to 35 years of age, for large textile-machinery manufacturing plant. Knowledge of up-to-date shop methods essential, also successful experience in the handling of mechanics. Applicant would be required to spend from one to two years in shop to become familiar with the various classes of work, after which the position of assistant superintendent with further excellent opportunities for promotion will be open to him. Salary at start, about $2500. Location Mass. 1191.

ASSISTANT SUPERINTENDENT. Man about 30 years of age who has worked his way through a technical institution along mechanical or chemical lines. Duties partake of the nature of assistant superintendent without such official title. Position requires application and long hours, and affords inducement and opportunity for pay beyond the starting wage. Salary to start, about $25. Location Virginia. 1192.

YOUNG DRAFTSMAN. Location Jersey City, N. J. Salary $20. 1193.

YOUNG ENGINEER to work [illegible] report on shop efficiency. Salary $20. Location Jersey City, N. J. 1194.

TWO YOUNG ENGINEERS: One a recent graduate with some electrical-engineering training, at a salary of $[illegible] a month; the other with some experience in drafting-room work, salary $125 per month. Location, New York. 1197, 1198.

YOUNG DESIGNER on jigs and fixtures. Salary $125 to start. Prefer young man with some shop experience. Location New York. 2000.

YOUNG TECHNICAL ENGINEER for sales work on fans, blowers, turbines. Need not have had previous experience in sales line. Salary to start, $1500. 2001.

TOOL DESIGNERS capable of designing jigs and fixtures on machine-tool equipment from the piece-part drawings. None but first-class man will be considered. Salary $35 per week; transportation charges paid. Location Middle West. 2004.

EXPERIENCED TOOL DESIGNERS. Familiar with tools, jigs and fixtures for miscellaneous machine shop production work, including turbines, reduction gears, guns and gun carriages. Attractive offer to capable man. Location Maryland. 2006.

DESIGNER of centrifugal pumps capable of taking charge of department in established concern manufacturing pumps for special conditions. State age, experience and references. Location Pacific Coast—New York City conference. 2008.

MAN 30 to 35 years old, preferably with some experience along manufacturing lines and capable of working into responsible position in short time. Opening is with well-established concern in New England, manufacturing variety of metal articles and novelties. Give full details of education, experience, positions held, salary expected, etc. 2009.

DRAFTSMAN with at least five years' experience in the detail of machine parts. State age, experience, salary expected and give references. Position permanent. Location near New York City. 2012.

CHIEF DRAFTSMAN with executive and engineering ability, competent to direct the work of eight draftsmen and superintend design of output of plant manufacturing large tanks, steel mill buildings, zinc-smelter equipment and [illegible] work along engineering lines. Must be competent to operate system now installed in relation to [illegible] and ordering materials. Want man with at least ten years' experience in manufacturing lines. Salary $2000. Location Kansas. 2013.

MANUFACTURING COMPANY has openings and invites applications from men of engineering experience familiar with design of plate, mechanical and construction work. These openings offer permanent positions and exceptional opportunities for men who are competent to prepare drawings, write bills of materials and shop orders and requisition materials for this class of work. Salaries entirely contingent on ability to produce results. Location Kansas. 2014.

DRAFTSMAN for general design of new machinery and improvement of existing machinery in large [illegible] plant. Position leads to industrial management work. Write giving full particulars. Location Maine. 2016.

MEN AVAILABLE

Only members of the Society are listed in the published notices in this section. Copy for notices should be in hand by the 15th of the month, and the form of the notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

INDUSTRIAL PLANT ENGINEER. Technical graduate, age 32. Nine years' experience in design, construction, operation and main-

[illegible] and power plants. Specialized in heating and [illegible] and drying of materials. H-269.

MECHANICAL AND ELECTRICAL ENGINEER of fifteen years' [illegible] and practical experience. Can design, supervise or organize [illegible] new work where initiative, tact or perseverance are required. Can [illegible] best professional and character references. Temperamentally qualified to adapt self to various personnel within or without [illegible] organization. At present employed but desires new connection where there is ample opportunity to produce results. H-270.

ASSISTANT OR ASSOCIATE PROFESSOR OF MECHANICAL ENGINEERING. Technical graduate, degrees of B.S. and M.E. Age 27, married. Two years' experience as assistant superintendent of manufacture with illuminating gas company, in charge of labor and mechanical equipment. Experience in drafting, heating and ventilation work and as assistant to a consulting engineer. Three years' experience teaching mechanical-engineering subjects. Desires position with a progressive college or university for the year beginning September 1, 1917. H-271.

MECHANICAL ENGINEER. Columbia graduate, age 37, married. Fourteen years' service in motive-power department of large western railroad, in testing laboratory, as draftsman, assistant engineer of tests and assistant mechanical engineer. Desires opportunity for advancement and greater responsibility. At present employed. H-272.

MECHANICAL ENGINEER. Technical graduate, with knowledge of Spanish and experience in power plant and sugar mill, desires position as manufacturer's representative, power-plant engineer, sugar-mill engineer or instructor in a technical school. H-273.

MECHANICAL ENGINEER, EXECUTIVE. Age 32, married. Ten years' experience. Aggressive and courageous, having an excellent record and many reliable references. At present employed as head of the engineering department of a large manufacturing firm. Would like position in engineering, production or sales department of commercial firm. Available on short notice. Salary expected, $2500 per year. H-274.

SALES ENGINEER. Graduate mechanical engineer having charge of New York territory for the past ten years for well-known company manufacturing factory equipment would like to make a change. At present employed. Highest references. H-275.

ASSISTANT TO EXECUTIVE. M.E., Cornell, age 31. Experienced as a machinist, draftsman and foreman. Desires position as assistant to an executive in a manufacturing or engineering firm where there will be an opportunity for advancement. H-276.

DESIGNING ENGINEER OR ASSISTANT TO EXECUTIVE. Mechanical engineer, university graduate, not liable for military service. Fourteen years' broad experience in the design and construction of special machinery, tools, jigs, etc., including ordnance, design of ammunition-handling devices, hydraulic machinery with automatic controlling attachments, structural-steel design and specifications. Familiar with shop methods and follow-up work. Thoroughly practical, with executive ability; not afraid of work or responsibility. Available on short notice. H-277.

RAILWAY MECHANICAL ENGINEER. Age 38. Technical education and 18 years' experience as railway machinist, draftsman, chief draftsman and mechanical engineer. Desires position with railway company, railway-equipment manufacturing company, supply house or industrial plant, with greater responsibility and opportunity. At present employed. Location immaterial. Salary $3000. H-278.

MECHANICAL ENGINEER OR SUPERINTENDENT. American, 14 years' practical and theoretical experience. Specialist in valves, fittings and engineering specialties of all descriptions; machines, tools, fixtures and equipment for same, shop maintenance; efficiency and production engineer. Successfully held positions and has references verifying above experience. H-279.

SALES ENGINEER. Age 32, technical graduate. Four years' experience selling power-plant equipment as well as in design, erection and operation. Good executive ability. H-280.

MECHANICAL ENGINEER for industrial plants. Six years' specialized work on steam and combustion equipment. Desires position as works engineer or superintendent. H-281.

TECHNICAL GRADUATE, M.E., Columbia, age 27. Three years' factory experience erecting and repairing sugar-refining machinery. One year doing master-mechanic work in an acid plant. At present a draftsman. Desires position in munition or other manufacture. H-282.

MECHANICAL ENGINEER with metallurgical training desires position as assistant metallurgist. Four years' shop experience. H-283.

INDUSTRIAL ENGINEER. Age 33, married, technical education. Two years' practical shop experience, 4 years in drawing room, 3 years designing and erecting mill buildings and machinery. At present employed as mechanical engineer with manufacturing company. Can furnish best references. H-284.

RESEARCH ENGINEER AND COMMERCIAL DESIGNER on gas and oil engines, farm tractors or marine motors. Employed in experimental engineering department of a university in Central Northwest. Desires position in commercial or educational research laboratory or large factory devoting entire time to research or research and design. Originative ability in application of scientific principles. Active member Society of Automotive Engineers. H-285.

MECHANICAL-ELECTRICAL ENGINEER. Columbia graduate, age 32, married. Desires position as works engineer. Ten years' experience in industrial-plant engineering, including the installation and operation of power-generating, transmission and receiving apparatus, and shop machinery. Also experienced in the application of electricity to shop processes, welding, electric heating, pyrometry, etc. H-286.

HEAT-TREATING AND RESEARCH ENGINEER. Graduate M.E., age 33, married. Seven years' experience in heat treatment of all kinds of steels. Shop and research experience in large munition factory. Can take full charge of all heat-treating and pyrometer testing. H-287.

MECHANICAL ENGINEER. Columbia graduate, 1912. Five years' experience in design, construction, and inspection with prominent concerns. Desires position in engineering department, or as assistant with good chance of advancement. Employed at present. Salary $1800 to $2000. H-288.

GRADUATE of university mechanical engineering course, age 26, desires position with a manufacturing plant or steel works where chances for advancement into the business end are good. H-289.

SALES PROMOTER. Successful specialty sales manager and salesman, especially good on introductory work, is open for high-grade connection. Enthusiastic, convincing talker, with initiative, stability, good appearance and judgment. Accustomed to handle large business; age 37, American born, single, technically educated, with practical experience. Has covered territory from New York to San Francisco. Will go anywhere. No objection to long trips. H-290.

EXECUTIVE OR WORKS MANAGER. Mechanical engineer with wide experience in positions as executive manager and engineer. Specialty, small arms and interchangeable parts production; last six years' work has been in that line. Position in East preferred. H-291.

EXECUTIVE position in the steel business either in the manufacturing or sales end desired by an American, technical graduate. Age 36; married. Fifteen years' experience in steel plant, general construction and varied engineering work. At present employed. Will arrange for New York interview. H-292.

MECHANICAL ENGINEER. American, 33, married. Technical education. Experienced in standardization work in manufacture, in design of heavy machinery, structural work, concrete. Engineer of construction. Especially experienced in power-plant construction and in combustion engineering. H-293.

MANUFACTURING EXECUTIVE desires to locate with progressive organization producing mechanical or electrical material. Has executive and practical experience in engineering and efficiency methods, costs, inter-department systems, tools, machinery, equipment, power, labor-saving methods, quantity production. Available after one month's notice. Location New York or vicinity. H-294.

BOILER MAN fully conversant with every detail of design and construction of steam boilers, particularly water-tube boilers, oil burners as well as automatic stokers, building, erecting, static and efficiency tests. Will be open for responsible position by August 20. Location near New York City. Highest references. H-295.

STEAM-TURBINE ENGINEER. Fifteen years' experience in the design, manufacture, testing and operation of all commercial types, especially small units, in U. S. and abroad. Desires to make a change. H-296

ENGINEERING SURVEY

A Review of Engineering Progress and Attainment in Mechanical Engineering and Related Fields, Including a Digest of Current Technical Periodicals and a Selected List of Engineering Articles

National Committee on Gas and Electric Service

SOME months ago the Committee of the American Gas Institute to Coöperate with the Government in regard to the Military Needs of the Nation and the Committee of the National Electric Light Association on War Conditions, at a joint conference held in New York City, decided to organize a National Committee which would secure to the United States Government the most effective coöperation in the conduct of the war from the gas and electric light and power industries. The National Committee on Gas and Electric Service was thereupon organized with a membership of representative men from these two industries and the related natural gas industry. The Committee, as constituted, has the following members of The American Society of Mechanical Engineers on its roster:

JOHN A. BRITTON, Vice-President, Pacific Gas and Electric Company, San Francisco, Cal.

ALEXANDER DOW, President, Detroit Edison Company, Detroit, Mich.

CHARLES L. EDGAR, President, Edison Electric Illuminating Company of Boston, Mass.

A. E. FORSTALL, President, American Gas Institute, New York, N. Y.

D. C. JACKSON, Professor of Electrical Engineering, Massachusetts Institute of Technology, Boston, Mass.

S. S. WYER, Consulting Engineer, Natural Gas Industry, Columbus, Ohio.

JOHN W. LIEB, Vice-President, The New York Edison Company, New York, N. Y.

The Committee is recognized by the Advisory Commission of the Council of National Defense as one of its advisory committees, and it has established an official headquarters in the Munsey Building, Washington, D. C., where it has placed itself at the service of the Government for any assistance it may be able to render in behalf of the public-utility industries it represents. It is prepared to act as a vehicle of communication between the various instrumentalities organized by the Government for the conduct of the war and the gas companies producing and distributing artificial and natural gas and the electric light and power companies furnishing electric service, in all matters relating to the national defense. It proposes to place promptly at the disposal of the Government any data or information which it may require as to the facilities in men or service which they may have available, to insure the continuous operation of their plants so as to enable the munition plants, navy yards and manufacturing establishments, through continuous and uninterrupted service, to maintain their maximum output, and it will endeavor to provide the Government with the necessary quantity of the essential by-products they can make available for the production of high explosives and of ammunition.

One of the most essential requirements in the coördination of the industrial resources of the country for the successful conduct of the war is to provide a regular and adequate supply of fuel to the important utilities engaged in enterprises through which they render service to the Government and to the public. To facilitate solving the many problems affecting the continuous supply of fuel to operate their plants, the National Coal Board has been pleased to appoint Mr. George M. Elliott, Secretary of the Committee, to membership on the Coal Committee. A questionnaire has been prepared and forwarded to every gas and electric light and power company in the country, asking them to send a statement of the various kinds and quantities of fuel each uses per annum for its various purposes, the water or rail connections over which they are received, together with a monthly statement of fuel contracted for, received and consumed. This will enable the Committee to give prompt information to the authorities of fuel shortage in any particular locality, with the transportation lines involved, loading and unloading delays, car shortages, routing and trans-shipment difficulties, etc.

Scientific Research in France

IN a paper under the title Organization of Scientific Research in France, presented by Henry Le Chatelier to the Academy of Sciences, the author bitterly complains of the slight estimation in which science is apparently held by society and government in France. He states that men of science are never consulted on measures of public interest, even those most directly connected with science, such as, for example, problems of organization of public education. He claims that science is not appreciated in France to the same extent as it is in Germany. There the captains of industry are proud of the right to prefix the title of Doctor. In France a man who would follow the same custom would make himself ridiculous. In England industrial magnates are quite flattered at being invited to preside at meetings of scientific societies. But that could not be done in France.

Curiously, even while we in America consider our state of research as quite backward, Le Chatelier, whose name, by the way, is quite well known in this country as that of the inventor of the pyrometer and other instruments and the author of many valuable papers on metallurgy, cites the United States as one of the examples of a progressive country where research is generously endowed.

In France there is one magnificent institution of research, the Pasteur Institute, of which the country is proud, but only one. As regards laboratories created specifically for industrial research, there is only the Experimental Station of the Coal Mines Committee at Lievin, maintained by the Coal Mines Company. While this laboratory is very well equipped, it does not make much of a showing as compared, for example, with the numerous laboratories of the German syndicates, metallurgical, mining, ceramic, cement industries, etc.

A field in which still more remains to be done is the creation of private-plant laboratories serving the needs of individual concerns. According to the statement of the writer, a good many industries completely neglect the use of laboratories and none knows how to fully profit by them.

When one comes to consider ways and means to remedy this deplorable condition, one finds that the main difficulty is the [illegible] of the educated classes in French society with respect to the [illegible] and usefulness of science.

Our [illegible] engineers, even those who have arrived at [illegible] in the industry, say: "Our study of science has never been of any use to us. It is nothing but good mental exercises, the same as fencing exercises are good bodily, even if one does not intend to use the art for actual purposes of fighting. Perhaps even the study of Chinese might prove of more value than that of mathematics."

Such statements are a clear proof of an incomplete scientific formation. The war, however, has thrown a vivid light on this subject and has shown in France, even if somewhat late, the exact state of affairs.

The principal error in the past has been that science was reduced to a collection of facts and laws; that is, to only the results of science, and in the presence of the immense number of problems facing the industry only a few of these results acquired with so much effort could be utilized in the course of the career of an engineer. Therein lies the explanation of the apparent uselessness of the study of science. But, side by side with the results there is the method of science, that which produced these results, and this method contrary to what is the case with the results themselves can be of daily application. It is to training in this way that the teaching of science should be exclusively devoted. It is not enough to clutter the mind with a variety of bits of knowledge; what should be done is to give it a certain formation.

This point of view being admitted, certain consequences immediately result therefrom. The basic method of physical sciences is the experimental method, and it is acquired in the laboratory and not in front of a blackboard. Therefore, the extension of laboratories, or rather their better utilization, as there are already a good many of them in universities, should apparently be the dominant problem in all reforms of our system of tuition. (*Revue de Métallurgie*, vol. 13, no. 3, May-June 1916, p. 161 and following.)

Changes in Boiler-Plate Specifications

As a result of an investigation by the Bureau of Standards of the requirements of the Steamboat Inspection Service for steel boiler plate, the interesting fact has been developed that the specifications heretofore in force have been unnecessarily severe and may be safely relaxed so as to increase the output without in any way lessening the safety of this material. Following the Bureau's report the executive committee of the Board of Supervising Inspectors of the Steamboat Inspection Service, at a meeting recently held here, has adopted a series of amendments in the general rules and regulations.

One of the most important changes recommended by the Bureau of Standards is the raising of the sulphur limit in open-hearth steel from 0.04 to 0.05 per cent. No change is made in the phosphorus, the amended rule reading as follows:

> Open-hearth steel shall contain not more than 0.04 per cent of phosphorus nor more than 0.05 per cent of sulphur.

The Bureau also recommended the adoption of a new rule relating to tensile-test specimens and quench-bend specimens which has been adopted, as follows:

> Two tension tests and one quench-bend test shall be made from each plate as first rolled from the billet, slab, or ingot, the tensile-test specimens to be taken from the diagonal corners of the plate, and the quench-bend specimen to be taken from that part of the plate which represents the top of the billet, slab, or ingot.
>
> The quench-bend specimen shall withstand, without fracture, being bent over until the ends are parallel and the inner radius equal to one and one-half times the thickness of the test specimen.

Section 18, Rule II, all classes, of the general rules and regulations, has been stricken out and a modified rule for determining the working pressure on flat surfaces of boilers has been adopted.

All the amendments agreed upon by the Board of Supervising Inspectors will be embodied in detail in a circular letter entitled "Sixth Supplement to General Rules and Regulations," which will be issued within a few days by the Steamboat Inspection Service to boiler manufacturers, manufacturers of boiler plate, steamboat companies and others. The circular may be obtained on application to United States local inspectors of the Steamboat Inspection Service. (*The Iron Age*, vol. 100, no. 2, July 12, 1917, p. 79)

New Navy Specifications for Steel Castings

New specifications governing the manufacture of steel castings have recently been issued by the United States Navy Department. They are dated May 1, 1917, and are designated as 49 Sld, superseding those issued June 1, 1916. The chemical and physical properties demanded by those specifications are as follows:

Grade	Percentage Chemical Composition (not over)		Physical Requirements				
	P	S	Minimum Tensile Strength, Lb. per Sq. In.	Minimum Yield Point, Lb. per Sq. In.	Minimum Elongation, Per Cent in 2 in.	Minimum Reduction of Area, Per Cent	Bending Test[2] (not less than)
F[1]	0.05	0.05	85,000	53,000	22	35	120 deg.
A	0.05	0.05	80,000	45 per cent of tensile strength obtained	17	20	90 deg.
D	0.05	0.05	70,000		22	30	120 deg.
B	0.06	0.05	60,000		22	30	120 deg.
C	0.06	0.07	....	....	..	..	......

[1] Grade F castings may contain nickel or other alloying metals.
[2] Cold bend about an inner diameter of 1 in.

It will be seen that the sulphur requirements are not over 0.05 per cent in all grades of castings except Grade C, which is not tested in any way.

Grade A is intended for all important parts subject to crushing stresses or surface wear only, such as hawse pipes, chain pipes, turret roller paths, engine guides, slippers, etc.

Grade B is intended for parts subject to tensile or vibratory stresses, such as stems, stern posts, stern tubes, rudder frames, struts, engine bedplates, cylinders, gun-mount stands, carriages, slides, and other parts subject to the shock of recoil.

Grade C is intended for gun mounts, such as brackets, levers, wheels, etc., not subject to shock of recoil, and for commercial fittings where structural strength and separation of watertight compartments are not involved, such as pipe flanges (other than bulkhead and deck), cagemast fittings, stowage lugs and clips, hinges for doors and hatches where watertightness is not involved, etc.

Grade D is intended for the same general purpose as Grade B, but where greater strength is required with equal ductility.

Grade F is intended for castings for gun yokes, gun-mount stands, carriage slides, deck lugs, etc., of large size.

The latest specifications of the Navy for structural steelwork, dated Feb. 1, 1917, and designated as 48 Slc, demand not over 0.05 per cent sulphur and phosphorus in all steel castings used in yards and docks and similar work and limit the sulphur to 0.045 per cent for rivet steel for bridges and buildings.

It is known that in many cases it has been difficult to meet a sulphur specification of not over 0.05 per cent in recent months, even in acid open-hearth work. The intensive stress for output under which blast furnaces and coke plants have had to operate has tended to increase rather than diminish the quantity of sulphur in these raw materials, thereby making it still more difficult for steel makers to meet specifications. (*The Iron Age*, vol. 100, no. 2, July 12, 1917.)

News of Other Societies

Annual Meeting of the S. P. E. E.

THE twenty-fifth annual meeting of the Society for the Promotion of Engineering Education was held in Washington, D. C., July 6 and 7, in coöperation with the Committee on Engineering and Education of the Advisory Commission of the Council of National Defense. The main topic of the meeting was the relation between the engineering schools and the national Government during the present emergency. An ambitious program was prepared which featured a number of addresses by government officials, by engineers rendering service at Washington on various public and semi-public committees at this time, and by representatives of foreign governments also on business in the capital. Considering the important calls upon the time of these men, the program was very satisfactorily carried out and there were but one or two disappointments.

The trend of opinion at the meeting was that students in engineering courses should be urged to continue their studies to completion rather than enlist in the national service, since by so doing they would ultimately become of much greater use to their country as trained specialists. On the other hand, the schools themselves should possibly devise means of speeding up their work so that men could complete their courses in less time and in consequence more men would be available. Opinions were also expressed that the engineering schools should introduce military instruction into their curricula.

President G. R. Chatburn occupied the chair during the meeting, and at the opening session greetings from Canada were extended by Dr. A. S. Mackenzie, president of Dalhousie University, who recited the mistakes of Canada at the outset of the war, especially in regard to the men in her engineering schools, and hoped this country would profit by the lesson Canada had learned.

Dr. S. P. Capen, specialist in higher education of the U. S. Bureau of Education, discussed the resolutions passed at a meeting of college presidents called by the Advisory Commission of the Council of National Defense. He considered it especially desirable that a comprehensive policy of coöperation between the colleges and the Government be established and maintained.

Dr. Hollis Godfrey, member of the Advisory Commission of the Council of National Defense, delivered an interesting address upon The Consulting Engineer in Public and Private Service, in which he reviewed the construction of the Council of National Defense, a body created to "coördinate the industries and resources for the national security and welfare." He spoke of the consulting engineer in his relation to the Government and of his place in making effective governmental organization and machinery in time of war.

The Hon. Newton D. Baker, Secretary of War, pointed out the duty of engineering schools in war. He said in part:

> The progress in the art of war is from day to day, not from year to year. There is almost lightninglike rapidity in ingenuity being fed to the troops at the front. There must be the same sort of response by the engineering scientists of this country. All must learn by constant reading and study, by evolving and bringing to as near completed form as may be advantageous to our efficiency and safety.
>
> In addition to that, the larger subject is the relation of engineering education and technical education to the prospective needs of the country. We are in need of fresh accessions of trained young men from the technical schools of the country. Our Coast Artillery and our engineer departments are in constant need of large accessions and they can get them at their very best from the schools. It therefore becomes the necessary thing that the great engineering schools of the country should in large part contribute to the actual organization of the Army in peace time a substantial part if not the major part of peace-time preparation for our defense should aggression force us into defensive action.
>
> I hope, therefore, that it will be assumed that one of the functions of the colleges and technical schools ought to be so to modify their curricula that the young men who have special aptitude for the scientific things which are useful in military science will have an opportunity to develop their aptitude and bring their talent to the aid of their country either for peace-time preparation or in an emergency such as faces the country now.
>
> So that my suggestion is that all of the engineering and scientific talent of the country—and the utmost pressure should be devoted—study the solution of the scientific problems presented by the war. You ought to expedite the training of young men for immediate use by the Government in this great emergency, and you ought to look forward for the future to a large contribution of your great engineer schools and colleges and collaborate the training so that it will be very easy for the young men to render a maximum assistance to the Government if the emergency comes.
>
> Nobody knows what the world is going to be like when this war is over. No imagination is able to picture the sort of civilization the world will have after this conflict is over. Nobody knows how long this war is going to last. But we do know that when this war is over the rehabilitation of a stricken if not paralyzed civilization is going to be a long-drawn-out and uphill task, and there will be need on every hand for trained minds, for trained and schooled men. That day of the engineer will be indeed the big day. Men should then be present in very great numbers to help bring about the rehabilitation of industries, the reconstruction upon an earth which has been swept by an all-consuming conflagration.
>
> And so I think you ought to have as an especial object the urgent invitation to young men of America to come into your technical schools and devote themselves to engineering branches of education: so that when this war is over the struggle will not have been in vain: so that young men can quickly and efficiently play a part in that reconstruction.

Brig. Gen. W. M. Black, Chief of Engineers, U. S. A., emphasized that for the good of the country the four-years' course in the engineering schools should be kept up and that men should not be graduated "half educated." He also thought we had enough men in the country without taking trained specialists "to shoulder a musket." Classes should keep right on with their work as in normal times, but of course if any young men particularly wanted to go to war, let them go.

Dr. Philander P. Claxton, U. S. Commissioner of Education, expressed his opinion that every man in the technical schools should remain there until he had completed his course, unless he left to do some work that could not be well done by some other person.

Commander Cluverius, U. S. N., described the methods adopted at Annapolis to speed up the courses and graduate men. He suggested that the schools along the Atlantic coast giving courses in marine engineering could do very effective

[illegible] the proper operation of steam engines and boilers.

Among the speakers were also Dr. W. P. McClellan, director of the Intercollegiate Intelligence Bureau, who described the work of the Bureau in getting graduates to fill positions in the civil service and in the enlisted service; Dr. S. W. Stratton, director of the U. S. Bureau of Standards, who described in an interesting manner the diversity of problems coming before the bureau; Civil Service Commissioner Galloway, who conveyed an idea of how the Commission is meeting the great demands now being made upon it by government departments for men; Mr. Frank B. Gilbreth; Prof. W. F. Durand, member of the National Research Council, who described the work of the committee on engineering of the Council; Prof. A. L. Williston; Dr. George Smith, of the U. S. Geological Survey, who emphasized the Government's great need of topographical engineers; Prof. H. Wade Hibbard; Dr. F. H. Newell, who pointed out the great shortage of engineers in state and city service; Prof. I. W. Lichfield; Prof. W. M. Thornton; Prof. W. G. Raymond; Prof. F. P. McKibben and Prof. F. H. Constant; Dr. J. A. L. Waddell.

On the second day a number of committees of the society, including those on engineering, education, physics, chemistry, English, mechanics and hydraulics and economics, reported the progress of their work.

At the close of the meeting Dean Milo S. Ketchum was elected president of the society for the ensuing year, and the retiring president, Dr. Chatburn, delivered his presidential address, entitled Our Patriotic Duty. Dr. Chatburn reiterated the necessity for speeding up the college courses, making any changes necessary in the curricula and then, if the war proves short, changing back again.

Society of Automotive Engineers

The S.A.E. held a two days' meeting on June 25-26 in Washington, momentous in the history of the society both because of the important problems considered and because of the very hearty and active participation of the Government. The idea of holding the meeting at the nation's capital was shown to be distinctly proper. As *The Automobile* (June 28, 1917, to which credit should be given for an excellent account of this meeting) states, there was hardly a report of the Standards Committee and not a single paper that was not strongly touched with the influence of the war problems on the nation.

The meeting opened on June 25 with the Standards Committee section at the Bureau of Standards Building, and was attended by a large number of members of the society who were not members of the Standards Committee. This had the good result of familiarizing the membership with the work done by its Standard's Committee before the resolutions were brought up for action by the general society. Hence, no delay was experienced and the entire conduct of the meeting was accelerated.

A number of new standards have been added covering matters aeronautic, research, parts, engines and electrical equipment.

The professional session held during the afternoon of the second day had six papers on its program, of which four were actually ready. Henry R. Sutphen, of the Elco Boat Company, presented a paper dealing with the standardized construction of high-speed motor boats used as submarine chasers, a subject on which he was particularly qualified to speak, as the Elco Company, under his direction, performed the remarkable feat of delivering to the British government in record time 550 80-ft. submarine chasers.

Wing Commander I. W. Seddon, of the British Commission, who has had actual war experience with the Royal Flying Corps, spoke of the design and construction of aircraft in war time and gave his views on the way in which America could aid in establishing the supremacy of the air.

Lieut. Amaury de la Grange, of the French Commission, who also took part in military flying on the other side, spoke of the classification and uses of battle planes and of what America can do in this connection.

H. L. Horning (Mem.Am.Soc.M.E.) presented a paper on Tractors and the Food Problem, discussing not only the immediate demands created by the war, but also those which may be expected to come from the pressure of the coming increase in the population of the world.

An interesting and pleasant feature of the meeting was that constituted by the participation of the highest Government officials in the work of the society. Thus, at the dinner of the society on June 26 in the grand ballroom of the New Willard Hotel, as chief speaker of the evening appeared Secretary of War Baker. The keynote of his speech was that the United States was now engaged in war and a twentieth-century war it was. When the history of this war is finally written it will be shown that we won because we were able to contrive more ingenious engines than our adversary. To reduce the percentage of our losses, we shall have to make use to the fullest possible extent of all the appliances which modern science affords. Aeroplanes would be a great aid in this connection. We must make better and more aeroplanes, so that we can see where our adversaries cannot. Engineers building aeroplanes should realize that they are as truly winning battles as though they were engaged at the front.

Edward A. Deeds (Mem.Am.Soc.M.E.), Chairman of the Aeroplane Construction Board, gave some information regarding the activities of the Aircraft Production Board which was organized on May 6 last and is now under the chairmanship of Howard E. Coffin (Mem.Am.Soc.M.E.).

American Society for Testing Materials

The annual meeting of the American Society for Testing Materials was held at the Hotel Traymore, Atlantic City, N. J., June 26-29, 1917. Among other activities of the meeting the following papers were presented:

The Committee on Steel, C. D. Young (Mem.Am.Soc.M.E.), Pennsylvania Railroad, Chairman, recommended a number of revisions in both standard specifications and tentative standard specifications and proposed a new tentative standard specification for carbon tool steel.

These specifications cover tool steel in ten classes and three grades determined by the chemical composition specified in a table. In this specification maximum manganese is given for the three grades, A, B and C, respectively, as 0.40, 0.45 and 0.60; phosphorus as 0.02, 0.025 and 0.035; sulphur 0.02, 0.035 and 0.04; and silicon 0.35, 0.35 and 0.25.

In the specification for steel tie plates are described two types of specimen which may be used. The 2-in. specimen of circular cross-section shall have filleted shoulders or threaded ends to fit into the holders of the testing machine in such a way that the line of action of the force exerted by the testing machine shall coincide with the axis of the specimen. Tension-test specimens may also be rectangular in section, in which case there shall be not less than $1\frac{1}{2}$ in. in width between the plane sides, and the test piece shall have two parallel faces

as rolled. When the tie plates are of such a design that the rectangular specimens cannot be obtained with out projecting ribs, these shall be planed off before the tests are made.

L. N. Edwards presented a paper entitled The Effects of Grading of Sand and Consistency of Mix upon the Strength of Plain and Reinforced Concrete. This paper describes the methods used and gives the results obtained from tests made upon (1) cylinders in which 12 sands of predetermined gradings were used as sand aggregates; (2) cylinders and reinforced-concrete beams, in the preparation of which five consistencies of mix were used; and (3) cylinders for which the time of mixing was varied from $\frac{1}{4}$ to 2 min.

The writer came to the following conclusions:

1 The commonly practiced "visual examination" test of sand aggregate for concrete is generally unreliable, since it gives at best only a superficial knowledge of the cleanliness of a given sand. Its adaptation to the determination of grading could be of value to the observer only after long experience in the granulometric analysis of sands.

2 The generally accepted practice of proportioning a concrete mix by volume, as, for example, 1 part cement, 2 parts sand and 4 parts broken stone, is impracticable and unscientific, since it does not take into account the adaptability of the grading of a given sand to the production of a dense, strong and reliable concrete. Proportioning by volume, as commonly used, gives no guarantee of the production of a concrete having a desired strength, hardness, or other physical properties.

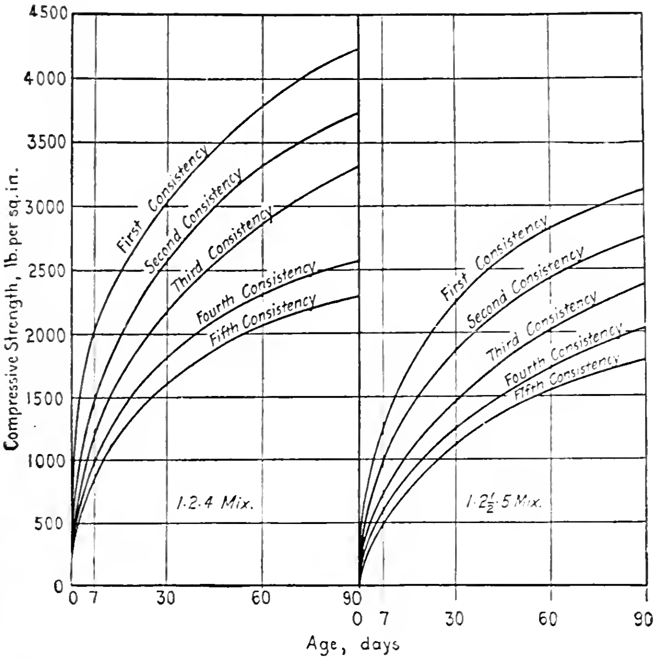


FIG. 1 COMPRESSIVE STRENGTHS OF TEST CYLINDERS OF DIFFERENT CONSISTENCIES

3 The strength, toughness and durability of concrete to be secured from the use of a given sand can be determined only by actual test of that sand in a properly prepared concrete.

4 In field operations incident to spading, slicing, or otherwise compacting the concrete, the movement of the water content of the mass is intensified whenever the sand aggregate contains sufficient fine material to hold the cement in suspension by the formation of an adequate amount of sandy paste. The free movement of the water tends to produce an improper distribution of the cement.

Fig. 1 shows the compressive strengths obtained from the tests of cylinders, in which the consistency of the mix was varied from a sticky, semi-plastic to a very wet condition. The sand and stone were of limestone origin.

Several conclusions may be drawn from these results. The use of a quantity of water sufficient to produce a concrete the mortar component of which is of a saturated, sticky, semi-plastic consistency, is for most practical purposes required in order to facilitate economical and efficient placing. The quantity of water is ample for the development of the proper functions of the cement. An increase in the quantity of water used results in a proportionate decrease in the strength of the concrete. This decrease is in no sense a function of the proportions of the mix.

The results of the test on the influence of time of mixing

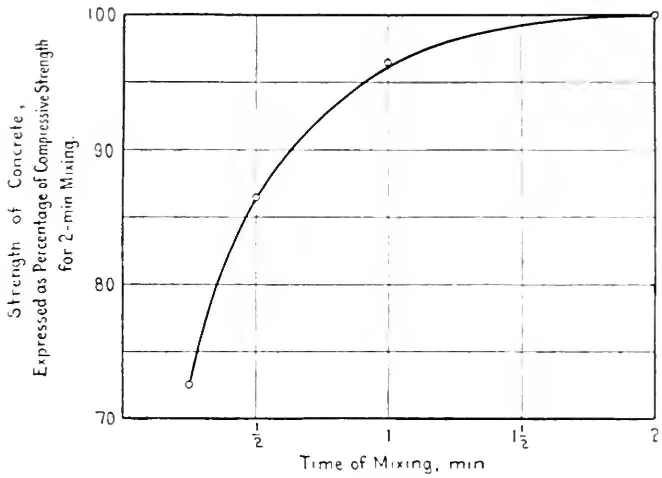


FIG. 2 RELATION OF TIME OF MIXING TO COMPRESSIVE STRENGTHS OF CONCRETE

are shown in Fig. 2. The abrupt change in the direction of the curve at the location indicating the 1- and 2-min. period of mixing, together with the rapid increase of strength shown for mixing periods of less than 1-min. duration, show exclusively the advantage gained by continuing the mixing operation for a period of from 1 to 2 min. after all the materials have been placed in the mixer.

H. A Gardner presented a paper on Metal Primer Tests reporting the continuation of his researches on painting materials (previously announced at other meetings of the same society).

In previous tests the writer observed that red lead which has been highly oxidized during production and which is, therefore, practically a neutral pigment, is not as well suited for application to metal as red lead which is highly basic in nature and which contains a considerable percentage of litharge. In the present tests it has been demonstrated that incompletely oxidized or highly basic red leads have a superior value. This was shown by an inspection of the paints at the end of three years' exposure.

The tests have further demonstrated that two coats of the neutral iron-oxide paint (chromated or containing zinc chromate or zinc oxide) are superior to two coats of the neutral red-lead paint. It has also been demonstrated that excellent results can be obtained with one coat of a highly basic red lead. Further a comparative durability of one- and two-coat work on an iron-oxide, zinc-oxide paint was demonstrated. The results obtained would indicate that all metal should preferably be given two coats of paint when erected.

The same series of tests covered problems of storage of red

lead in package. Some of the paint used in this test had been stored [illegible] three years in half gallon cans. When the cans were opened some of the clear oil was removed from each package and ashed to determine the amount of pigment that had gone into the solution.

The results indicate that red leads high in lead tetroxide are quite as soluble in linseed oil as red leads high in lead monoxide. The condition of the paints, observed at the time of opening, would seem to indicate that the softness of red-lead paints after aging is due not solely to the amount of litharge contained therein, but also to the settling properties of the red lead. In other words, red leads of high weight per volume will settle down to the bottom of the cans and become hard; whereas, red leads of low specific gravity are more likely to be maintained in a bulky form.

The results obtained in the storage tests indicate that some chemical action takes place other than that which can be accounted for by the formation of lead linoleate. The writer is of the opinion that the chemical reactions which are partly responsible for the hardening of red-lead paints cause the formation of lead glycerinate, a substance that is recognized as one of the hardest and one of the most durable cementing materials. (Abstracted through the *Railway Age Gazette,* vol. 63, no. 1, July 6, 1917 pp. 13-16, 4 figs., *ge*)

Junior Institution of Engineers

IN THE course of a short paper on Gas Turbines, recently read before the Junior Institution of Engineers, Mr. S. E. Hutson stated that the great hindrance in the way of the development of the gas turbine as a commercial unit was the, at present, insurmountable difficulty of finding a metal which would withstand the extremely high temperature of the gases. He referred to the general lines along which most gas-turbine designers had proceeded, and showed that practically all the experimental machines which had been built were based upon one of three principles. The first involved the use of a combustion chamber lined with refractory material into which some form of fuel was forced, together with such an amount of compressed air as was necessary for combustion. The gases were ignited in this chamber, and were then directed on to the buckets of an impulse wheel after passing through the diverging nozzles. The air and fuel were driven into the combustion chamber by means of pumps or compressors, which took power from the turbine. The second type of turbine was based on much the same principle as the first, but was fitted with a water jacket which surrounded the combustion chamber. The third principle, which the author considered the most feasible and upon which he had himself been working, was described as the regenerative principle. In this case a charge was forced into the combustion chamber, surrounded by the water jacket, and, after combustion, was brought down to a temperature more suitable to the turbine blading, on to which it was passed through nozzles. The reduction of temperature in the combustion chamber was brought about by steam generated in a special type of boiler placed in the path of the gases as they exhausted from the turbine. After briefly describing several of the experimental machines which had been built by British and continental engineers, Mr. Hutson described the designs of a turbine for which he was largely responsible. This design was based upon the regenerative principle, and in many points showed considerable ingenuity; but Mr. Hutson had found himself up against most of the difficulties which had confronted other experimentalists, and, as he admitted, his efforts had been attended with as little success as theirs. In the first place, he had been unable to obtain a suitable material to withstand the high temperature of the gases. He had, moreover, found that in nearly all the experimental turbines which had been built, the fuel and air compressors had consumed a very large percentage of the output of the machines, but on his machine Mr. Hutson had naturally had to resort to the use of a feed pump to get the water into his boiler, which was an additional drain upon the power developed by the turbine. (*The Mechanical Engineer,* vol. 39, no. 1013, pp. 442)

Notes from the Engineering Colleges

Equipment of Laboratories—Investigations in Progress—Changes in Curricula

BELOW is a continuation of the review of professional work being undertaken at the engineering colleges. The articles contain information regarding (1) characteristics of laboratory equipment, (2) tests or researches under way or in prospect, (3) important changes in curricula.

The articles will be concluded next month.

UNIVERSITY OF CINCINNATI

Research Work: The principal investigational work carried on in the Department of Mechanical Engineering was a study of times of explosions of mixtures of natural gas and air. This work was undertaken over a year ago, and results which were thought to be reasonably accurate were secured. The experiments made at that time suggested certain refinements in apparatus, which have been followed during the past year.

The apparatus is an interesting device for obtaining a graphical record of the explosion of a gas in a closed vessel. The principal feature is the use of an oscillograph. The pressure due to the explosion of the gas is made to act directly on a steel diaphragm in the wall of a cylinder. The deflection of this diaphragm displaces a small amount of mercury from a well, causing it to move up a glass tube of small bore. Within the glass tube is a small carbon filament carrying an electric current. The movement of the mercury column along the carbon filament varies the resistance and hence the amount of current flowing in the circuit. Since the oscillograph registers instantly any variation in the current, the building up of the pressure in the cylinder is accurately recorded.

This type of apparatus can be adapted for use on a gas-engine cylinder, since it will follow very rapid fluctuations in pressure and can therefore be used to determine the proper mixture. It was used in the University laboratory to study the time of explosion and the pressure produced by various mixtures of air and natural gas. The advantages obtained by its use were that no carbon deposits could interfere with the moving parts, and that there was practically no inertia effect. The time of the explosion was obtained by sending a 60-cycle alternating current through the oscillograph at the time of the explosion. Then the distance from peak to peak of the alternating-current wave represented to scale 1-60 sec., and the time between various points on the explosion curve could be read directly in sixtieths of a second.

The apparatus consists of an explosion cylinder, gas meter, vacuum pump, and oscillograph, and is shown set up in Fig. 1. A number of tests were made with varying amounts of gas, and different ratios of gas and air. No difficulty was found in adjusting the apparatus to record both the extremely rapid explosions of rich mixtures and the much slower explosions of lean mixtures. Table 1 gives typical results.

In typical curves obtained it is noticed that after the spark is passed the pressure increases very slowly for a time, then there is a rapid increase to maximum pressure.

Another piece of work done was an analysis of a Stuebing lift truck. A series of graphs was obtained of the force required to drag the truck over concrete, wood-block, and steel-plate floor surfaces, with different loads and using plain and roller bearings. The graphs were continuous, showing the starting, maintaining, and stopping forces. Static tests were made to ascertain the strength of various parts of the machine under load. One of the interesting features of the experiments was that the wheels of the truck were caused to revolve while the truck was under load for an equivalent of eighty miles of travel. Chemical analyses of these steels were obtained and microphotographs of a section of each shaft after use in the roller bearings, to show the change in structure of the material. One such microphotograph is shown in the accompanying Fig. 2.

TABLE 1 TYPICAL EXPLOSION DATA

	No. 1	No. 2
Ratio of mixture	14.6 to 1	10.8 to 1
Volume of natural gas, cu. ft.	0.040	0.080
Initial pressure, lb. per sq. in.	40.0	60.0
Maximum pressure, lb. per sq. in.	190.0	415.0
Time between spark and rapid increase in pressure, sec	0.10	0.05
Time between rapid increase in pressure and max. pressure, sec.	0.23	0.11
Time between spark and max. pressure, sec.	0.23	0.157

Several interesting tests were begun upon machine tools. One was of a large new-type milling machine. The principal deflections of the main frame members of a column-and-knee-type milling machine were obtained by means of static loading. This load was first applied in a horizontal direction then 45 deg. with the table. The comparative deflections due to both twisting and bending of the main units were obtained. The power consumed at the cutter in removing cast iron was obtained. The meters, motor and machine were calibrated.

Other work consisted of tests of a 6-ft. plain radial drill when drilling holes of various diameters in cast iron and machinery steels. An apparatus was designed for obtaining the power required to feed a drill and to turn the drill. The apparatus is now complete, but the tests have not yet been made. It is expected that this will be done this summer.

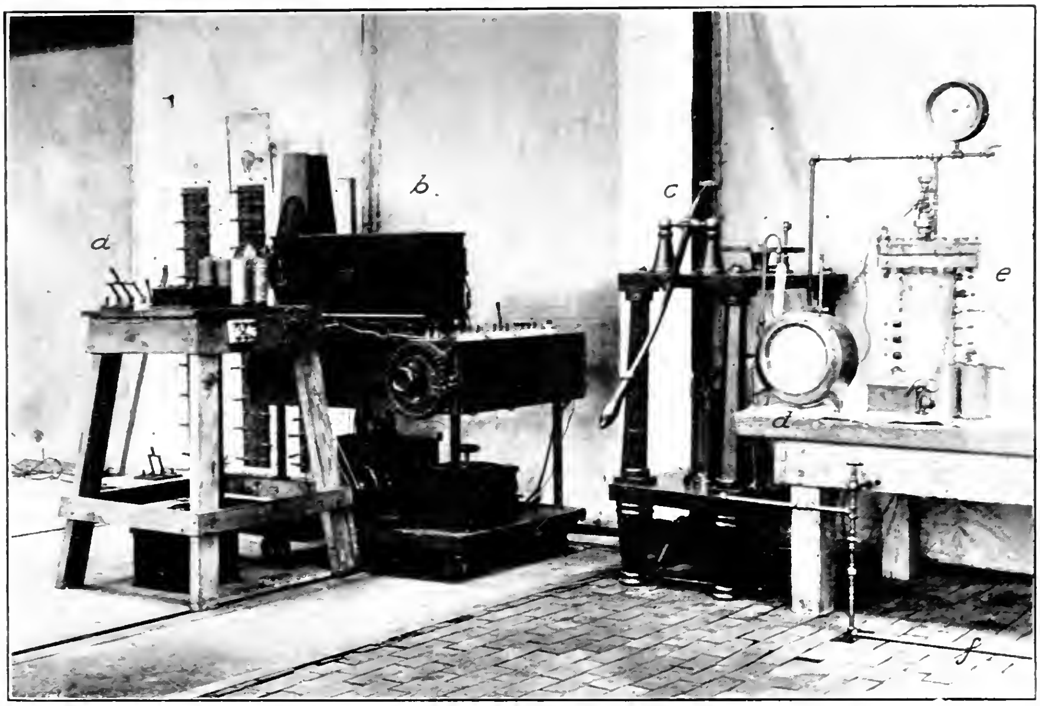


FIG. 1 APPARATUS FOR STUDYING TIMES OF EXPLOSIONS OF MIXTURES OF NATURAL GAS AND AIR
a, Operating Bench; *b*, Oscillograph; *c*, Vacuum Pump; *d*, Gas Meter; *e*, Explosion Cylinder; *f*, Compressed Air.

Equipment: A new electric dynamometer has been purchased for the measurement of power of internal-combustion engines of high speed, which has a capacity of 100 hp. and 3500 rev. per min. In the design of this dynamometer careful study was made of existing dynamometers at the Automobile Club of America and elsewhere, and it is believed that very delicate tests will be possible on this machine.

FIG. 2 MICROPHOTOGRAPH OF SECTION OF A SHAFT AFTER USE IN ROLLER BEARINGS (0.20 CARBON, 0.39 MANGANESE)

University of Michigan

Equipment: Special equipment for the testing of heating and ventilating apparatus; radiator-testing apparatus and other special heat-testing devices, small refrigerating plant for special research work, besides standard instructional apparatus.

The new university power plant contains a 500-kw. cross-compound, non-condensing steam engine; a new 275-kw. turbine of the impulse type is about to be installed.

Experimental Work: Tests on steam radiators to determine coefficients under different circumstances, such as location, and the characteristics of different types of radiators; also to determine the effect of enclosing a radiator in a nook with a grating in front; determination of the rate of heat transfer through an iron coil and through a brass coil located in a tank of water; investigations to determine coefficients for sharp-edged orifices in connection with the measurement of steam flow; investigation of the coefficient of friction of steam flowing in pipes at different pressures and various velocities; investigation of the coefficient of heat transfer through walls of various building materials, notably hollow building tile. Also tests on screw threads, more particularly to determine the size of tapping drill to be used in tapping out nuts up to, say, 1-in. size; and whether threads in the nuts shallower than the full-depth thread will not be just as strong as full-depth threads; what depth will make a combination as strong as the screw at the root of the thread; and stresses on taps when tapping the nuts at different speeds.

Virginia Polytechnic Institute

Equipment: The engineering laboratories are designed more on pedagogical lines than for research, and for practical utility rather than for scientific research work. There are chemical, metallurgical, physical, and agricultural laboratories.

Metallurgical Laboratory: Volume changes during the hardening and setting of silver, tin and other amalgams; possible connection between the microstructure, Brinell hardness, and the durability of valve and piston packing rings for locomotives.

Graphics Laboratory: Investigations in pure mechanism and special problems in machine design: classification of higher plane linkages, non-circular rolling wheels, parallel motions of straight-line-describing linkage; design of a dynamic balancing machine to weigh quickly and accurately the unbalanced forces of rotating masses.

Pure Mathematics: Mathematical investigation has been completed on the subject of a new transition curve.

Mining Engineering: Determination of the best methods of treating complex ore in Spottsylvania County; examination of natural deposits of ores and minerals.

Experimental Engineering: Investigation of the local power plant for a determination of the cost of heat and power per unit; test of bearing metals and dental alloys, with specially designed impact machine; freezing and oil-penetration tests of cement and concrete; test of brick of the state for the American Society of Testing Materials.

Quite radical changes in the courses of instruction are now being prepared. On account of the improved condition of the primary schools of the state, the degree courses in engineering will be reduced from five years to four years. As the entrance requirements were put on a fourteen-unit basis some years ago, this change can be made at this time.

This Month's Abstracts

THE reference, taken from a paper read before the Aeronautical Society of Great Britain, to a 475-hp. 18-cylinder engine is a good showing of what has been done abroad in the last two years in the way of developing big power plants for aircraft.

A table is reprinted giving standard dimensions of copper tubes for aircraft as adopted by the British Air Board.

In the section Engineering Materials will be found an abstract of an investigation, published by the Bureau of Standards, on the properties of component parts of portland cement. Taken in conjunction with previous data, it forms a valuable contribution to our knowledge of this important material of construction.

The data on iron-aluminum alloys melted in vacuo, taken from the *University of Illinois Bulletin,* are of particular interest as an example of an originally purely laboratory investigation rapidly becoming industrially important—first in the field of electrical engineering and now mechanical.

Attention is called to an abstract of a paper in a German periodical on the influence of radiation on fire temperature.

From the *Journal of the Society of Mechanical Engineers of Japan* are abstracted data on the thermal relations of casting and molding sand, throwing an interesting light on the processes of solidification of metal.

In the section Lubrication will be found data on a series of tests on lubricating oils, interesting both because of the results and because of the novel method adopted by the authors. Particular attention is paid to the determination of the durability of oils.

Those engaged in the design of screw pumps will be interested in the abstract of an investigation on this type of machinery taken from a German periodical. Unfortunately, the original of the article is not now available in this country.

In the section Railroad Engineering there are abstracts of several articles on locomotive engineering. Particular attention is drawn here to the description of the Pennsylvania Decapod locomotive, which embodies some quite novel features for this type of construction.

In the same section will be found an abstract of a paper reporting some tests on corrugated culvert pipe under a sand bed, the significant feature of which is that, among other things, it appears that a sand load over a culvert pipe behaves essentially in the same manner as a grain load in an elevator.

An extensive abstract is made of a paper in the *Proceedings of the German Society of Engineers* on the construction and operation of boilers for intensive service.

The absolute value of entropy and energy is discussed in an interesting manner in a paper presented before the French Academy of Sciences, and from the *Proceedings of the Royal Academy* (Great Britain) is taken an abstract of a paper on the determination of the heat of vaporization of water at 100 deg. cent, and one atmosphere of pressure in terms of the mean calorie.

The Automobile Committee of the Council of National Defense has inaugurated a comprehensive industrial inventory of the automobile industries, including automobile, airplane and watercraft factories, to make available to the Government all possible information regarding their manufacturing facilities and possibilities of expansion for Government work. The inventory is being taken by the industrial inventory section of the Council of National Defense.

REVIEW OF ENGINEERING PERIODICALS

Aeronautics

Standardization of Copper Tubes for Aircraft

Difficulties having been experienced by aircraft contractors in obtaining supplies of copper tubing, the causes were investigated, and they were found to be (1) the great variety of sizes called for and (2) the fact that tube makers received orders very irregularly and for small quantities.

Arising out of the investigation, the specification committee of the Air Board has decided that in future copper tube for aircraft contracts will be specified in terms of external diameter and legal standard wire gage. As far as possible tubes of 20 gage (0.036 in.) will be used to the exclusion of all other thicknesses. Where for special considerations it is desirable to use other thicknesses, the choice will, as far as possible, be restricted to gages 16, 18 and 22. The last-named is difficult to manufacture, and will be avoided as far as possible. A new Air Board specification for copper tube will shortly be issued, and will have as an appendix the following list of sizes and gages which the Air Board regard as standard:

20 Gage: $\frac{3}{16}$ in., $\frac{1}{4}$ in., $\frac{5}{16}$ in., $\frac{3}{8}$ in., $\frac{7}{16}$ in., $\frac{1}{2}$ in., $\frac{5}{8}$ in., $\frac{3}{4}$ in., $\frac{7}{8}$ in., 1 in., $1\frac{1}{8}$ in., $1\frac{1}{4}$ in., $1\frac{3}{8}$ in., $1\frac{1}{2}$ in., $1\frac{5}{8}$ in., $1\frac{3}{4}$ in., 2 in.

18 Gage: 1 in., $1\frac{1}{4}$ in., $1\frac{1}{2}$ in., $1\frac{3}{4}$ in., 2 in.

16 Gage: $\frac{1}{2}$ in., $\frac{5}{8}$ in., $\frac{3}{4}$ in., $\frac{7}{8}$ in., 1 in., $1\frac{1}{4}$ in., $1\frac{1}{2}$ in., $1\frac{3}{4}$ in., 2 in., $2\frac{1}{2}$ in.

22 Gage: 1 in., $1\frac{1}{8}$ in., $1\frac{1}{4}$ in., $1\frac{3}{8}$ in., $1\frac{1}{2}$ in., $1\frac{3}{4}$ in., 2 in. (*Engineering*, vol. 103, no. 2685, June 15, 1917, p. 577)

Sunbeam-Coatalen Aircraft Engines

Description of several types of these engines used in the British Army.

A feature common to all of these engines is that the crankcase and nose piece are cast in one, an arrangement which has the advantage of lightness and rigidity, as well as accessibility. Flywheels are absent.

Overhead valves are used exclusively, with two inlet and two exhaust valves per cylinder.

In the big 18-cylinder engine of 475 b.hp. there are no fewer than six magnetos, each one being enclosed. Two sparks are furnished to each cylinder from two independent magnetos. There are also six carburetors. Shortness of crankshaft and absence of vibration are achieved by the linking of the connecting rods, three cylinders working on one crankpin, the outer rods being linked to the central master one. In consequence of this arrangement, the piston travel in the case of the central row of cylinders is 160 mm., while the stroke of the pistons of the cylinders set on either side is in each case 168 mm.

In the 12-cylinder 350-b.hp. aircraft engine a duplicate ignition scheme is also employed. But this engine is characterized by the passage formed through the center of each induction pipe for the spark plug in the center of the cylinder of each block of three. (Lecture before the Aeronautical Society of Great Britain, abstracted through the *Auto*, vol. 22, no. 23/857, June 8, 1917, pp. 405-406, 4 figs., *d*)

Engineering Materials

Properties of Calcium Silicate and Calcium Aluminate Occurring in Normal Portland Cement, P. H. Bates and A. A. Klein

It has been shown previously, e.g., by Rankin (cp. abstract in The Journal, July, 1916, p. 591), that commercial portland cement is made up essentially of three constituents, viz., tricalcic silicate, dicalcic silicate and tricalcic aluminate. The present investigation has for its purpose the determination of the physical properties of these compounds, alone and mixed in various proportions.

The writers come to the following main conclusions:

1 At early periods the constituents of portland cement of normal composition and manufacture, in the order of their strength-conferring properties, are tricalcium silicate, tricalcium aluminate, and dicalcium silicate.

2 At periods beyond 28 days, the dicalcium silicate gains sufficient strength to place it almost on an equality with the tricalcium silicate.

3 Tricalcium aluminate containing 10 per cent plaster gains practically no strength after the first period at which it was tested: that is, 24 hours.

4 Tricalcium silicate of the purity used in this investigation (90 per cent $3CaO.SiO_2$ in one case and 95 per cent in the other) has all the important properties of portland cement, especially those of the "rate of setting" and strength developed.

5 Dicalcium silicate, such as used in this investigation, sets too slowly and attains strength too slowly to be of any commercial value when used alone.

6 Tricalcium aluminate alone, as used in this investigation, sets too rapidly and attains too little strength to be of any commercial value as a hydraulic cementing material.

7 Tricalcium aluminate, when used to replace about 19 per cent of the dicalcium silicate (which is approximately the amount of aluminate present in portland cement), adds somewhat to the strength of the latter at the later periods. This

mixture when used in addition of 3 per cent of plaster gives lower strengths than the silicate alone, as neat test pieces, but as a 1:3 mortar the strengths are higher than any of the dicalcium silicate mixtures not containing the tricalcium silicate.

8 Tricalcium aluminate, when used to replace about 19 per cent of tricalcium silicate, did not add to the strength of the latter, showing rather a slight tendency to decrease it. The addition of 3 per cent of plaster gave higher early strengths but lower later ones.

9 Tricalcium aluminate, when used to replace about 19 per cent of mixture of equal parts dicalcium and tricalcium silicate, increased the strength at 24 hours and 7 days, but decreased it at the later periods. The addition of 3 per cent of plaster increased the strength at all periods.

10 Plaster of paris, when added to any of the compounds or mixtures of those studied, generally increased their strength. This effect is more marked at the early periods.

11 The amount of water of hydration of any of the compounds at any period is not a measure of the strength developed, as the dicalcium silicate at one year with 5.5 per cent water of hydration has a strength almost as great as the tricalcium silicate with 11.5 per cent, whereas the tricalcium aluminate with 26.4 per cent has a strength of less than 100 pounds per square inch.

12 The dicalcium silicate hydrates to a very granular porous mass, which allows of ready egress of solutions, and, while it is chemically more resistant to the action of solutions than the tricalcium silicate, yet it furnishes a great number of voids in which salts may crystallize out of solution, and it is consequently very little able to resist the mechanical action of the "freezing out" (crystallization) of salts from solution.

13 On the other hand, the hydrated tricalcium silicate, with its very dense structure, composed of gelatinous (colloidal) silicate interspersed with crystals of lime hydrate, is probably very susceptible to strains produced by alternate wettings and dryings, colloidal material of this kind being subject to considerable volume change resulting from slight moisture changes.

14 It appears, therefore, that the composition of portland cement should be along lines which would not produce a great preponderance of either silicate. The ideal cement should possibly have an excess of the dicalcium silicate, which would give a not too dense hydrated material, gaining strength at later periods. A lesser amount of the tricalcium silicate would furnish the desired early strength and also overcome the excessive porosity of the dicalcium silicate.

15 It is possible to make a cement that will have the properties of portland cement by grinding together the previously separately burned constituents in approximately the amounts in which they exist in portland cement.

16 The function of tricalcium in the finished cement is somewhat problematical. A cement with less than one per cent of alumina has all the properties of portland cement. Such a cement is, however, not a commercial possibility from the manufacturing standpoint, on account of the temperatures and amount of burning involved. To state, however, that the aluminate in the finished cement is of the nature of a diluent or inert material would be drawing a conclusion which, while justified by the present investigation, requires further confirmatory work.

17 The actual products of the hydration are those noted by Klein and Phillips, excepting as noted before the case of the dicalcium silicate, when apparently during the hydration of this compound lime hydrate is formed.

(*Technologic Paper of the Bureau of Standards*, No. 78, June 9, 1917, 38 pp., 21 figs., *eA*)

MAGNETIC AND OTHER PROPERTIES OF IRON-ALUMINUM ALLOYS MELTED IN VACUO, Trygve D. Yensen and Walter A. Gatward

Data of results of experiments carried out at the University of Illinois to determine the magnetic and allied properties of iron-aluminum alloys melted in vacuo. Only the part referring to the mechanical properties of these alloys is reported here.

In general, it has been found that aluminum in the absence of carbon increases the strength of iron in almost direct proportion to the amount added. Furthermore, aluminum appears to affect the toughness of the iron only slightly, for in alloys containing in the neighborhood of 0.1 per cent carbon, aluminum up to 8 per cent has no marked effect either upon the strength or upon the toughness of the iron, which is especially evident in the case of annealed alloys.

The effect of small amounts of carbon is particularly great upon nearly pure iron and increases its strength about 50 per cent. The strength curves for alloys containing small amounts of carbon will consequently be nearly horizontal, and will raise the curves for the more nearly carbon-free alloys at 4 to 5 per cent aluminum, where the effect of carbon seems to be very small. In general, the effect of small amounts of carbon is to conceal the true effect of aluminum on the mechanical properties of iron.

The writers also compare the effect of aluminum upon the mechanical properties of iron with that of silicon. Up to 4.5 per cent, silicon increases the strength much more than does aluminum. On the other hand, 2.5 to 4.5 per cent silicon markedly increases the brittleness of iron; aluminum has no such effect. Furthermore, silicon beyond 4.5 per cent rapidly decreases both the strength and the toughness, while aluminum continues to add strength to the iron without materially affecting the toughness.

It has also been found that aluminum is more powerful as a deoxidizer than is silicon, for it does not commence to combine with iron until all oxides present are reduced. Aluminum forms a solid solution with iron throughout the range studied.

It has been found that the ultimate strength of a 6 per cent aluminum-iron vacuum alloy is 85,000 lb. per sq. in. in the unannealed state and 70,000 lb. in the annealed state. The corresponding figures for pure iron are 48,500 lb. and 35,000 lb., respectively. (*University of Illinois Bulletin*, vol. 14, no. 22, January 29, 1917, 50 pp., 19 figs., *etA*)

Firing

INFLUENCE OF RADIATION ON FIRE TEMPERATURE, Deinlein (*Zeits. d. Bayerischen Revisionsvereins*, July 31, 1916; *Elektrot. u. Maschinenbau*, 35, p. 10, Jan. 7, 1917, Abstract.)

It is usual to determine the temperature of gases above boiler grates without reference to radiation from the burning surface, it being assumed that all the heat developed by the fuel is in the combustion chamber. If allowance is to be made for the lower temperature of the glowing surface, as compared with that in a furnace protected against radiation loss, it must be remembered that when equilibrium is established, the heat corresponding to the reduction of the combustion temperature is equal to the heat radiated at the reduced temperature. If B denote the weight of calorific value H, L the weight of the air needed for combustion, G the weight of gas, t_1 the combus-

tion temperature, c_p the specific heat content of the gas, then $BH + BLc_pt_L = Gc_pt_1$. Also if t_2 denote the true fire temperature, t_3 temperature of heating surface receiving radiation, C the radiation constant, R the combustion surface, and ϕ a coefficient giving the fraction of the heat radiated from the grate, which falls on the heating surface, then $G(t_1c_{p_1} - t_2c_{p_2}) = C\{[(t_2 + 273)/100]^4 - [(t_3 + 273)/100]^4\}\phi R$. If $\phi = 0$, i.e., if no part of the heating surface is affected by grate radiation and if heat radiated from the grate is not wasted, then $t_2 = t_1$, that is, the actual fire temperature equals the theoretical combustion temperature. The above equation permits of calculation of the radiation ratio $\sigma = (t_1 - t_2)/t_1$ from the measured fire temperature, and hence determination of how much of the calorific value of the fuel is absorbed by radiation to the heating surface. For a given rate of combustion the radiation ratio is practically independent of the fuel. When the rate of combustion is 100 kg. per sq. m., $\sigma = 27$ per cent (ca.); i.e., about 27 per cent of the thermal value of the fuel is conveyed to the heating surface by radiation. At 25 kg. per sq. m. the radiation ratio increases to 44 per cent. The radiation ratio is higher the lower the rate of combustion, and from the relation between fire temperature and radiation ratio it follows that the latter (for a given fire temperature) is higher the better the fuel used. (*Science Abstracts,* Section B—Electrical Engineering, vol. 20, pt. 5, May 1917, pp. 164-165)

Foundry

Thermal Researches on Casting and Molding Sand, Masatosi Okochi

An investigation on the heat conductivity of molding sand.

As an apparatus for the experiment, a wooden box 33 cm. square and 21 cm. deep was filled up with ordinary molding sand. A cylindrical wooden pattern 7.1 cm. in diameter and 15.7 cm. in height was pressed into the sand to half its height at the center of the box. Then molten lead having a temperature of 358 deg. cent. was poured into the mold. Six thermometers were used. The first, nearest to the face of the mold, was a thermocouple, made necessary by the rapid rise of temperature as soon as the molten metal was poured in. The next five thermometers, located respectively at distances of 7 mm. for the first and 20 mm. for the second and equal intervals of 10 mm. for the rest, were of the mercury type.

The molding sand was ordinary river sand with a humidity equal to dry sand plus 10 per cent by weight of water.

Fig. 1 shows data of one of the experiments. This indicates that T_1 rises rapidly as far as about 85 deg. cent. and then rises very slowly until it reaches the maximum of 128 deg. cent. A feature to which special attention is called is that the temperature remains stationary in the range of 96 to 98 deg. cent. This fact was observed in another experiment and is ascribed to the influence of the humidity in the sand. According to the writer, the diminished rate of rise of temperature near the casting is maintained under 100 deg. cent., because a certain fixed amount of heat flowing out of the casting is made use of in evaporating the water contained in the cylindrical layer of the sand between the thermometer and the casting.

In another test there was a very slight amount present, resulting in a temporary rapid rise of temperature. The writer investigates this phenomenon analytically by means of the theory of heat conductivity and comes to the conclusion that castings will prematurely solidify, or, in other words, poured metal will not have sufficient fluidity if there is much humidity in the sand, even if the surface of the mold is thoroughly dried. (*Journal of the Society of Mechanical Engineers,* Tokyo, Japan, vol. 20, no. 47, February 1917, pp. 1-14, 4 figs., *et*)

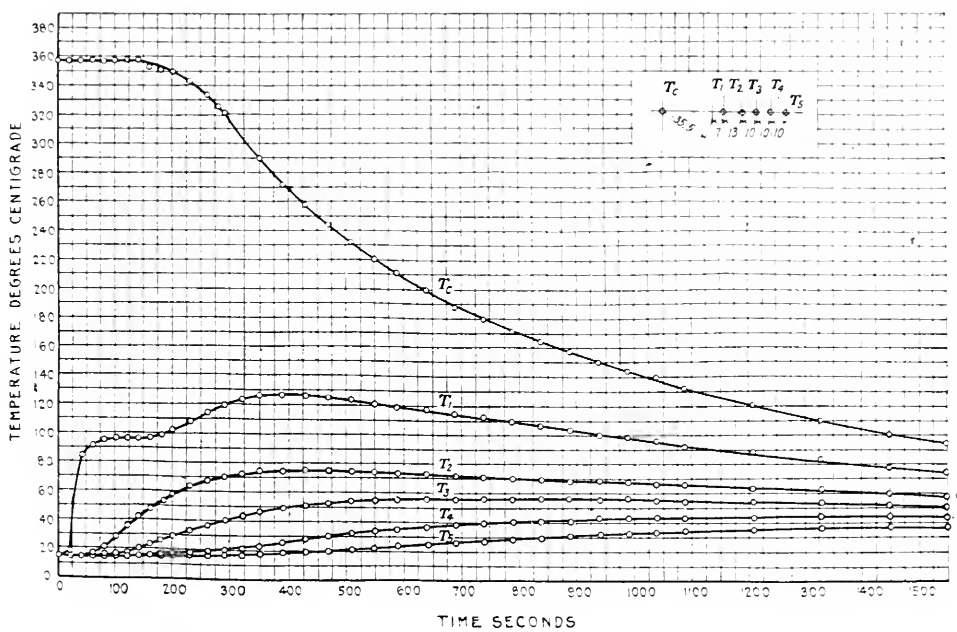


Fig. 1 Curves of Flow of Heat in Molding Sand

Internal-Combustion Engineering

Tractor-Engine Design, C. E. Sargent (Mem.Am.Soc.M.E.)

Paper describing the ideal combination of high compression of less than a cylinderful of air and injection of fuel, expansion to a low temperature and pressure, and control by oil regulation. The writer states that under the most favorable conditions an efficiency of 40 per cent is possible.

In a standard gasoline engine the efficiency at full load is limited first by the low compression, and, other things being

equal, the thermal efficiency increases as the cooling surfaces of the cylinder walls during inflammation. The second loss is caused by releasing the burning gases at an absolute pressure three times as great as it was before compression, eliminating the benefits of expansion so essential for efficiency in other heat engines. The third loss and the greatest limitation to the efficiency of the present engine is the method of reducing the mean effective pressure when developing only a light or idling load. In order to fill the engine cylinder with combustible mixture when its greatest possible output is desired, large inlet valves are provided; yet when less than full load is required, and that is most of the time, the gas is throttled, which not only reduces the compression so essential for efficiency, but puts a back pressure of as much as 10 lb. per sq. in. on the piston. As a result, at least 10 per cent of the power of the engine is required to overcome the braking effect inherent in this form of speed control. Controlling by throttling the intake is a method both simple and cheap, but, as was the case with the early steam engines, is not conducive to economy.

The writer proceeds to the discussion of the use of kerosene as a fuel. He believes that burning kerosene commercially in

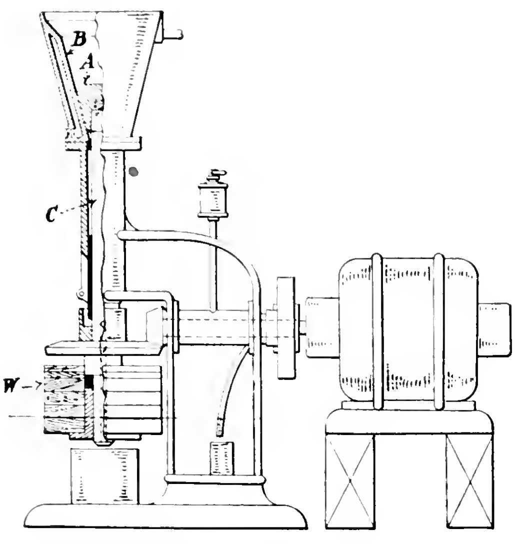


FIG. 2 MACHINE FOR TESTING LUBRICATING OILS

a gasoline engine will never be accomplished until the temperature of the induced charge can be maintained constant automatically, irrespective of the exhaust temperature, compression and cooling effect of throttling. Even if this can be accomplished, the engine capacity will decrease as the temperature is raised to the point necessary for a perfect gas. Regulation by throttling, then, is not conducive to the burning of kerosene.

What the writer suggests is an engine with a 50 per cent longer stroke but of the same bore. Such an engine will weigh a few pounds more than an engine with two-thirds piston displacement, but there will be a net gain of 25 per cent more power from the same fuel. The exhaust will be cooler and the average temperature much less during the working stroke; also the cycle will permit of a speed control that eliminates the back pressure caused by throttling.

The ideal tractor engine (and it is almost real) is one that compresses pure air to a predetermined pressure sufficiently hot to ignite the fuel when introduced, one in which the power and speed can be reduced without introduction of back pressure, in which the fuel used varies with the load and the burning charge is expanded to a greater volume than the air compressed. Every feature embodied in the description of the ideal engine is stated to have been attained. (Paper presented at the Semi-Annual Meeting of the Society of Automotive Engineers, Washington, June 26, 1917, abstracted through *Automobile Topics*, vol. 46, no. 8, June 30, 1917, pp. 889-890, 7 figs., *td*)

Lubrication

TESTING OF LUBRICATING OILS, Hugh K. Moore (Mem.Am.Soc. M.E.) and G. A. Richter

Description of an apparatus for testing of lubricating oils, and data obtained in the tests.

The writers assert that the selection of the most suitable lubricating oil for plant operation depends upon three things: the specific conditions under which the oil is to be used, the cost of lubrication, and the cost of power. This they corroborate by experimental data.

The apparatus used is shown diagrammatically in Fig. 2. It consists essentially of the bearing cone *A*, which is rotated within the conical sleeve *B*, the desired pressure being maintained by a suspended weight *W* on the shaft *C*. The machine is operated by a ½-hp. direct-current motor through a gear drive. The conical sleeve is made high enough to use cones of the different sizes, and is jacketed in order to maintain any desired temperature either high or low at the bearing surface, and also to provide means for bringing the temperature of the bearing to any selected temperature just previous to each successive run in a series.

The power consumption by friction during the operation is measured by means of an ammeter and voltmeter, and the results obtained with different lubricants are directly comparable when the efficiency of the motor is known.

Provision is made for several different methods of testing the oil in question and the writers indicate several such factors. Thus, when the power consumption is a determining factor, the input in watts is plotted against time. In this way the "durability" or "breaking-down" qualities of the oil may be studied. In this case the oil was allowed to circulate in a closed cycle.

TABLE 1 RESULTS OF TESTS OF MACHINE OILS

Number of Oil	Temperatures, Deg. Cent.			Time in Minutes		
	Initial	Final	Increase	Run I	Run II	Average
7	24.0	36.5	12.5	40	40	40.0
13	26.5	30.5	4.0	5	7	6.0
14	22.0	38.5	16.5	47	54	50.5
19	23.0	36.0	13.0	30	32	31.0
23	25.0	38.0	13.0	31	33	32.0
30	23.0	37.0	14.0	35	38	36.5
35	22.0	32.0	10.0	24	24	24.0
36	20.0	37.0	17.0	26	28	27 0

NOTE.—Normal pressure, 1.5 lb. per sq. in. End of groove in cone plugged. No circulation of oil; 3 cc. of lubricant used for each test. Bearing material, brass.

Another method consists in eliminating the oil pump and dropping the lubricant on to the bearing as needed. This determines the consumption of lubricant per unit of time. A third method is to plug the lower end of the spiral feeding grooves leading to the bearing surface, add a certain amount (3 cc.) of oil to the bearing and record the power input each

minute. The machine is allowed to run until the maximum allowable power input is reached, and the power is plotted against time. Such a curve gives information regarding the internal friction (power consumption) and also the "durability" of the oil in question.

In the tests made by the writers it has been found that the oil which stands up for the longest period of time without exceeding the allowable power consumption requires a comparatively higher power input *during* that interval of operation than do the other oils which reach the same predetermined maximum in shorter time. This indicates that although the one oil possesses greater durability, most of the other oils require a much smaller power consumption during their time of operation. Hence, the selection of the most economical oil depends on both the cost of the lubricant and the cost of power. The most economical oil is not necessarily the most suitable, however, since factors such as bearing temperature, gumming and cold test must be considered also.

Data of some of the tests are presented in the form of curves and a table (compare Table 1).

From this table it appears that with the flooded type of bearing, oil 14 is by far the most durable, but its average power consumption is greater than that of the other oils (Fig. 3). On the other hand, oils 19 and 30 last for a shorter interval, but during that interval the average power consumption is much less. Hence, if the cost of power is the deciding factor, oils 19 and 30 are probably more economical to employ than is oil 14, the proportional saving depending on the relative cost of power and of the oil.

The tests referred to in this article were carried out at the Research Laboratory of the Berlin Mills Co., Berlin, N. H. (*Metallurgical and Chemical Engineering,* vol. 16, no. 12, June 15, 1917, pp. 692-694. 3 figs., *ed*)

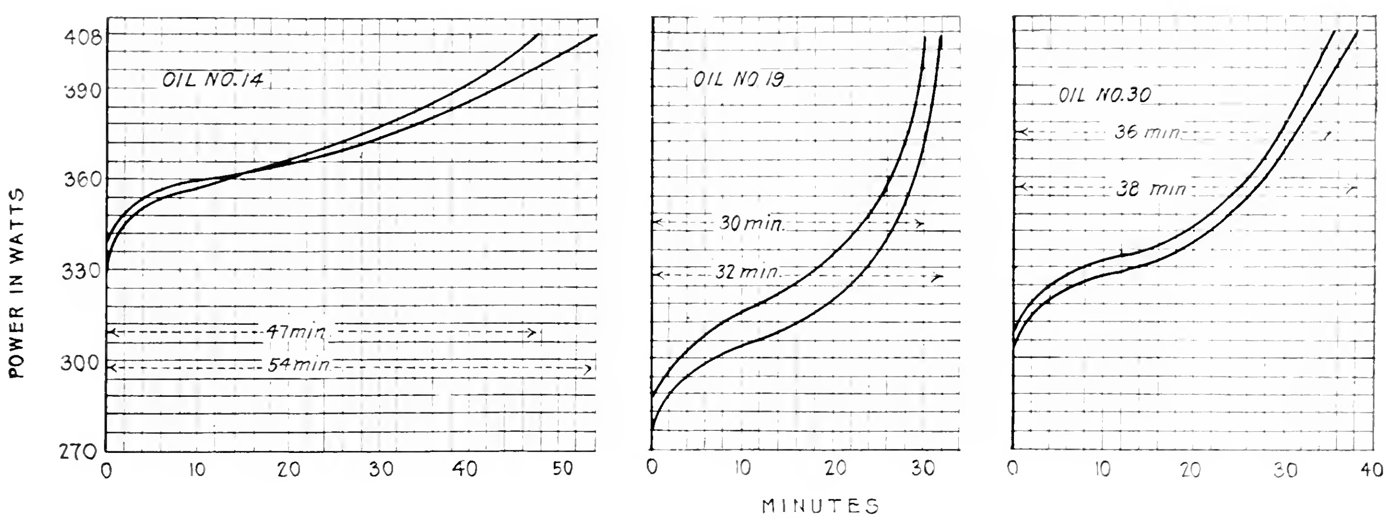


Fig. 3 Curves Obtained in Testing Lubricating Oil

Pumps

Investigation with Screw Pumps, A. Pfeiffer

(*Zeits. ges. Turbinenwesen,* Nos. 17-25, 1916. *Elektrot. u. Maschinenbau,* vol. 35, pp. 10-11, January 7, 1917, Abstract.)

The author presents fresh contributions to the theory and design of screw pumps, based on tests carried out in the Munich Technical Institute. Tests undertaken with and without suction and delivery guide wheels, with sharpened and unsharpened guide and runner-wheel blades, show that this type of pump behaves exactly like centrifugal pumps, and that the fundamental equations of turbine theory are applicable to it. In all the tests it was found that the quantity of water q delivered by the runner wheel $= kn$, that is, is proportional to the speed n r.p.m. Further, if H = delivery head, then $H = k_1n^2$, so that $Q^2 = k_2H$ or $Q = k_3\sqrt{H}$. Since $Q \propto n$, $n \propto \sqrt{H}$, the power N of the pump $= Q\gamma H/75 = k_4H\sqrt{H} = k_5n^3$. This equation and the above ones between Q, n and H are already well known in connection with Francis turbines and centrifugal pumps. The best efficiency of the screw pump (about 57 per cent) is obtained by using a suction guide wheel with sharpened flat blades approximately perpendicular to the direction of rotation, and with an inclination of the runner-wheel blades to the direction of circumferential velocity of $\beta_2 = 30$ deg. Tests without guide wheel show the most favorable blade angle to lie between $\beta_2 = 25$ deg. and 30 deg. The gain in efficiency as compared with the efficiency without suction guide wheel is so small (about 3 per cent) that it is doubtful whether it is worth providing the guide wheel. The influence of a delivery guide wheel on the efficiency of the pump has yet to be determined, the tests made hitherto bearing only on the most favorable blade angle $\alpha_0 = \alpha_3 = 90$ deg. as determined with suction guide wheel alone. As regards the runner-blade angle β_2 giving highest efficiency, it is found that on increasing β_2 from 10 deg. to 50 deg. almost exactly the same delivery on the same head is obtainable, but the efficiency increases up to $\beta_2 = 25$ deg. or 30 deg., and then decreases again. The revolutions per minute decrease to a minimum at $\beta_2 = 30$ deg. (approx.), and thereafter increase again. The delivery head being predetermined, the blade angle β_2 affects only the speed and efficiency of the pump, and *not* the quantity of water delivered. One therefore selects, for each newly designed runner wheel, that value of β_2 yielding the highest efficiency. The efficiency is 55 per cent with $\beta_2 = 25$ deg. and six sharp, flat runner-wheel blades, and apart from the small increase (about 3 per cent) due to addition of a suction guide wheel. If the pump diagram be constructed for this blade angle, the runner-wheel dimensions may be determined for any delivery head and quantity by observing the ratios $b/D = 0.1835$ and $l/D = 0.25$, of blade width and length to runner-wheel diameter. The diagram must be altered when for predetermined

r.p.m. [illegible] exceeds the permissible limit. Results are then [illegible] normally that [illegible] are needed to give the [illegible] calculations. Screw pump wheel may be [illegible] at least [illegible] from each [illegible] should be [illegible] (Science Abstracts, [illegible] vol. 20, pt. [illegible], May 1917, p. [illegible])

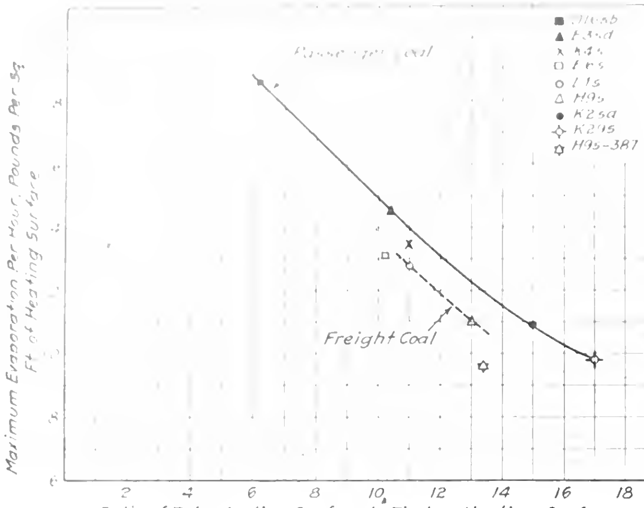


FIG. 4 THE EFFECT OF HEATING-SURFACE DISTRIBUTION ON RATE OF EVAPORATION

Railroad Engineering

MIKADO AND CONSOLIDATION TYPES COMPARED

Additional data (compare THE JOURNAL, May 1917, p. 471) of tests made at the Altoona testing plant of the Pennsylvania Railroad of a Consolidation 2-8-0 type of locomotive as compared with the Mikado 2-8-2 type. The present article reports especially data obtained from the tests on this latter type.

The tests were all run with a wide-open throttle, the speeds ranging from 7.2 to 31.1 miles per hour with cut-offs from 20 to 80 per cent of the stroke. The coal used was run of mine, as used in freight service on the Pennsylvania, with the heating value between 13,600 and 14,300 B.t.u. per lb.

As regards the *boiler performance*, the maximum steam temperature obtained was 590.6 deg. fahr., the superheat then being 207 deg. From curves given in the original article, it is seen that, as a rule, the smokebox temperatures are below 550 deg., indicating the efficiency of the heating surfaces. On the other hand, the firebox temperatures above 2400 deg. for rates of firing above 85 lb. per sq. ft. of grate per hour are unusually high, and the whole range of firebox temperatures is greater than usual.

From comparisons of tests with seven locomotives at the testing plant, it is apparent that the maximum evaporation is closely related to the fire area or the area of all the tube openings. These seven locomotives indicate that under normal conditions each square foot of fire area of the tubes should give a maximum evaporation of about 7000 lb. of water per hour. But with the improved Consolidation locomotives (H9s) a maximum evaporation of only 5308 lb. per sq. ft. of fire area of tubes was obtained. This was due to certain features of construction of the Consolidation locomotive firebox.

Fig. 4 indicates, however, how the relatively large firebox heating surface makes possible a high rate of evaporation per unit of total heating surface.

Other data obtained in the test (compare Fig. 5) indicate the equivalent evaporation per pound of dry coal. The results for the Consolidation are considerably below those for the Mikado, as the latter on a basis of heating surface shows a range of evaporation between 3 and 16 lb. of water per sq. ft. of heating surface.

Very interesting curves of boiler efficiency are shown in

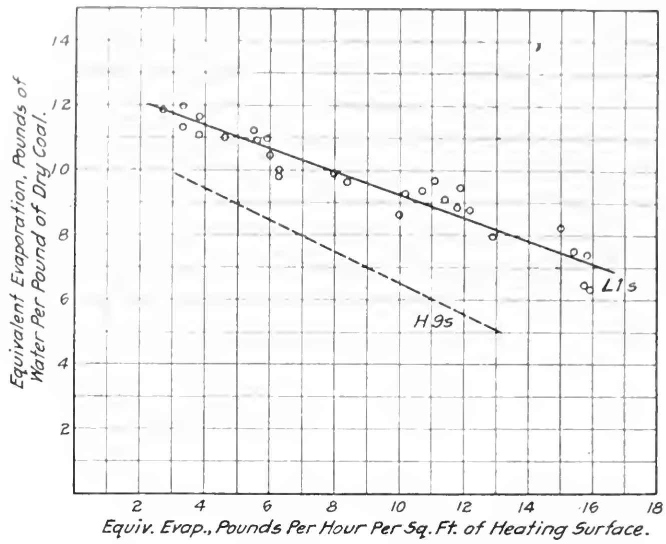


FIG. 5 RELATION OF EQUIVALENT EVAPORATION PER POUND OF DRY COAL TO THE RATE OF EVAPORATION

Fig. 6. They bring out how rapidly the efficiency of the Consolidation boiler falls off compared with that of the Mikado

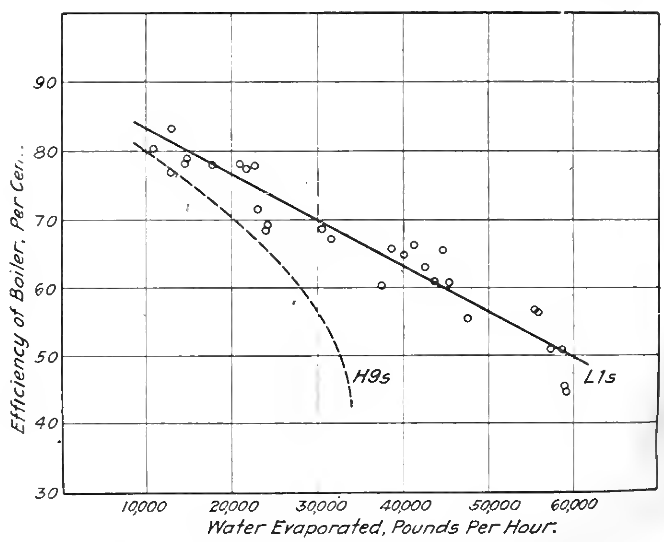


FIG. 6 VARIATION OF BOILER EFFICIENCY WITH EVAPORATION RATE

at rates of evaporation above 2500 lb. per hour. It is stated that for the Mikado the firing rate was between 20 and 175 lb. per sq. ft. of grate, the efficiency of the boiler ranging between 80 and 45 per cent. The maximum evaporation of the Mikado's boiler was 6990 lb. of water per sq. ft. of fire area through the tubes, a rate never before obtained at the test plant.

Engine Performance. The indicated horsepower of the Mikado covered a range between 356, with 20 per cent cut-off and a speed of 7.2 m.p.h., and 2837 at 60 per cent cut-off

and a speed of 31.7 miles per hour. The best steam performance of the Mikado is at a rate of working about 2000 i.hp., the steam rate varying between 19 and 24 lb. The maximum horsepower obtained from the Mikado is greater than that obtained from any other freight locomotive ever tested at the Altoona plant. The curve in the original shows the economical relation of the water rate to the indicated horsepower to be in favor of the Consolidation, probably due to the higher degree of superheat obtained.

On the other hand, in the matter of back pressure the Mikado shows a minimum of less than one pound and a maximum of 16 lb. At the maximum hp. of the Consolidation, which was 1800 in these tests, the back pressure is 8 lb., while the Mikado shows but 4 lb. at the same power. The larger exhaust nozzle of the Mikado (38.3 sq. in. as against 30.9 sq. in. for the Consolidation) probably has an important bearing on this result. Engines of the Mikado type use from 18,500 to 26,100 B.t.u. per i.hp-hr. and convert into work from 9.7 to 13.7 per cent of the heat supplied. In plotting the thermal efficiency of the engines it has been again found that they are the most efficient when developing about 2000 i.hp.

Dynamometer tests have also shown the advantage of the Mikado over the Consolidation for all classes of freight service. In fact, the drawbar pulls obtained indicate that it gives 25 per cent greater pulls at 10 m.p.h. and 60 per cent greater at 30 m.p.h. (Pennsylvania R. R. Testing Plant Bulletin, No. 28, abstracted through the *Railway Age Gazette*, vol. 62, no. 23, June 8, 1917, pp. 1187-1191, 13 figs., *eA*)

Design of Locomotives with Interchangeable Parts

The St. Louis-San Francisco Railway has recently received forty locomotives of modern and heavy types from the Baldwin Locomotive Works, and advantage was taken of the fact that this large order was given at one time. Of these forty locomotives, ten are of the Pacific type for express passenger service, and thirty of the Santa Fe type for heavy freight service. In many respects the two types are similar in construction, and interchangeable details are used when practicable.

Thus, in the case of the Santa Fe locomotives, the machinery and running-gear details are similar to those of the passenger locomotives. The piston valves are interchangeable, and as the frame width and driving journals are of the same dimensions, the driving boxes and shoes and wedges interchange. The same is true of the rear trucks.

The valve gear of the Pacific-type locomotives is of the Baker type and is controlled by the Ragonnet power reverse mechanism. An interesting detail is the pistons, which have rolled-steel heads of dished section with bull rings and packing rings of Hunt-Spiller metal. (*Railway Review*, vol. 60, no. 25, June 23, 1917, pp. 863-868, 9 figs., *d*)

New Electric Locomotives of the Pennsylvania R.R. Co.

In anticipation of the application of electric power to the portion of its main line traversing the summit of the Allegheny Mountains between Altoona and Conemaugh, Pa., the Pennsylvania Railroad has constructed a large electric locomotive.

This locomotive is designed to operate on 11,000-volt, single-phase, 25-cycle current from an overhead trolley. The phase converter changes it to three-phase current for the use of traction motors. These motors, of which there are four, have a rating of 1200 hp. each, giving the locomotive a capacity of 4800 hp. Two motors are mounted on each truck frame; they are geared to a jackshaft impelling the driving wheels through connecting rods, the springs in the gears of these jackshafts being so adjusted as to give the effect of a solid gear up to a tractive effort equivalent to 25 per cent of the weight on drivers. Therefore, under all ordinary conditions, the effect of a solid gear is obtained. (This jackshaft is illustrated in the original article.)

Each truck receives power from its two motors through a spring gear wheel on each side mounted on a jackshaft. Each gear wheel is connected to the three drivers by the usual side rods and the remainder of the drive and running gear is similar to those used for steam locomotives. The spring gear for each truck is of the three-point-suspension type, one point being over the pony truck and the other two points over each frame, consisting of equalizers over each box, elliptical springs between journals and helical springs outside the first and third journals.

The articulation between the motor trucks is of a construction involving a pedestal adjustment to the car center sills. The lower ends of the pedestal legs are connected by means of a tie bar, permitting each truck to rotate around the axis of the center plate without restriction. All bearing surfaces in the articulation are plated with manganese steel. The design is such that pulling and pushing strains between drawbars carry through the trucks and articulation in a direct plane 34½ in. above the rail, so that the cab is entirely relieved of these strains. (*Railway Review*, vol. 60, no. 25, June 23, 1917, pp. 870-873, 7 figs., *d*)

Tests of Corrugated Culvert Pipe under a Sand Bed, Geo. L. Fowler (Mem.Am.Soc.M.E.)

Description and data of tests of pressure produced by a bed of sand. These tests were made in several ways, described in detail in the original article.

The first tests were made with wrought-iron pipes 2, 4 and 6 in. in diameter, 18, 16 and 21 in. long. Each was fitted with a flange coupling at one end, to which a similar flange could be bolted. A sheet of cheap white wood-pulp writing paper was bolted between the coupling flanges. This formed a diaphragm closing the pipe. Wooden plungers were provided that fitted loosely in the pipe and by means of which the pressure could be applied to the paper diaphragm. The amount to burst the diaphragm was noted. Then a fresh diaphragm was put in place and covered to a depth of 1 in. with dry sand. The pressure was again applied and the amount noted. In this way were determined the loads required to burst the paper diaphragms and the results have been plotted in a diagram of bursting pressures, assuming that a circle at the center carrying 60 lb. was the pressure transmitted to the paper and that the annular space outside of it represented the pressure carried by the arching of the sand.

In the diagrams, of which Fig. 7 is given as an illustration, the line B is drawn from the ends of the percentage lines at 3½ diameters of such diagram to the edge of the pipe. The angle which this line B makes with the side of the pipe is 6 deg. 58 min. 37 sec. for the 6-in. pipe, 6 deg. 57 min. 56 sec. for the 4-in. pipe, 7 deg. 2 min. 39 sec. for the 2-in. pipe, or a total variation of 4 min. and 43 sec. This is a very close agreement and may be considered as an approximation to the angle of arching sand. Further, it tallies closely with the investigations of J. A. Jamieson on grain pressure.

These investigations were supplemented by tests with different arrangements in which lateral thrust of the sand under

a superimposed load and the vertical pressure of the sand were recorded by dynamometers. As regards vertical pressure it was found that the bottom pressure decreased with the depth of sand, but for any given depth the ratio of pressure is nearly constant and rises on approximately straight lines as in the other tests above referred to.

However, as regards the pressure of the sides, an entirely different state of affairs was found. With the depth of $10\frac{1}{2}$ in. of sand above the bottom and $4\frac{1}{4}$ in. above the center of the side dynamometers, there was a steady rise in the lateral

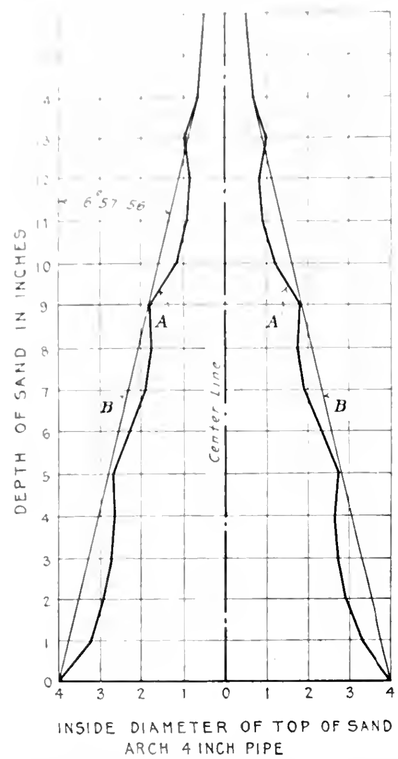


Fig. 7 Diagram of Bursting Pressures of Paper Diaphragm in Tests of Corrugated-Pipe Culvert

thrust as the pressure increased. But when the load was removed from the top the compacted mass of sand continued to exert its side pressure and there was an initial load, and after the depth had been increased and loads were applied there was practically no increase of pressure on the side. In other words the lateral thrust rose rapidly to its maximum under a comparatively shallow depth of sand and then remained practically constant for all increases of depth. It appears from this that on a slightly yielding bottom like that of the type of a corrugated culvert the sand arches and the bottom are relieved of the load.

These tests were checked by another series of tests with a more elaborate equipment. These new tests have emphasized in a marked manner the importance of having the material well tamped against the pipe. It was further found that the sand flows and transmits its pressures without much delay. The influence of a vertical load does not extend very far laterally. During the building up of high pressures the sand yields.

In general, these experiments have corroborated the work of J. C. Meem, who found that in an excavation the lateral pressure increased very rapidly from the top down, reaching a maximum at a point dependent on the angle of repose of the material and then decreasing. It appears that after a certain, as yet undetermined, depth has been reached there can be no further load put upon a culvert pipe by an increase of the depth of cover. And furthermore, such an increase of depth serves directly to protect the pipe against any burden due to an increase of surface loading.

The question next investigated was that of the behavior of culverts under a loading similar to that applied in railway service, where, instead of the application being made on a broad platform covering a considerable area, it is applied through ties of limited width and separated by intervals in which no load is applied to the material. It was found that with the load applied to broad platens, the increase of loading was stopped when the pipe had been deflected by approximately one inch, it being quite evident that the platen would carry a greater load. With the load applied on the ties, the increase was stopped automatically by the ties sinking in the sand and thus refusing to carry more. The result was that the distortion of the pipes under the greatest pressures obtainable was very slight.

These tests have established the fact that under the heaviest load that can be applied to the ties of a railroad track by the wheels of any existing locomotive or car, a 24-in. corrugated culvert pipe having proper depth of corrugation and thickness of metal and buried under a cover of 24 in. of dry sand cannot be deflected beyond its elastic properties of complete recovery of its shape when the load is removed. (*The Railway Gazette*, vol. 26, no. 24, June 15, 1917, pp. 687-691, 7 figs., *e*)

Pennsylvania Locomotive of the Decapod Type

In December 1916 the Pennsylvania Railroad built at the Juniata shops a Decapod locomotive having unusual features of construction, and, among other things, a total weight of

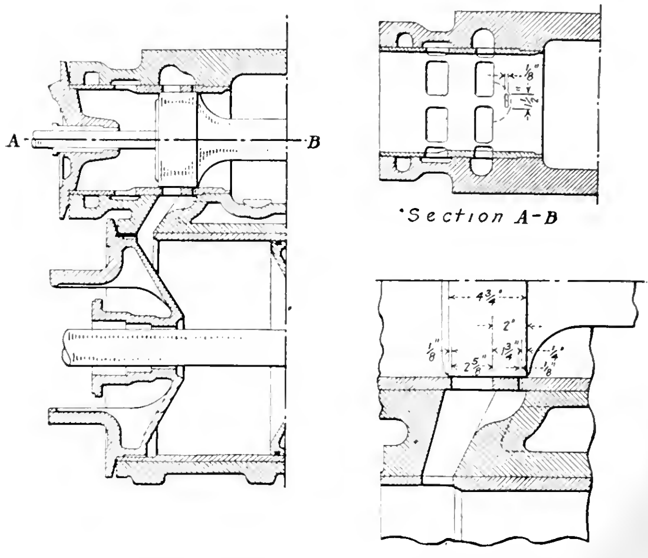


Fig. 8 Details of the Auxiliary Starting Port

366,500 lb., a weight on drivers of 344,500 lb. and a tractive effort of 80,640 lb.

Instead of operating at a maximum cut-off of approximately 90 per cent, the valves have been given a steam lap of 2 in. and a maximum cut-off with a reverse gear in the corner of 50 per cent (for reasons explained below).

The desire to secure a maximum tractive effort in proper relation to the weight on drivers necessitates the use of much larger cylinders than are required where 90 per cent cut-off can be obtained. Hence, the cylinders are made 30 in. in diameter by 32 in. long, the boiler pressure being fixed at 250 lb.

per sq. in., so as to take care of clearance limitations which prohibit a still further increase in the diameter of the cylinders.

The use of a 2-in. steam lap necessitates some auxiliary means of admitting steam to the cylinders when the locomotive is standing, in order that it may be started from any position of the crankpins. This difficulty was overcome in a very simple manner. Pockets about 1¾ in. deep are cored out of the inside edge of each steam port in the valve chamber, two in each port. Two ports, ⅛ in. wide and 1½ in. long, are cut through the valve chamber opposite the openings into the pockets in the cylinder casting. This arrangement is shown in Fig. 8, from which it is seen that the auxiliary ports are so placed that their steam lap is ¼ in. These ports serve merely to move the engine until the main ports are opened.

The purpose of the use of 50 per cent cut-off is to eliminate the range of cut-offs within which the water rate of the cylinder is excessive, thereby making possible an increase in the ratio of cylinder power to boiler capacity. (*Railway Age Gazette,* vol. 62, no. 24, June 15, 1917, pp. 1241-1243, 4 figs., *d*)

Analysis of the Axle-Generator Belt Problem

The *Railway Electrical Engineer* announced in April a competition for papers presenting an analysis of the axle-generator belt problem. The two papers which received the first and second prizes, respectively, are published in the article of which this is an abstract.

J. R. Sloan, Engineer Electric Car Lighting, Pennsylvania Railroad, gives the following list of factors affecting belt life in axle-generator service:

1 Lost motion in running gear of cars
2 Type of generator suspension
3 Track conditions and water conditions
4 Size of pulleys
5 Alignment of pulleys
6 Belt fasteners and their application
7 Character of belt.

The writer then discusses in detail each one of these factors. The size of pulleys used is an important factor in the life performance of the belt; the smaller the diameter of the pulley, the less the area of contact and consequently the greater the belt tension for the same amount of power transmitted. Also the smaller the pulley, the greater the relative motion of the fibers of the belt, and the greater the tendency toward internal wear due to friction of the fibers of the belt on each other. To obtain maximum belt service, therefore, the pulleys should be as large as possible.

As regards belt fasteners and their application, the writer states that all types of belt fasteners known to him, with the exception of one, weaken the belt by cutting the fibers and are objectionable in that respect. They have also the disadvantage of introducing a rigid section in the belt.

The writer has a record of approximately 15,000 individual belts, of about thirty different makes, of widths from 4 in. to 6½ in. and plies from four to six, on which various types of fasteners were used. These belts were rubber, friction and canvas. This record shows car number, date and place of application, and date and place of application of the next belt, and the Car Record Office furnishes the mileage between the two dates and places as above. The belts were practically all bought under the same specifications and the record has been carefully studied with a view of determining what make and type of belt is the most suitable.

The evidence is, however, too contradictory to enable one to say that any one make of belt is best, although it has made it possible to eliminate the purchase of certain belts that were decidedly poor. It has also shown that, with operating conditions as they are, a 5-in. 5-ply belt will give service at the least cost per thousand miles. However, the more these records are studied, the more convinced the writer becomes that the reason for low belt mileage is not so much the quality of the belt used as it is the effect of the other causes enumerated above, and it is believed the fastener is the greatest factor, with rough handling of cars next. The perfect belt fastener for axle-generator service has yet to be devised.

The writer's idea of a suitable belt for axle-generator service is a 5-in. 5-ply belt, the yarn being Sea Isle long-fiber cotton woven to weigh not less than 28 oz. per sq. yd., and with the edges straight, the variation in width not to exceed 3.5 per cent plus or minus.

Each inch of width of each ply should have a tensile strength of at least 200 lb. and the plies should be cemented together with a friction of at least 18 lb. per in. of width when tested at a speed of 20 in. per min. The outer surface should be covered with a 1/32-in. layer of good-quality rubber. The complete belt under test load should not stretch over 1½ in. in 18 in.

J. R. Davis, Electrical Engineer of the Baltimore & Ohio, in discussing the same problem states that his experience has shown that alignment and maintenance of suspensions and trucks is a more vital factor in affecting belt life than the difference between the two general types of suspension. In addition, the kinds of belting and fasteners used are also important factors affecting belt maintenance. The following belt-performance data with various types of suspensions are based on an average extending over a period of more than two years. The number of equipments shown, however, are those at present in service.

Table 2 Data on Axle-Generator Belting, Baltimore & Ohio R. R.

Type of Suspension	No. of Cars	Average Belt Mileage
TRUCK SUSPENSION		
Two-point swinging link	44	14,300
Parallel link with belt passing over end frame and under brake beam	24	21,500
Parallel link with open-end truck and inside-hung brake beam	8	35,000
Inverted link	33	15,900
BODY SUSPENSION		
Variable-speed generator with constant-tension device	60	16,900

The experience so far obtained does not permit of reaching any definite decisions with reference to types of suspensions and kinds of belting, but indicates the following:

1 The belting and belt fasteners that have given very satisfactory results with truck-mounted generators may not be at all adapted for body-mounted generators.

2 To secure the best results, with respect to belt life, with body-supported generators of constant-speed type, a belt of special quality is required which should, however, give equally satisfactory results with other types of equipment.

3 Truck-mounted generators of either the two-point swinging type or parallel type, with open-end truck and inside-hung brake beam, thus eliminating all possibility of belt interference, will give longest belt life.

4 The advantages of the body-supported generator as compared with the truck-supported are that it has greater ease for

inspection and making repairs, especially under adverse weather conditions; materially reduced maintenance cost of [illegible] incidental thereto, which will probably be [illegible] greater importance than any differences that [illegible] belt life. (*Railway Electrical* [illegible], no. 6, June 1917, pp. [illegible])

Steam Engineering

Construction and Operation of Boilers for Intensive Service, F. Munzinger

(*Zeits. Vereines Deutsch. Ing.*, vol. 60, pp. 933-939, Nov. 11; 958-962, Nov. 18; 1001-1006, Dec. 2, and 1017-1021, Dec. 9, 1916)

The author considers modern boiler practice from the standpoint of cheapness obtained by better utilization of constructional materials and higher stressing of the finished equipment. The influence of turbine development on boiler practice has been far-reaching. The possibility of concentrating very high power in single, compact units led to the development of two-story boiler houses; large overhead bunkers gave way to small pockets directly coal-handling plant became sufficiently reliable; this eliminated much heavy ironwork and saved greatly on the size and cost of buildings. By using comparatively small and cheap feed heaters it became possible to add to overall efficiency while cutting away that portion of the boiler which would otherwise extract heat from the cooled flue gases. A good example of the nature and rapidity of progress in boiler practice is to be found in the power stations erected by the A. E. G. during the period 1908-1912. The boiler-house designs submitted in 1906 contemplated a cheaper construction than had hitherto been employed, and these plans were further improved in respect of the space occupied by feed heaters. By building the economizers of wrought instead of cast iron, and by making them an organic part of the boilers, sufficient saving was effected to outweigh the probably shortened life of the economizer tubes; also, loss in the pipe line was reduced by the shorter pipes and higher steam velocities possible. The first cost of the whole boiler installation and the invariable losses are both reduced considerably. Interesting data concerning boiler installations in South Africa, at Brakpan, Simmerpan, Roshervilledam, and Vereeniging, respectively, are as follows: Date of construction, 1908, 1909-1910, 1911, 1912; weight of boiler, feed heater, and induced-draft equipment, 405, 405, 306, 323 kg. per sq. m. of boiler heating surface; total weight of boiler equipment and steelwork of boiler house, 576, 546, 344, 400 kg. per sq. m. of boiler heating surface; ground space of boiler house, 0.292, 0.287, 0.204, 0.204 sq. m.; space occupied by boiler house and bunkers, 5.70, 5.24, 3.05, 2.24 cu. m. per sq. m. of boiler heating surface in all cases. The cost of boilers in a modern central station working at a high load per unit of heating surface is 25 to 30 per cent of the total installation cost, and the constant losses of the boiler are more serious with the usual type of load curve than in works with nearly constant load. In the case of a public supply station, even the shortest interruption of supply must be avoided at any cost. As a consequence, special desiderata in the boiler equipment are maximum efficiency, adaptability to load variations at minimum capital expense, great reliability and liberal reserve capacity.

Boilers are almost unique in the amount of careful attention which they demand in respect to often contradictory requirements, and there cannot be a boiler which is at once the most desirable for such industrial service as that of a paper mill, and also for central-station work. Too much importance is often attached to a high thermal efficiency, apart from other considerations. The total cost of one ton of steam must be a minimum, and this includes interest and depreciation on the first cost of the boilers with buildings and site, and the cost of coal, repairs, maintenance, and attendance. High efficiency increases in importance with rising price of fuel and longer working hours, but the other factors in "total cost" should never be overlooked. Good efficiency, high steaming capacity, and compact construction are often found in boilers which have serious organic defects, and when an apparently good boiler is discovered, it often happens that some part of the equipment or construction is very unsatisfactory (e.g., defective brickwork or bad grate bars in an otherwise satisfactory boiler).

The steaming capacity, referred to heating surface, has been so much increased that a continuous output of 35 to 40 kg. per sq. m. is nothing unusual in modern boilers. To allow for the heavier depreciation and repairs, the cost of these items should be referred to the weight of steam produced and not to the heating surface. This applies particularly to the fire arch and lining of the combustion chamber. A characteristic of well-designed high-power boilers is the flat course of the upper portion of their efficiency curve, due to the large heating surface exposed to radiation over the grate and to the large economizer surface (as compared with boiler heating surface). In boilers with inclined tubes, radiation from the large volume of luminous flame in the combustion chamber is an important factor, and gives additional efficiency, which is, however, offset to some extent by the better transfer of heat by contact when the gases are guided through and through the tubes by baffle plates. Test data relating to six modern high-power boilers, with heating surfaces ranging from 344 to 770 sq. m., economizers and induced draft, show the evaporation to range from 18 to 53 kg. per sq. m. of heating surface per hour; boiler efficiencies (including superheater) from 67.3 to 81 per cent; and overall efficiencies from 79 to 90 per cent. Tests on two boilers, taken for 24-hour periods without the knowledge of the boiler crew, showed the efficiency to be only about one per cent lower after six months' service than the value obtained during the acceptance test. Heavy brickwork mounting causes an apparent decrease in efficiency during the period at the beginning of the day and a corresponding increase at night after the load decreases. An A. E. G. boiler with plate casing, however, withstood load reduction from 6000 kw. to 2800 kw. in ten minutes without blowing off, although the pressure all day was within 7½ lb. of the safety-valve setting.

The water connections between the bottom drums of vertical and inclined water-tube boilers should be so arranged that the circulating water passes through the lowest parts of the drums. Where boilers have to be put in and out of service very frequently, provision should be made to pass steam from the mains into the lower drums so as to equalize heating and reduce unbalanced stresses. The author shows diagrammatically the water and steam circuits in various boilers, and discusses the relative merits of the several arrangements. Where very reliable load has to be supplied, there is some advantage in preheating the feedwater on part of the boiler heating surface before mixing it with the remainder of the water; part of the boiler then serves the function of economizer. The author considers it of minor importance whether water tubes are straight or curved; it is a little easier to inspect straight tubes, but it is not easier to form a correct estimate of the thickness of scale; probably the chief advantage of straight lines is the simplicity of renewals. In boilers with separate steam and water connections between the upper drums, the steam velocity

may range from 2½ to 8 m. per sec., but if a common connection for water and steam be used, the velocity must be reduced to 0.8 to 2½ m. per sec. (approximately). When water in the front drum is very much agitated by severe working of the front tubes, steam in the front drum is apt to be very moist, and it is given an opportunity of separating if the flow to the rear drum is subdivided and at moderate speed. Moderate steam velocity also favors uniform pressure and water level in the two drums: if any marked pressure difference exists, pressure variations with fluctuating load are transmitted partially through the water tubes, disturbing the water circulation and producing wet steam. Owing to the violent agitation of water in the top drums of water-tube boilers, special measures are generally needed to secure dry steam. The author recommends that in all cases a separate, large steam accumulator should be provided between the top drum and the steam main. The greater the heating surface, the larger must be the top drums, steam accumulator, and all internal water and steam connections of a vertical-tube boiler. It is not enough merely to change the grate surface in order to change the steaming capacity. If properly designed and constructed, this type of boiler will give as dry steam as double-header boiler.

In large central-station boilers an automatic feed regulator is generally installed between economizer and boiler. The economizer is then exposed to all shocks in the feed pipe, and if of cast iron is particularly liable to be damaged. It is preferable to place the regulator in front of the feed heater, especially as this does not affect the actual feeding in any way. Quick-acting control valves naturally cause greater pressure rises than slower valves; air vessels reduce the shocks caused by quick-acting valves, but it is better to use a slow-acting valve. Pressures up to 25 atmospheres were reached in front of a quick-acting valve controlling the feed to a large boiler through a 100-m. pipe line. Higher water velocities and more severe stresses are reached with intermittent than with continuous feed. Steam generated in the feedwater can escape more easily if the control valve is not between economizer and boiler.

The author gives the results of measurements by optical pyrometer on various types of boilers at various loads. The firebox temperatures range from 1067 deg. to 1500 deg. cent. The combustion space of vertical-tube boilers is generally much loftier than that of double-header water-tube boilers, and in order to bring the flames into close contact with the tubes, large arches were often placed over the grate in the early vertical-tube boilers. By preventing direct radiation to the heating surface, such arches increase the temperature of the combustion chamber, favoring complete combustion, but shortening the life of the refractory bricks. In a certain case the furnace lining became useless after 600 working hours due to this cause. The better heat transmission by radiation in an open combustion chamber compensated for the less favorable transmission by contact.

Flue passages must be such that there is maximum "washing" of the heating surface, with minimum loss of draft. Sharp turns, and pockets in which explosive gas mixtures might collect, are to be avoided. Easy access should be provided to rivets, flanges, etc., and for cleansing. The lower drum should foul up very slowly. Manholes should be properly sealed and protected from the heat; suitably placed inspection posts are very useful, as also are openings for pyrometers. Staggered tubes are useful, especially in the back rows, so long as renewals are not made difficult. Tubes should not be set at too small pitch, otherwise the cost of construction is increased, and even flow of gases and good heat transmission are made impossible. The great difference in output per sq. m. of heating surface of economizers differing little in construction is due to the more or less complete distribution of gases over the heating surface. Consequently it is difficult to establish any definite relationship between feed heating performance and gas velocity. Provision should be made for varying the effect of the superheater at will; refractory plates should be used, and a temperature regulator is desirable where the quality of the coal varies much and often. By placing the superheater in parallel with part of the heating surface, the steam temperature may be kept nearly constant within a wide range of load. The superheater should be surrounded by boiler heating surface rather than by brickwork, otherwise very high steam temperatures may be reached after a sudden decrease in load.

A good fireproof material for boiler masonry must resist high temperatures without melting or softening. Quartz tiles resist intense heat, but are sensitive to temperature changes, and do not resist the fire so well in the direction of their grain as perpendicular thereto. Firebricks composed of SiO_2 and Al_2O_3 are used more commonly. Classification of such bricks as acid or basic is lax and unreliable. A small percentage of such fluxes as Fe_2O_3, CaO, MgO, K_2O lowers the heat-resisting value of the brick. Quartz additions always lower the melting point. Undue importance should not be attached to high Al_2O_3 content, nor should the Seger cone number be taken as a complete index of refractoriness. (*Science Abstracts*, Section B—Electrical Engineering, vol. 20, pt. 5, May 1917, pp. 161-164)

Steel Plant

Relative Methods of Forming Steel by Pressing, Hammering, or Rolling, John Lyman Cox

Paper presenting comparative data on effectiveness and quality of product in very heavy work with hammers and presses. The paper is partly historical.

With the exception of the tube, which is generally made solid, the larger forgings for heavy artillery are usually made hollow, as are marine shafts and other forgings when desired of especially high quality. As it is difficult to manipulate under a hammer, in upsetting and punching, blocks too heavy to be handled on levers, it is customary to bore the ingot with a hole of considerable size and cut from it a hollow block of the proper weight for the job. This involves a considerable waste of material, which may, however, be avoided by proper arrangements.

The width of a hammer anvil block is not great, and if the forging is heavy, it is, in practice, necessary to use an ingot of initial section sufficient to give the requisite weight in the short length that will go between the checks of the mandrel housing, for upsetting of heavy blocks under a hammer is impracticable.

The employment of ingots of large cross-section being objectionable for various reasons constitutes one weakness of the hammer, namely, it cannot make great hollow forgings such as are easily producible under the press. It might be urged that an anvil of a special design would permit the use of long billets of less diameter, but the low, unsupported mandrel will not withstand the impact of hammer blows. A 14-in. mandrel on a span of 45 in. to open a hole some 2 in. is about the limit for a hammer.

When made under a hammer of ample power, forgings show test results practically identical with press forgings made

under the same conditions, so long as neither is expanded, but beyond the point where hammer expansion is possible, the advantages are altogether with the press.

Lest it be thought that too much stress is laid upon the advantages of expansion in the manufacture of hollow forgings, the writer cites an experience of the Midvale Steel Company with jackets for a lot of 12 in. steel coast defense mortars. These were rather short forgings drawn on about a 19-in. mandrel and bored originally with a 20 in. hole. The hole was so small that it had been decided expansion would not pay. But on testing, the jackets gave a great deal of trouble, and it was concluded to bore the ingot with a 11.5-in. hole, expand on a 14 in. mandrel to 16.25 in. in diameter, substitute a 15.75-in. mandrel and expand to 20 in., and after this draw the forgings in the V die as before. Expansion of the whole increased the outside diameter by only $1\frac{5}{8}$ in., giving that much reduction in the V-dies, but on the other hand, the amount of testing was reduced to 21 per cent.

The danger in solid hammered work is always that for economy's sake too light a hammer is used, and the forging left with an imperfectly reduced grain size towards the center.

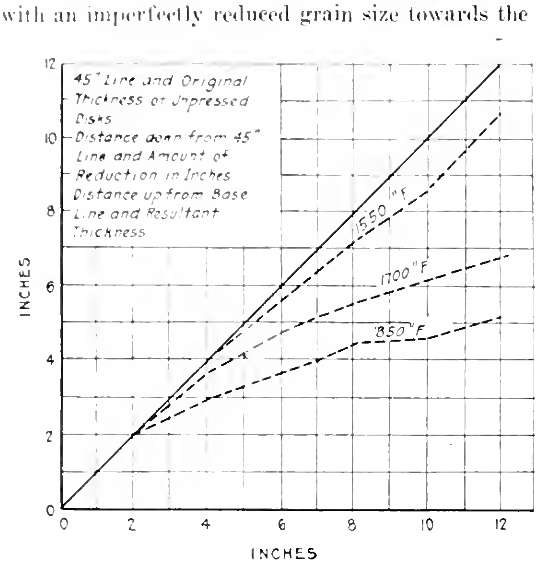


Fig. 9 Relative Effects of Various Thicknesses and Temperatures from Experiments on Forging Pressures

The pressure produced by a hammer is directly proportional to the effective stroke and inversely proportional to the contact area of the dies and to the distance through which the pressure is exerted. The pressure exerted by a press is independent of the stroke, is definite in amount, equaling the net power of the tool divided by the contact area of the dies and the piece being forged.

In press forging the work is turned up after every stroke, thus always presenting a new and smaller contact surface. In cogging down an ingot under a hammer before rounding up begins, several blows are usually struck in the same spot until fear of lapping stops them. Due to the inertia of the part of the ingot beyond the die at the instant the blow falls, there is a tendency to cock up the end of the piece, and the tendency in practice is to let it occur and for the hammer die to cut in more deeply on one side of the ingot than on the other, gradually throwing the axis of the forging out of the axis of the ingot. This does not occur in the press.

As regards the limits of effective reduction, the writer calls attention to the fact that friction between press-die faces and their work is very great, while the longer time of contact as compared with the hammer tends to chill the surface of the forging and to prevent the flow along the die faces. This results particularly in a reduction of the effective thickness of the forging and the increase in the pressure required to forge it. The article gives a table containing ratios of thickness to pressure; in addition to this, Fig. 9 is given, showing graphically the relative effects of the various thicknesses and temperatures employed in a recent series of experiments. The important influence of thickness is corroborated by two full-sized experiments, where, in upsetting at full forging heat 37 in. octagon slices from 43 in. to 13.5 in. in length, it required 8700 tons, which, figured on the areas of the final diameters of 59 in. and 65 in. at the die faces and center, respectively, gives 3.18 tons per contact inch and 2.6 tons at the center. In upsetting the 48-in. round from 45 in. long to 33 in. long, it took only 1.4 tons per sq. in. of contact area and 1.3 tons per sq. in. of median area, on account of the extra thickness of the piece.

With all its advantages, such as convenience of handling and absence of shock, the press has two failings, due to its lack of impact: first, it is harder to get rid of scale, and second, it cannot strike in a mold as large a forging as a hammer its equivalent in other respects. At the Midvale Steel Company they consider a 500-ton press the equivalent of a $2\frac{1}{4}$-ton hammer; a 1200-ton press the equivalent of a 10-ton hammer, and a 2500-ton press the equivalent of a 25-ton hammer. Yet the $4\frac{1}{2}$-ton hammer can make drop forgings which are beyond the power of a 1200-ton press, and a $2\frac{1}{2}$-ton hammer can about equal it.

The rest of the article is devoted to a comparison of forged and rolled rounds and to armor-plate practice. (*The Blast Furnace and Steel Plant,* vol. 5, no. 6, June 1917, pp. 252-257, 8 figs., *e*)

Thermodynamics

Concerning the Absolute Value of Entropy and Energy, E. Ariès

The writer asserts that there is an initial stage common to all bodies and convenient to be used as a starting point for measuring their entropy and energy. For all bodies this state is defined by the following conditions: The body is at zero absolute temperature, is condensed to the state of saturation, and not subject to any pressure. Any finite increase of volume to which it may be subjected at constant temperatures results only in the body being forced to emit at fixed pressures ($T = 0$, $p = 0$) an inappreciable quantity of vapor (which cannot be measured), so that the entropy and energy of the body remain nil.

On the other hand, every reduction of its volume obtained by means of compression at constant temperature increases its pressure and energy which have at first been nil and now become positive, but its entropy remains at zero. In short, a body when at zero of absolute temperature has an entropy equal to zero and an energy either nil or positive, no matter what may be the pressure to which it is subjected and the volume which it occupies.

Let v be the volume thus occupied by the body at zero absolute temperature. Next, let the body while maintaining the constant volume undergo a succession of increases of temperature dT in such a manner as to bring about some state determined by its initial volume v and by its final temperature T. As often happens, the application of these elementary transformations of one of the laws so fruitful of displacements of equilibrium leads to quite remarkable conclusions.

The law under consideration in this case states that each

transformation at constant volume with a positive variation dT of temperature will produce an increase of entropy, the product $dSdT$ being necessarily positive. From this it follows that the entropy S of a body taken in any state whatsoever determined by its volume and its temperature (v, T) is a positive quantity, except for the case of the zero absolute temperature, when this entropy becomes equal to zero. In each of the elementary transformations thus considered, the variation of energy dU is given by the classical formula

$$dU = TdS - pdv$$

and as $dv = 0$,

$$dU = TdS$$

Since, according to what has been stated above, dS is positive, so will be dU. Each elementary rise dT of temperature will produce an increase of energy, and as the body starts from temperature zero with an energy nil or positive, it will necessarily reach a temperature T and a volume v, i.e., any state whatsoever, with a positive energy.

These two important consequences of the fundamental principles of thermodynamics tend to throw a vivid light on the notions of *absolute magnitude of entropy and absolute magnitude of energy.* It has just been shown that the entropy and the energy of a body can never go below the value which they have at the initial stage, as selected and defined above. And that can only mean that both the entropy and the energy of a body are quantities perfectly determined, usually positive, never negative, which are to be measured from this initial stage.

Furthermore, there is nothing surprising in the conditions under which entropy and energy become zero. In fact, these conditions appear fairly rational. The body maintained at the limit temperature of zero absolute, no matter what pressure it may be under, can have no tendency to transmit heat to the ambient medium, which is at least at the same temperature: hence, it is entropy which cannot undergo any reduction and has to be considered as being zero. If, in addition to that, the body does not support any pressure, then it has no expansive force, though capacity for work. And if it can cede its energy neither in the form of heat nor in the form of work, its energy must also be considered as nil. (*Sur la valeur absolue de l'entropie et de l'énergie.* E. Ariès. *Comptes rendus des séances de l'Académie des Sciences*, vol. 164, no. 20, May 14, 1917, pp. 774-776, *t*)

A Determination of the Heat of Vaporization of Water at 100 Deg. Cent. and One Atmosphere Pressure in Terms of the Mean Calorie, T. Carlton-Sutton

An article describing how the value of the latent heat of vaporization of water at 100 deg. cent. and one atmosphere pressure was measured directly in terms of the mean calorie by using a steam calorimeter that may be regarded as a development of Joly's classical apparatus. It is claimed that a high degree of accuracy has been attained on account of

1 An ice-bath that remains steady for one or two hours
2 A shielding device, by means of which a damp body can be left hanging in a steam chamber without loss or gain in weight: and
3 A determination of the effect of the dampness of the steam.

The temperature of a bulb of thermal capacity K is raised from the freezing point θ to the boiling point Θ by surrounding it with steam, a mass m of steam being condensed on the bulb, where

$$K(\Theta - \theta) = mL.$$

The bulb was then filled with water (of mass M) and the process repeated, a mass m' of steam being condensed, where, omitting small corrections,

$$(K - Ms)(\Theta - \theta) = m'L$$

whence

$$L = \frac{Ms}{m' - m}(\Theta - \theta) .$$

i.e., the heat of vaporization is measurable in appropriate calories $(s = 1)$ in terms of a temperature difference and the ratio of the masses M and $(m' - m)$.

The author then proceeds to describe the apparatus used and details of the method of experimentation and the necessary corrections applied.

The following results have been obtained: Determination with first bulb, 538.89 mean calories; with second bulb, 538.86 mean calories. These determinations are independent in the sense that they have been made with different bulbs and under different conditions of steam supply, and that any one measurement is used in one series only.

The values may be expected to agree to within seven or eight units in the fifth figure, a degree of accuracy that is confirmed by the experimental figures (see Tables).

The conclusion is, therefore, that the value 538.88 mean calories for the heat of vaporization of water at 100 deg. cent. and one atmosphere pressure is correct to the fourth significant figure for the samples of steam used; and in consideration of the results of Section E IX, it is held that the dampness of these samples has not affected the result to the extent of one part in 5000. (*Proceedings of the Royal Society*, Series A, vol. 93, no. A 649, pp. 155-176, 3 figs., *eA*)

Prizes for Research on Hardness of Metals

The Institution of Mechanical Engineers (Great Britain) has announced that Sir Robert A. Hadfield has placed in its hands the sum of £200, which, with any income thereon, may be awarded at the discretion of the Council of the Institution as a prize or prizes for the description of a new and accurate method of determining the hardness of metals, especially of metals of a high degree of hardness.

The ordinary tests of hardness such as are described in the report of the Hardness Test Research Committee (*Proceedings of the Institution of Mechanical Engineers*, 1916, pp. 677-778) fail to some extent when the hardness of the material exceeds about 600 to 800 Brinell. What is desired is a description of a research for, or an investigation of, some method of accurately determining hardness suitable for application in metallurgical work in cases where present methods partially fail.

The Council of the Institution will consider annually all communications received, but in January 1922 the offer of prizes will be withdrawn. Communications should be addressed to the Secretary, The Institution of Mechanical Engineers, 11 Great George St., Westminster, London, S.W.1, and marked "Method of Determining Hardness," and should reach him at least one month before the first of January in any year.

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

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A Departure in Design of Export Coal Piers. Railway Age Gazette, vol. 62, no. 24, June 15, 1917, pp. 1226-1230, illustrated.

†Pennsylvania Locomotive of the Decapod Type. Railway Age Gazette, vol. 62, no. 24, June 15, 1917, pp. 1241-1243, 4 figs.

†Decapod Locomotive for the Pennsylvania R. R. Railway Review, vol. 60, no. 25, June 23, 1917, pp. 875-878, 15 figs.

†New Electric Locomotive, Pennsylvania R.R. Railway Review, vol. 60, no. 25, June 23, 1917, pp. 870-873, 8 figs.

Small Locomotives Used at the Front. Railway Age Gazette, vol. 62, no. 25, June 22, 1917, pp. 1383-1386, 7 figs.

Quick Repairs to a Heavy Locomotive. Railway Age Gazette, vol. 62, no. 25, June 22, 1917, pp. 1370-1373, 6 figs.

†Tests of Corrugated Culvert Pipe under a Sand Bed, George L. Fowler. The Railway Gazette, vol. 26, no. 24, June 15, 1917, pp. 687-691, illustrated.

Betrachtungen über die störenden Nebenbewegungen der Eisenbahn-Fahrzeuge mit besonderer Berücksichtigung des Einflusses der Radreifen-Konizität, U. R. Ruegger. Schweizerische Bauzeitung, band 69, no. 24, June 16, 1917, pp. 271-276, illustrated.
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The Ronay Metal Briquetting Process, A. L. Stillman. Automotive Engineering, vol. 2, no. 3, March 1917, pp. 77-79, 5 figs.

Reclaiming and Reusing the Factory Scrap, Joseph H. Gallon. Automotive Engineering, vol. 2, no. 4, April 1917, pp. 113-116, 2 figs.

The Briquetting of Metal Swarf. No. 3. The Engineer, vol. 123, no. 3208, June 22, 1917, pp. 557-588, figs. 5-6.

Ny Metod för Ekonomiskt Tillgodogörande af Metallaffall. Teknisk Tidskrift Mekanik, 47 arg., häft 6, pp. 53-55, 6 figs.
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Exhaust Heads. Practical Engineer, vol. 21, no. 13, July 1, 1917, pp. 534-535, 6 figs.

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The Development of the Water Tube Boiler, W. F. Schaphorst. Steam, vol. 20, no. 1, July 1917, pp. 3-5. (to be continued).

Use of Thermometers to Increase Boiler Efficiency, H. A. Cozzens, Jr. Practical Engineer, vol. 21, no. 14, July 15, 1917, pp. 583-584.

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†Sur la valeur absolue de l'entropie et de l'énergie, M. E. Ariès. Comptes Rendus Hebdomadaires des Séances de L'Académie des Sciences, tome 164, no. 20, May 14, 1917, pp. 774-776.
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Intorno ad Alcuni Modi di Calcolare L'Esperienza di Clement e Desormes e di dedurne l'equivalente meccanico della caloria, G. Guglielmo. Il Nuovo Cimento, Anno 62, serie 6, vol. 12, 2 Sem., fasc. 11, November 1916, pp. 195-212.
Concerning some methods of computing the experimental data of Clement and Desormes, and of deducing from them the value of the mechanical equivalent of heat.

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Assisting Shrinkage in Autogenous Welding by Mechanical Means. The Railway Gazette, vol. 26, no. 25, June 22, 1917, p. 717, 1 fig.

VARIA

Balancing Machine Improved. The Automobile, vol. 36, no. 24, June 14, 1917, pp. 1132-1133, 3 figs.

The Primary Volatile Products of the Carbonization of Coal, Guy B. Taylor and Horace C. Porter. Bureau of Mines, Technical Paper 140, 55 pp., 25 figs.

The New Engineering Laboratories. The Technology Review, vol. 19, no. 1, January 1917, pp. 1-8.

The National Physical Laboratory in 1916-1917. Engineering, vol. 103, no. 2686, June 22, 1917, pp. 598-599, 1 fig. (to be continued).

National Physical Laboratory Report for the Year 1916-17. Flight, no. 443 (no. 25, vol. 9), June 21, 1917, pp. 611-612.

Workshop Training of Apprentices in the Light of Recent Developments, Neil J. Maclean. Engineering, vol. 103, no. 2686, June 22, 1917, pp. 583-584.

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L'Enseignement Technique Supérieur, Discussion sur la formation des ingénieurs à la Société des Ingénieurs Civils de France. Le Génie Civil, tome 70, no. 25, June 23, 1917, pp. 399-404.
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The Relation of American Colleges and Universities to the National Government. Engineering Education, vol. 7, no. 10, June 1917, pp. 591-609.

How to Organize a Fire Drill in Your Factory, Chief Guerin. Construction, vol. 4, no. 3, March, 1917, pp. 119-120.

Six United States Army Wing Sections, Captains Edgar S. Gorrell and H. S. Martin, U.S.A. Aviation and Aeronautical Engineering, vol. 2, no. 6, April 15, 1917, p. 256.

The National Research Council and Its Chemistry Committee, A Preliminary Statement to the Chemists of the United States. The Journal of the American Chemical Society, vol. 39, no. 5, May, 1917, pp. 841-855.

Some Observations on Dust Separator Problems, B. F. Henry. Metal Worker, Plumber and Steam Fitter, vol. 87, no. 15, April 13, 1917, pp. 479-481, 7 figs.

The University Man as an Industrial Asset, Dwight T. Farnham. Industrial Management, vol. 53, no. 2, May, 1917, pp. 209-216.

The Divining Rod, A History of Water Witching, with a Bibliography by Arthur J. Ellis. Water-Supply Paper 416, Department of the Interior, United States Geological Survey, 59 pp.

Goodyear Adopts Metric System. Scale Journal, vol. 3, no. 8, May 10, 1917, p. 7.

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New Chicago Electric Steel Works, George H. Manlove. The Iron Trade Review, vol. 60, no. 19, May 10, 1917, pp. 1039-1040, 1 fig.

Reducing Cost of Ingot Molds. The Iron Trade Review, vol. 60, no. 16, April 19, 1917, pp. 880-884, 12 figs.

Hyperbolic Analysis for Engineering Problems, W. D. Peaslee. Journal of Electricity, vol. 39, no. 1, July 1, 1917, pp. 8-10.

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Balanced-Rudder Stocks, Peter Doig. The Shipbuilder, vol. 16, no. 82, June 1917, p. 310.

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Chart to Determine Relative Cost of Coal and Oil Fuel, R. L. Wales. Engineering and Mining Journal, vol. 103, no. 26, June 30, 1917, pp. 1147.

The Synthetic Air Chart, Dr. E. V. Hill. Journal of the American Society of Heating and Ventilating Engineers, vol. 23, no. 4, July 1917, p. 494.

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Chart Showing Power Required to Move Air Through the Channels, Arthur K. Ohmes. Journal of the American Society of Heating and Ventilating Engineers, vol. 23, no. 4, July 1917, p. 581.

LIBRARY NOTES

From the Libraries of the Four Founder Societies and the United Engineering Society, in the Engineering Societies Building, New York City

A. S. M. E. Accessions

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GREENFIELD TAP AND DIE CORPORATION. Manual containing instructions and information issued to employees *Greenfield, n.d.* Gift of Greenfield Tap and Die Corporation.

HOW TO PUT THE CRIPPLED SOLDIER ON THE PAYROLL. By Frank B. and Lillian M. Gilbreth. Reprinted from the May 1917 number of the Trained Nurse and Hospital Review. Gift of Author.

INDUSTRIAL DEVELOPMENT IN KANSAS. By P. F. Walker. Gift of A.S.M.E.

INTERNATIONAL HIGH COMMISSION. An appendix to the report of the United States section of the International High Commission on the first general meeting, held at Buenos Aires, April 3-12, 1916. U. S. Senate, 64th Congress, 2d session. Doc. No. 739. *Washington, 1917.* Gift of A.S.M.E.

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS. Proceedings, 1909-10, 1915-16. *Boston, 1909, 1915.* Gift of Association.

OUTLINE OF THE METALLURGY OF IRON AND STEEL. Blue print. By Frank E. Sanborn. *1917.* Gift of author.

POLYTECHNIC ENGINEER. Vol. XVII, 1917. *Brooklyn, 1917.* Gift of Brooklyn Polytechnic Institute.

RICE'S GUIDEBOOK ON WATER TREATING FOR INDUSTRIAL PURPOSES. By Cyrus W. Rice. *Philadelphia, n.d.* Gift of author.

SCIENTIFIC MANAGEMENT PRACTICALLY APPLIED. Address by Fred J. Miller before the Cleveland Chamber of Commerce, Dec. 12, 1916. Gift of F. J. Miller.

THEORETICAL DEPRECIATION. Presented for the consideration of the Public Service Commission for the First District, State of New York, by the Consolidated Gas Company of New York. Gift of A.S.M.E.

U. E. S. Accessions

AMERICAN GAS INSTITUTE. Proceedings. Vol. XI, pt. 1-2. *New York, 1917.* Purchase.

BOSTON PUBLIC LIBRARY. Annual Report of the Trustees, 1916-17 *Boston, 1917.* Purchase.

CARNEGIE LIBRARY OF PITTSBURGH. Annual Reports to the Board of Trustees. 21st. *Pittsburgh, 1917.* Purchased.

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COMITE CENTRAL DES HOUILLERES DE FRANCE. Codes Miniers—Russie. *Paris, 1895.* Purchase.

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ELECTRIC SWITCH AND CONTROLLING GEAR. By Charles C. Garrard. *London, 1916.* Purchase.

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THE EXTENSION OF MUNICIPAL ACTIVITIES and its effect on municipal expenditures, including a review of the budgets of New York City since consolidation, 1898-1917. Lecture by W. A. Prendergast. Delivered at the College of the City of New York, Feb. 14, 1917. Gift of New York City Dept. of Finances.

GEOLOGY OF A PORTION OF THE FLATHEAD COAL AREA, BRITISH COLUMBIA. Canada. Mines Department. Memoir 87. *Ottawa, 1916.* Purchase.

HYPERACOUSTICS. Division I—Simultaneous tonality. By John L. Dunk. *London-N. Y., 1916.* Purchase.

LOS ANGELES BOARD OF HARBOR COMMISSIONERS. Port of Los Angeles, Jan. 1, 1917. Gift of Board of Harbor Commissioners.

MANUFACTURE OF SULPHURIC ACID AND ALKALI WITH THE COLLATERAL BRANCHES. Ed. 1. Supplement to Vol. 1. Sulphuric and Nitric Acid. By George Lunge. *London, 1917.* Purchase.

MILWAUKEE (WIS.) CITY PLANNING FOR MILWAUKEE. What it means and why it must be secured. *Milwaukee, 1916.* Gift of Milwaukee Real Estate Association.

NEW INTERNATIONAL YEAR BOOK, 1916. *New York, 1917.* Purchase.

NEW YORK STATE BRIDGE AND TUNNEL COMMISSION. Report, 7th. *Albany, 1917.* Gift of Commission.

NEW YORK (STATE) PUBLIC SERVICE COMMISSION FOR THE FIRST DISTRICT. Report, 1915. Vols. I-II. *Albany, 1916.* Purchase.

OIL AND PETROLEUM MANUAL, 1917. By Walter H. Skinner. *London, 1917.* Purchase.

ROYAL SOCIETY OF VICTORIA. Transactions. Vol. VI, 1914. *Melbourne, 1914.* Purchase.

SPECIAL COLLECTIONS IN LIBRARIES IN THE UNITED STATES. By W. D. Johnston and Isadore G. Mudge. U. S. Bureau of Education, Bulletin no. 23. *Washington, 1912.* Purchase.

THE STORY OF BETHLEHEM STEEL. By Arundel Cotter. The Moody Magazine and Book Co., *New York, 1916.* Cloth, 5 x 7½ in., 65 pp., 8 illustrations. $0.75. Gift of the publisher.

TEXT BOOK ON MOTOR CAR ENGINEERING. Vol. III—Design. By A. G. Clark. *London, 1917.* Purchase.

TOPICOS TECNICOS. By Octavio A. Acevedo. *Santo Domingo, R. D., 1917.* Gift of author.

TREATISE ON QUANTITATIVE INORGANIC ANALYSIS. J. W. Mellor. *London, 1913.* Purchase.

UNDERWRITERS' LABORATORIES. List of Inspected Mechanical Appliances, July 1916. Purchase.

—— —— List of Inspected Electrical Appliances, April 1917. Purchase.

U. S. DEPARTMENT OF COMMERCE, Bureau of Foreign and Domestic Commerce. Artificial Dyestuffs used in the United States. Special Agents Series, no. 121. *Washington, 1916.*

—— —— Danish West Indies, their resources and commercial importance. Special Agents Series, no. 129. *Washington, 1917.*

—— —— Government Aid to Merchant Shipping. Special Agents Series, no. 119. *Washington, 1916.*

—— —— Lumber Markets of the West and North Coasts of South America. Special Agents Series, no. 117.

—— —— Pilotage in the United States, summary of laws and regulations relating to pilotage in the several states. Special Agents Series, no. 136. *Washington, 1917.*

—— —— Statistical Abstract of the United States, 1916. *Washington, 1917.* Gift of United States Department of Commerce.

VALUE OF PEAT FUEL FOR THE GENERATION OF STEAM. Canada. Mines Department. Bulletin 17. *Ottawa, 1917.* Purchase.

GIFT OF WM. PAUL GERHARD

CONTROL OF PLUMBING WORK BY WATER DEPARTMENTS. By W. P. Gerhard. Reprinted from the Sanitary Engineer, 1916.

PROGRESS OF THE PUBLIC MOVEMENT IN THE UNITED STATES. Reprinted from Metal Worker, Dec. 12, 19, 1913.

PUBLIC BATH HOUSES AND SWIMMING POOLS. By Wm. P. Gerhard.

PUBLIC COMFORT STATIONS. By Wm. P. Gerhard.

WATER SUPPLY OF COUNTRY HOUSES. By Wm. P. Gerhard. Reprinted with permission of The Review of Reviews Company, 1914.

PERSONALS

***I**N these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by August 16 in order to appear in the September issue.*

CHANGES OF POSITION

Paul Fenton, formerly instructor of machine design at Cornell University, Ithaca, N. Y., has accepted a position as engineer with the Hughes Tool Company, Houston, Tex.

Emile G. Jegar, formerly assistant chief engineer of The Arlington Company, Arlington, N. J., has become affiliated with the Du Pont Fabrikoid Company, Newburgh, N. Y.

Olaf T. Ansson, mechanical engineer with The Iola Portland Cement Company, Iola, Kan., has become associated with the Cuban Portland Cement Company, Mariel, Cuba.

Howard A. Gillan, formerly assistant engineer with the Union Pacific System, New York, has assumed the duties of purchasing engineer of the Eastman Kodak Company, Rochester, N. Y.

Howard G. Wright, superintendent of construction, Anaconda Copper Mining Company, Anaconda, Mont., is at present connected with the U. S. Smelting Company, Salt Lake City, Utah.

Walter Grothe has severed his connection with the National Carbon Company, Fremont, O., and has taken up the duties of engineer for the C. L. Best Gas Traction Company of San Leandro, Cal.

Andrew Westwater, formerly with the Columbia River Ship Building Corporation, Portland, Ore., has been appointed chief engineer of the G. M. Standifer Construction Corporation of the same city.

C. R. Cady, until recently industrial engineer with Smith, Hinchman and Grylls, Detroit, Mich., has assumed the duties of manager of the wheel department of The Clark Equipment Company, Buchanan, Mich.

Clarence Fichter has severed his relations with the Chatfield Manufacturing Company, Cincinnati, O., and has accepted a position as combustion engineer with Day and Zimmermann, of Philadelphia, Pa.

John W. Woodcock has severed his connection with the Crane Company, of Bridgeport, Conn., and has accepted the position of mechanical superintendent of the Pratt and Cady Company, Hartford, Conn.

James L. Kirsch, formerly engineer in the estimating department of Struthers-Wells Company, Warren, Pa., is now associated with the Adamson Machine Company, Akron, O., in the capacity of superintendent.

Henry A. Stringfellow has resigned his position of mechanical engineer with the Sedgwick Machine Works, New York, and has accepted a position as designer with the Epping-Carpenter Pump Company, of Pittsburgh, Pa.

Robert R. Keith, for the past five years in charge of the Sheffield Plant of the Fairbanks-Morse Company, Three Rivers, Mich., has recently accepted the position of plant manager of The Holt Manufacturing Company, Peoria, Ill.

Richard M. James, rate setter with the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., has entered the employ of the Boonton Rubber Manufacturing Company, Boonton, N. J., as foreman of the finishing department.

Walter S. Giele, formerly general superintendent of the plants of the Harrison Safety Boiler Works, Philadelphia, Pa., is now connected with the Lebanon Gear and Machine Works, Lebanon, Pa., as vice-president and general manager.

Ronald V. Billington has become associated with the Interstate Commerce Commission, Kansas City, Mo., as junior engineer. He was, until recently, connected with the engineering department of the Great Western Sugar Company, Lovell, Wyo.

Axtell A. Lloyd has left the employ of the American Ammunition Company, of New York, and has become affiliated with the Greenfield Tap and Die Corporation, in the capacity of designer, with headquarters at their Springfield, Mass., arsenal.

Edwin P. Davis, for the past two years in the engineering department of the Remington Arms and Ammunition Company, Bridgeport, Conn., has resigned to accept the position of superintendent of the Modern Manufacturing Company of the same city.

Robert W. Sweeny, chief draftsman of the car department of the Chicago, St. Paul, Minneapolis and Omaha Railway, Hudson, Wis., has become affiliated with the Minnesota Manufacturers' Association, North St. Paul, Minn., in the capacity of chief engineer.

John B. Price has entered the employ of The Mechanical Appliance Company, of Milwaukee, Wis., with temporary headquarters at Chicago, Ill. He was, until recently, connected with the Peerless Electric Company, Warren, O., as assistant superintendent.

Siegfried Rosenzweig, formerly mechanical engineer with the Erie City Iron Works, and at the present time consulting engineer of the steam-engine department of the York Manufacturing Company, York, Pa., has also joined the American Spray Company, New York, in a similar capacity.

George P. Rettig, mechanical engineer with the Cincinnati Motor Syndicate, Cincinnati, O., has become associated with the office of the army inspector of the Curtiss-Elmwood plant at Buffalo, N. Y. Mr. Rettig is connected with the U. S. Signal Service at large, as inspector of airplanes and airplane-engines.

ANNOUNCEMENTS

James H. Herron has been elected president of The Cleveland Engineering Society.

Charles C. Lynde, editor of *The Blast Furnace and Steel Plant*, joined the Engineers' Officers Reserve Camp at Fort Oglethorpe, Ga., on May 21.

Leroy T. Byron has enlisted in the U. S. Naval Reserve Forces as chief petty officer, and is on duty at the Brooklyn Navy Yard, Brooklyn, N. Y.

Amasa M. Holcombe has been assigned to active duty in the small arms division of the Ordnance Department, United States Army, Washington, D. C.

Lieut. A. Langstaff Johnston, Jr., has been called to active duty at the Newport News Shipbuilding and Drydock Company, Newport News, Va., and has temporarily closed his office in Richmond, Va.

Ambrose Swasey, Past-President, Am.Soc.M.E., was elected president of the Cleveland Young Men's Christian Association, at the annual election on June 1. He has been very active in the association, and has been its first vice-president for several years.

Captain Elmer K. Hiles has been called into active service of the Fifth Regiment, Engineers' Reserve Corps, and has reported for duty. Captain Hiles is secretary of the Engineers' Society of Western Pennsylvania, and began training for the service last summer at Plattsburg.

John P. Flippen, formerly chief engineer of the C. H. Wheeler Manufacturing Company, Philadelphia, Pa., is now district manager of that company's interests in Western Pennsylvania, Ohio and West Virginia, with offices in Cleveland and Pittsburgh. Mr. Flippen is operating in conjunction with the Baker Dunbar Allen Company, contracting engineers.

It was incorrectly stated in the July Journal that Gail H. Browne left the employ of Ford, Bacon and Davis. Mr. Browne has been transferred from the New Orleans office of the company to their New York office, and is still employed by them as resident engineer on an increased power project for the Lehigh Valley Transit Company at Allentown, Pa.

THE NEW BOOKS

ALL books received by The Journal will be listed under this heading, generally accompanied by brief descriptive notes. Works of special importance to mechanical engineers will be commented on at length by members and others peculiarly qualified by reason of their experience and training.

Franco-American Trade. Report to the American Manufacturers' Export Association by the American Industrial Commission to France. The American Manufacturers' Export Association, 160 Broadway, New York, 1917. Boards, 8 x 10¾ in., 256 pp., 51 illustrations and 10 folding maps

The American Industrial Commission to France, organized and sent by the American Manufacturers' Export Association in August 1916 (see THE JOURNAL, September 1916, p. 735), has recorded in a handsome volume, just issued, the results of its comprehensive study of the means whereby American resources may best be made available for the reconstruction of the devastated regions, and Franco-American trade relations may otherwise be furthered.

The Commission, whose personnel included Messrs. W. W. Nichols (Chairman), Laurence V. Benét and J. E. Sagne of this Society, was composed of twelve members representative of a wide range of interests, and in the forty-odd days spent in the chief industrial centers and ports of the sister republic managed to accumulate the wonderful fund of information which is here set forth with an abundance of illustrations and maps.

The work consists of twenty-five chapters and an appendix, and among the many topics treated are those of trade and tariff, industry and plant construction; industrial and agricultural machinery, labor, syndicates and coöperative socities; chambers and courts of commerce, seaports and shipping, transportation; hydroelectric power; chemical industry; alcohol, social welfare, city planning; education, the devastated regions and their rehabilitation; Belgian reconstruction, etc. Manifestly it has been impossible to give more than a very general outline of any one subject, but it is the belief of the Commission that the facts cited and opinions expressed will throw light not only on present conditions, but on some of the probable developments that may be anticipated as a result of the war. A suggestive bibliography, as well as reports and recommendations of the American Chamber of Commerce in Paris, made at the request of the Commission, are included.

A Discussion of the Principles and Practice Underlying Charges for Water, Gas, Electricity, Communication and Transportation Services. By Harry Barker. McGraw-Hill Book Co., Inc., New York, 1917. Cloth, 6 x 9 in., 387 pp. $4.

The author's aim has been to present, concisely and impartially, and as far as possible in non-technical language, the diverse phases of rate-making for public utilities, including a comprehensive discussion of (1) such corporation and municipal activities as affect service and rates; (2) the trend of public opinion and court and commission decisions; and (3) the most important engineering and economic problems involved, with the hope that it will prove of service to lawyers and legislators, to editorial writers of the daily press, to students of municipal affairs, and to the general public. Contents: Development of Utility Regulation; Utility Privileges and Obligations; Rights of the Public; Product and Service Companies; Some Definitions of Rates and Services; Various Bases for Rates; Details of the Cost-of-Service Study of Rates; Test for Fixed and Operating Charges; Fair Value of a Utility Property; Valuation as an Engineering Task; Appraisal of Land and Water Rights; Reasonable Return, Interest, Compensation for Risk and Attention, Extra Profits; Depreciation as it Affects Utility Rates; Miscellaneous Problems Indirectly Related to Rate-Making; Problems of Railway Rates; Problems of Express Transportation Rates; Rate Problems of Street and Interurban Railway Transportation; Problems of Water Rates; Rate Problems of Gas Utilities; Rate Problems of Electricity Supply Works; Problems of Telephone Rate-Making; Appendices (4).

Modern Underpinning: Development, Methods and Typical Examples. By Lazarus White and Edmund A. Prentis, Jr. John Wiley & Sons, Inc., New York, 1917. Cloth, 6 x 9 in., 94 pp., 48 illustrations. $1.50.

Exhibits by means of photographs and drawings the essential steps in underpinning as illustrated by the methods used in subway construction in New York City. Only enough text to supplement the illustrations is included. Contents: General Aspects; Development of Underpinning and Methods; Shores, Needles, and Foundation Reinforcements; Specific Examples of Underpinning; Appendix.

Steam Piping. Its Economical Design and Correct Layout. By A. Langstaff Johnston, Jr. The Engineering Magazine Co., New York, 1916. Cloth, 5 x 7½ in., 62 pp., 7 illustrations, $2.

Consolidated and revised from a series of articles published in *The Engineering Magazine* in 1915. The factors governing the flow of steam in pipes are analyzed, and a group of curves is presented for use in solving the problems of practical installation and determining the most economical size of pipe to select for any given conditions. Contents: How to Find the Right Pipe Sizes; Special Conditions Affecting Low-Pressure Systems; and Savings Obtainable from Exhaust Steam.

Microscopic Examination of Steel. By Henry Fay. John Wiley & Sons, Inc., New York, 1917. Cloth, 6 x 9 in., 18 pp., 32 full-page plates. $1.25.

While originally issued by the Ordnance Department, U. S. A., and intended for the exclusive use of inspectors of ordnance material, this volume is now published for the use of others interested in the inspection of steel. It presents an outline of metallographic methods, illustrating typical examples. It is intended, not for use as a textbook, but particularly for those who are in need of some help in the interpretation of results.

Steam Power. By C. F. Hirshfeld and T. C. Ulbricht. John Wiley & Sons, Inc., New York, 1916. Cloth, 5¼ x 8 in., 420 pp., 232 figs. $2.

The authors have endeavored to collect in a comparatively small book such parts of the field of steam power as should be familiar to engineers whose work does not require that they be conversant with the more complicated thermodynamic prin-

ciples considered in advanced treatments, and the work is primarily intended for use as a textbook by students of civil engineering and in teaching power plant operators. Mathematical treatment of the subject has been eliminated to the greatest possible extent.

The Theory of Machines. By Robert W. Angus, B. A. Sc., Mem.Am. Soc.M.E. Second edition. McGraw-Hill Book Co., Inc., New York, 1917. Cloth, 6 x 9 in., 510 pp., 193 figs., $3.

This is a treatise on the principles of mechanism and the elementary mechanics of machines, for use in colleges. It deals with problems of fairly common occurrence, for which graphical solutions have been devised by the author. In the first part of the book a vector method of representing the relative motions of the different parts of a mechanism, called the "phorograph" method, is employed, which, it is stated, appeared in print for the first time in the previous edition. The second part, of much greater difficulty, is devoted to governors, speed fluctuations, flywheel weights, accelerations in machinery and their effects, balancing (new chapter), etc.

The Ventilation Hand Book: The Principles and Practice of Ventilation as Applied to Furnace Heating; Ducts, Flues and Dampers for Gravity Heating; Fans and Fan Work for Ventilation and Hot Blast Heating. By Charles L. Hubbard. Sheet Metal Publishing Co., New York, 1916. Cloth, 6 x 8 in., 218 pp., 137 figs. $2.

A series of questions, answers and descriptions, with illustrations arranged from a series of articles prepared for *Sheet Metal*. The author states that he has endeavored to keep all descriptions and mathematical work well within the understanding of the student and beginner.

Handbook of Casinghead Gas. By Henry P. Westcott. Metric Metal Works, Erie, Pa., 1916. Cloth, 5 x 8 in., 274 pp., 49 illustrations, $2.50.

Information on the processes used for extracting gasoline from natural gas, based on visits to many existing plants and a study of their reports. Contents: General Physical Properties of Casinghead Gas Wells; Construction of Pipe Lines; Measuring Casinghead Gas; Gasoline Plant, Compression Method; Gasoline Plant, Absorption Method; Transportation of Gasoline; Miscellaneous.

Steam Turbines: A Treatise Covering U. S. Naval Practice. By G. J. Meyers. The U. S. Naval Institute, Annapolis, Md., 1917. Cloth, 8 x 12 in., 246 pp., 202 figs. $4.50.

This book has been prepared to serve as an elementary treatise on steam turbines for the use of midshipmen at the U. S. Naval Academy, and deals mainly with types found in the U. S. Naval Service.

Practical Sheet Metal Duct Construction: A Treatise on the Construction and Erection of Heating and Ventilating Ducts. By William Neubecker. The Sheet Metal Publishing Co., New York, 1916. Cloth, 6 x 8 in., 194 pp., 217 figs. $2.

Illustrated descriptions of the various operations involved in the construction and erection of sheet-metal air ducts.

A Handbook for Cane-Sugar Manufacturers and Their Chemists. By Guilford L. Spencer. Fifth edition, enlarged. John Wiley & Sons, Inc., New York, 1916. Leather, 4 x 7 in., 529 pp., 83 figs. $3.50.

The book is divided into two parts, Manufacture of Cane Sugar and Sugar Analysis, and includes a chapter on sugar refining as practiced in the United States. The chemical section of the book, it is stated, has been revised to meet the conditions of the very large factories now in operation.

Central-Station Electric Service: Its Commercial Development and Economic Significance as Set Forth in the Public Addresses 1897-1914, of Samuel Insull. Edited, with an Introduction by William Eugene Kelly. Privately printed, Chicago, 1915. Cloth, 6 x 9 in., 195 pp., 105 figs.

A collection of forty speeches bearing on central-station electric service delivered by the author between 1897 and 1914. The editor states that these addresses are the work of one who has led the way to new conceptions of the economic functions of central-station electric service, and that much information of historical value, some of it never before published, is scattered through the book.

A Manual of Fire Prevention and Fire Protection for Hospitals. By Otto R. Eichel. John Wiley & Sons, Inc., New York, 1916. Cloth, 5 x 7½ in., 69 pp. $1.

An outline of the principles of fire prevention and protection, with indications for their application in institutions housing the sick, based on the personal observation and study of the author, who is Director of the Division of Sanitary Supervisors, New York State Department of Health.

Hendricks' Commercial Register of the United States for Buyers and Sellers. Twenty-fifth annual edition. S. E. Hendricks Co., Inc., New York, 1916. Cloth, 8 x 10 in., 1738 pp. $10.

An annual directory of producers, manufacturers, dealers and consumers connected with the architectural, contracting, electrical, engineering, hardware, iron, mechanical, mill, mining, quarrying, railroad, steel and kindred industries. Intended as a reference book for buyers.

Spon's Electrical Pocket-Book: A Reference Book of General Electrical Information, Formulae and Tables for Practical Engineers. By Walter H. Molesworth. Spon & Chamberlain, New York, 1916. Cloth, 4 x 7 in., 488 pp., 325 figs. $2.

It is stated in the preface that the author's aim has been to treat all of the subjects concisely and to avoid intricate mathematics. Full metric conversion tables are included.

Electric Traction: A Treatise on the Application of Electric Power to Tramways and Railways. By A. T. Dover. Whittaker & Co., New York and London, 1917. Cloth, 6 x 9 in., 667 pp., 523 illustrations. $5.50.

This work is designed for the use of engineers and advanced students. Representative examples of modern tramway and railway practice are included, but detailed accounts of electrification have been omitted and generating stations and transmission lines have not been considered. A number of worked-out examples are given in the text. Contents: Mechanics of Train Movement; Motors; Control; Auxiliary Apparatus; Rolling Stock; Detailed Study of Train Movement; Track and Overhead Construction; Distributing Systems and Sub-Stations; Bibliography on Electrification.

French Measures and English Equivalents. By John Brook. Spon & Chamberlain, New York, 1917. Cloth, 3 x 4 in., 80 pp. $0.40.

Gives the English equivalents (correct to six places) of the metric measures of length and weight and of the old French, Prussian, Austrian and Russian measures of length. Intended for engineers, manufacturers and workmen.

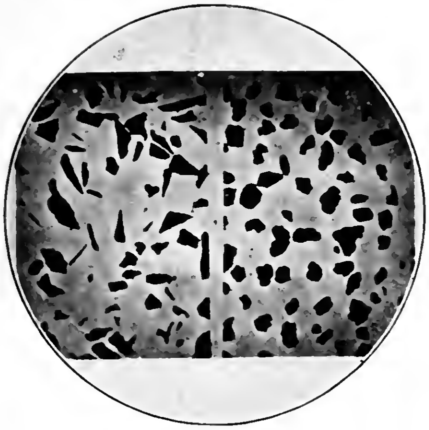

Fig. 1 Crystalline and Amorphous Natural Graphite

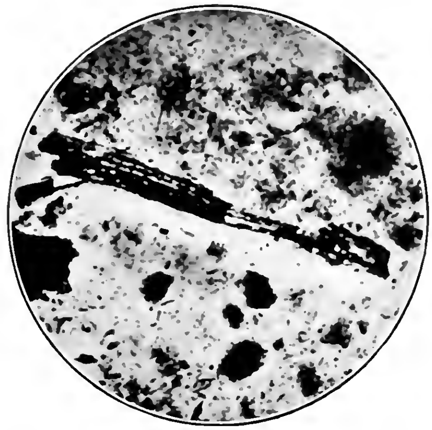

Fig. 2 Cross-Section of a Flake of Micaceous Graphite (200 Diameters)

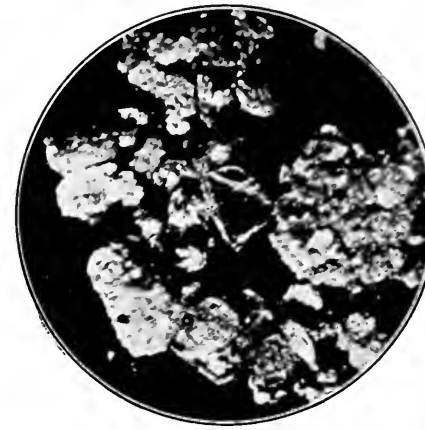

Fig. 3 Impurities in Micaceous Graphite (120 Diameters)

A STUDY OF GRAPHITE AND OF ITS COMPOUNDS FOR LUBRICATING PURPOSES

By CHRISTOPHER H. BIERBAUM,[1] BUFFALO, N. Y.

Member of the Society

MAN'S earliest knowledge of graphite dates back to the remotest antiquities, its application for useful purposes being shown in the prehistoric remains on continental Europe. Here it had been used not only as a coloring material in the early art of pottery making, but also mixed with clay for making refractory melting pots or crucibles.

The earliest written history of graphite seems rather indefinite, leaving considerable doubt in some instances as to whether graphite was actually referred to or some other mineral substance. This was due entirely to a lack of exact chemical knowledge, which resulted in confusing graphite with lead and molybdenite and gave rise to the terms—still modern—plumbago, black lead, *reisblei, crayon noir,* and the like.

The first positive and definite written accounts of graphite and its uses for refractory melting pots are given by Agricola (1494-1555). The next definite economic use of graphite of which we have written history is in the lead pencil, made as far back as the sixteenth century by placing a carefully shaped piece of natural graphite into a grooved wooden stick. It may never be known who first used graphite for lubrication in modern machinery, though bearing troubles in the modern sense could not have existed until after modern machinery existed. Statistics show that the number of users of graphite for lubricating purposes is increasing at an enormous rate, the consumption for this purpose for the latest year for which we have data, namely, 1913, being 30,000 tons.

Early in the writer's experience with bearings and lubricating problems, graphite proved an inviting subject. The results obtained, however, were so varied and at times so unsatisfactory that he was finally led to investigate broadly the entire subject of graphite for lubrication, which resulted in perfecting a process by means of which more than thirteen per cent of earthy materials have been eliminated from one of the best-known graphites on the market.

Graphite is one of the three allotropic forms of the chemical element carbon, amorphous carbon—say, the charcoal made of pure sugar—and the diamond being the other two. All three forms are subject to a large number and variety of impurities. It is the impurities of a graphite that largely determine its physical characteristics, and, strange as it may seem, graphite is a material whose impurities give it its designation.

The origin of graphite is twofold—natural and artificial. Artificial graphite is a by-product of the electric furnace in the production of silicon carbide, which is known in the trade as carborundum and crystolon. Natural graphite is derived from coal or early vegetable forms, and from bituminous sources. The gradual process in which Nature has produced graphite from the vegetation of the Carboniferous Age is distinctly seen in the successive steps in the development of the coal formations—peat, lignite, semi-bituminous, bituminous, semi-anthracite, anthracite, and finally graphite itself, having all the impurities corresponding to the admixture of earthy matter during the entire development. The natural graphite of vegetable origin is that generally known as natural amorphous graphite. This is usually a high grade of graphite, that is, the carbon is usually very completely graphitized and free from the high hydrocarbons, but has very decided drawbacks owing to its impurities, consisting mostly of earthy admixtures. The other class of natural graphite is that formed of asphaltic or bituminous matter. The best examples of this class are the Ceylon grades, many of which are known as crystalline or columnar—sometimes called fibrous graphites. In addition to earthy impurities, this graphite also contains some of the very highest orders of the hydrocarbon compounds. The affinity that hydrogen has for carbon is very strikingly shown in these graphite formations: the conversion of the carbon to graphite seems complete and the hydrogen is still held in combination, at least in part. In fact, one of the world's greatest diamond experts finds that the Brazilian

Presented at a meeting of the Buffalo Section of The American Society of Mechanical Engineers, October 29, 1916.

[1] Chairman of the Sub-Committee on Bearing Metals of the Research Committee and Vice-President of the Lumen Bearing Co.

FIG. 4 ABRASIONS MADE BY IMPURITIES (120 DIAMETERS)

FIG. 5 ARTIFICIAL GRAPHITE SHOWING SILICON CARBIDE (120 DIAMETERS)

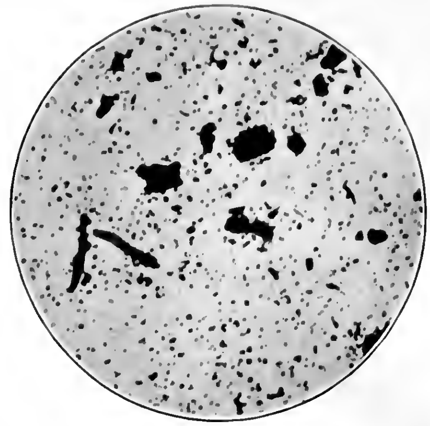

FIG. 6 ARTIFICIAL GRAPHITE SHOWING SILICON CARBIDE (120 DIAMETERS)

diamond still possesses a small percentage of hydrogen and that its specific luster is due to this impurity. To the latter class of natural graphites, those of bituminous origin, belong the micaceous graphites, those formations in which the flakes are made up of alternate layers of mica and graphite; and also those having sufficient micaceous material to impart to the graphite the crystallized structure corresponding to the different varieties of mica.

It will be observed that the usual classification is not adhered to—that the micaceous graphite is not included in the crystalline variety. The reasons for this classification are as follows:

1 Some of the very finest microscopic subdivisions of the coarsely laminated micaceous varieties appear to be amorphous

2 All varieties of the micaceous graphites when ground to ultramicroscopic fineness show transparent particles of mica

3 There is a clear dividing line between the micaceous and non-micaceous graphites of bituminous or non-organic origin.

The characteristic difference between two of the natural graphites, the amorphous and crystalline, is shown in Fig. 1. The right-hand side represents the amorphous graphite and the left side the crystalline. They are substantially of the same degree of purity, one—the amorphous—having more or less irregular rounded particles, while the other has sharp and angular particles. This holds true even though the particles are reduced to the minutest microscopic subdivisions. According to the foregoing classification the strictly crystalline graphites, not being suited for lubrication, are not given further consideration.

Fig. 2 shows a very beautiful specimen, a sliver or transverse section of the micaceous variety of graphite (magnified 200 diameters), in which are seen the alternating layers of mica and graphite, the mica being translucent or light colored and the graphite black or strictly opaque. This striated oblong particle shows a small portion broken off from the main body but still held by a filament of mica which has been bent, showing that the mica is of the flexible variety. This, together with the lines of fracture shown under the microscope, indicates that this particular mica is the variety known as muscovite, a comparatively tough and flexible variety. This specimen has rather coarse laminations, corresponding to the largest flake formation, the layers of mica approaching a thickness of 0.0001 in. Anyone can appreciate that graphite having this amount of mica as an impurity is undesirable in bearings. To illustrate, if one of these particles should become located between an engine shaft and its babbitt bearing over night, the inevitable result would be "pockmarking."

Fig. 3, a photomicrograph, shows the impurities taken from one of the highest grades of micaceous or flake graphite procurable on the market. It shows a number of crystals of abrasive material and other particles composed of mica, clay, alumina, hornblende, and the like. A simple method of testing the abrasive properties of these impurities was resorted to: it consisted in placing a small soft-wood block on the

FIG. 7 ABRASIONS MADE BY SILICON CARBIDE (120 DIAMETERS)

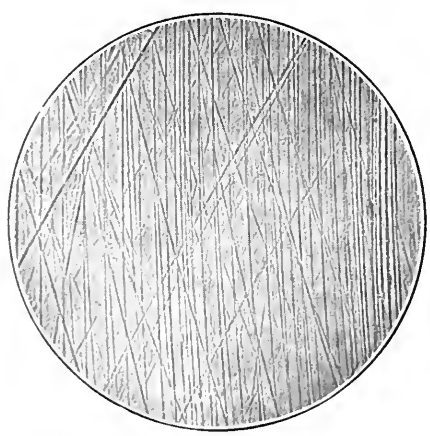

FIG. 8 ABRASIONS MADE BY SILICON CARBIDE (120 DIAMETERS)

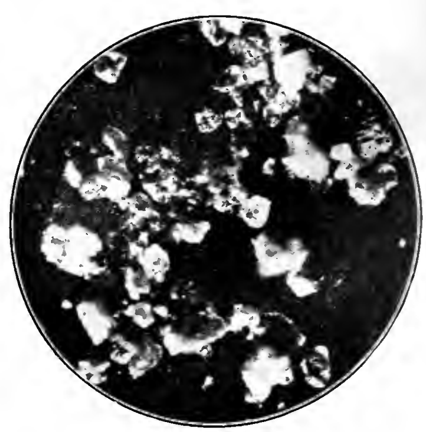

FIG. 9 IMPURITIES IN AIR-FLOATED GRAPHITE (120 DIAMETERS)

Fig 10 Abrasions Made by Impurities in Air-Floated Graphite (120 Diameters)

Fig. 11 Milled Bronze Surface (100 Diameters)

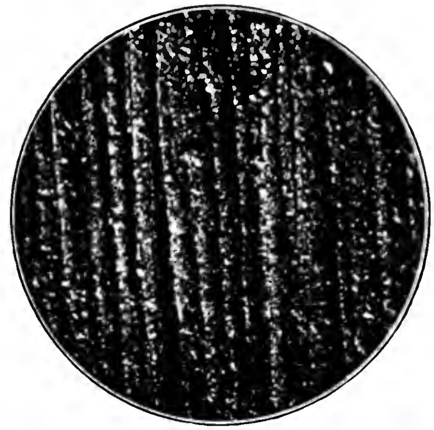

Fig. 12 Surface Shown in Fig. 11 Abraded by the Impurities in Air-Floated Graphite (100 Diameters)

end of a small fan-motor shaft, then mixing the impurities with oil and applying the mixture to the end of this wooden block, holding a microscopic slide against the block while it was revolving rapidly, and then making a photomicrograph of the abraded microscopic slide, using oblique illumination. Fig. 4 shows this abraded surface. It will be appreciated that in all of these abrading tests only those particles which are hard enough to cut glass have been brought into consideration, since all particles hard enough to cut glass are also hard enough to cut any bearing for which graphite might be used as a lubricant, whether it be a babbitt, bronze, or hardened-steel roller or ball bearing.

Artificial graphite is an amorphous graphite, as is clearly shown in Fig. 5. As already stated, it is a by-product of the electric furnace in the manufacture of silicon carbide—next to the diamond the hardest known abrasive substance—and it is difficult to remove all traces of this matter from the graphite. In the center of the view is shown a small spicule of this material, so undesirable in a lubricant. Fig. 6 likewise shows a pair of silicon-carbide crystals.

Fig. 7 is a photomicrograph of a glass surface abraded in the manner already described by using artificial graphite which had been marketed in the dry form. It is interesting to note the sharp, definite cuts in this view, characteristic of a high-class abrasive.

Fig. 8 shows an abraded surface made with an artificial-graphite compound marketed in the form of a graphite grease.

Fig. 9 shows the impurities of an amorphous natural graphite. These impurities are somewhat clotted together, though sharp and distinct crystals—mostly silica or white sand—are discernible. It will be observed that these crystals are more or less rounded, and Fig. 10 shows a surface abraded by matter resembling sea sand, but not in as clear-cut a manner as in the preceding figures.

It has sometimes been argued that the impurities of graphite could be counteracted by simply using a larger amount of graphite, just as an excess quantity of oil or grease is supplied when the quality is deficient. This, however, cannot be done with graphite. The following two photomicrographs (magnified 100 diameters) show that any abrasive impurity whatever cannot be present in the graphite without leaving its undesirable or destructive effect upon the bearing surfaces. Fig. 11 shows the smooth-milled surface of a bronze gear tooth of a rotary pressure pump which was used for pumping a mixture of substantially equal parts of water and fine air-floated graphite, the mixture having the consistency of cream. The pump was used for pumping this mixture against a head of 2 lb. per sq. in. for the purpose of forcing the graphite and water through a burr mill in order to effect proper grinding. Fig. 12 shows the surface of this tooth after it had been in use for thirty days, and demonstrates very conclusively that it is impossible to use graphite with impurities in any form between metallic wearing surfaces without having the injurious abrasive effects of these impurities.

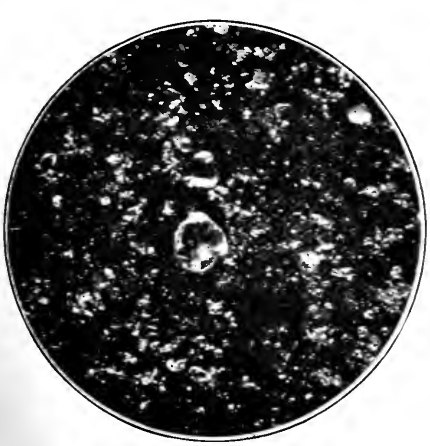

Fig. 13 Impurities in Air-Floated Graphite (100 Diameters)

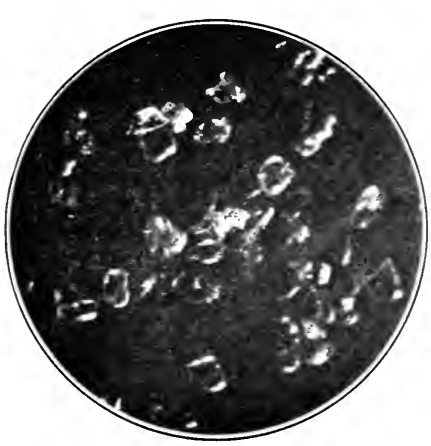

Fig. 14 Impurities in Air-Floated Graphite (120 Diameters)

Fig. 15 Impurities in Air-Floated Graphite (120 Diameters)

FIG. 16 ABRASIONS MADE BY IMPURITIES IN AIR-FLOATED GRAPHITE (120 DIAMETERS)

Fig. 13 shows the impurities separated out from the graphite-water mixture passing through the pump mentioned, also magnified 100 diameters.

Fig. 14 shows the washed crystals of another natural amorphous graphite of a very high-grade variety. While this graphite was prepared with the greatest care before marketing, the purifying process being that of air floating, it nevertheless contained a very fine-grained clear sand.

Fig. 15 shows the impurities of another variety of air-floated graphite on the market which are of a somewhat different nature, being more oblong or elongated crystals. This is due to the nature of the composition of these impurities, which are crystallized aluminum oxide. If we had these impurities in their natural colors they would represent jewels, the blues being sapphires, the yellow and canary-colored ones oriental topazes, and the whites leucosapphires. Fig. 16 shows an abraded surface made by the impurities shown in the preceding figure.

Fig. 17 shows a microscopic scale consisting of a very fine graduation on a glass surface, the smallest subdivision being 0.01 mm. (about 0.0004 in.). This scale was subjected to the abrasive test previously described, the graphite used on the small revolving block being that from which the impurities had been removed by the Bierbaum process. The surface of this slide speaks for itself—there was no abrasion, and it can be appreciated that the slightest abrasive particle on this finely graduated surface would have left its mark.

Fig. 18 shows a fungus growth in a graphite compound purchased on the market, and evidences the fact that a vegetable or animal oil was used, at least in part, in its preparation.

Fig. 19 shows the developing spore of another variety of fungus also growing in this graphite compound, and Fig. 20 still another species entering into the decomposition of the oil while it is in the process of becoming rancid.

Fig. 21 shows the fatty acid crystals in the decomposed oil. All animal and vegetable oils, chemically speaking, are salts, glycerine being the base and the acids being the organic radicals corresponding to the chemical composition of these oils. This decomposition cannot and does not occur in pure mineral oils. Graphite compounds using animal or vegetable oils should be thoroughly sterilized before they are sealed in their containers.

It has always been found difficult to apply the dry graphite to an ordinary bearing, and for that reason grease or oil has been chosen as a carrier. In the case of grease there is no difficulty—the graphite will not settle out, but in the case of oil it has given rise to the interesting study of graphite suspension. Anyone who has observed the suspension of dust in the air as revealed by a small beam of bright sunlight entering a dark room must be forced to the conclusion that this suspension of material particles in the air, that is, solid matter suspended in a gaseous medium, is due entirely to the extreme fineness of the particles, since it is observable in air which for days has been in a quiescent state. The suspension of a solid in a fluid should therefore be more easily obtainable, especially when we consider graphite and oil, since there is a film tension of oil around each particle of graphite and the oil has a positive capillary affinity with the surface of the graphite, and by the fine subdivision of the graphite its aggregate surface is increased enormously. To illustrate, if it were possible to crush a 1-in. cube of graphite to such a state of fineness that its largest particle would not exceed 0.000001 in. in diameter, the aggregate surface area of this quantity of graphite would then exceed 1 acre, whereas its

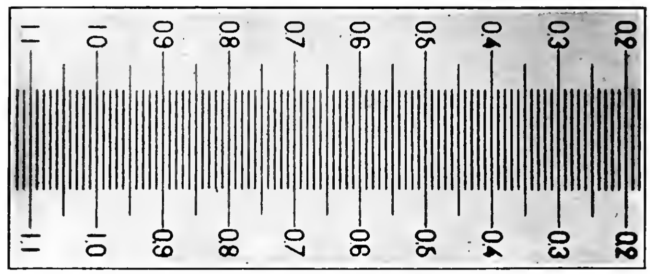

FIG. 17 MICROSCOPIC GLASS SCALE AFTER ABRASIVE TEST WITH PURIFIED GRAPHITE

FIG. 18 FUNGUS IN RANCID OIL (900 DIAMETERS)

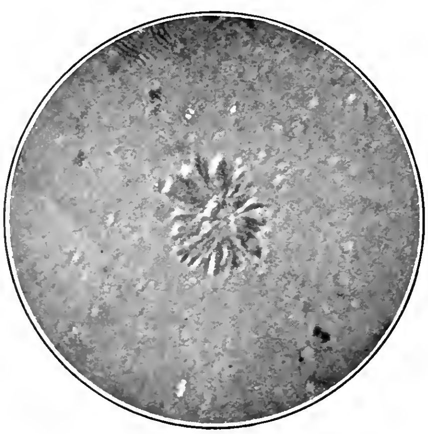

FIG. 19 FUNGUS IN RANCID OIL (900 DIAMETERS)

FIG. 20 FUNGUS IN RANCID OIL (900 DIAMETERS)

original surface area was but 6 sq. in. Such an extreme degree of fineness, however, is not necessary in order to bring the graphite out of reach of the action of gravity when mixed with a light mineral lubricating oil; in fact, microscopic observations seem to indicate that particles 1/200,000 in. in diameter are beyond the reach of the action of gravity.

It may be of interest to express the results of subdivisions mathematically and for the purpose start with an inch cube and consider the successive subdivisions in decimal order. The first subdivision gives cubes of one-tenth inch, the second hundredths, the third thousandths, and so on. Now, let A represent in numerical value the length of an edge of a cube, and we have for the successive subdivisions: A^{-3} the number of cubes, $6A^{-1}$ the aggregate surfaces of any subdivision, $6A^{-2}$ the surface of a single cube, and A^{-3} the weight of a single cube. As the subdivision is increased the weight of the particles is decreased and the relative surface increased, lessening the weight of a particle and increasing capillary affinity, and the ratio of these two values in any subdivision gives the specific buoyancy for that subdivision; that is, $6A^{-2}/A^{-3} = 6A^{-1}$; and omitting the common factor 6 we have A^{-1} for the specific buoyancy, which, from the accompanying tabulation of results, is seen to increase directly in proportion to the increased subdivision.

Fig. 21 Fatty Acid Crystals in Decomposing Oil (900 Diameters)

Fig. 22 is a graphic representation showing the law of increase of surface corresponding to an increased subdivision. Of necessity, only a limited part of the curve is given, still it shows that the curve is hyperbolic and asymptotic to the X-axis and that an infinite subdivision gives an infinite amount of surface.

From a purely mechanical viewpoint the suspension of graphite in oil should be a relatively simple matter; unfortunately, however, when the particles of graphite are fine enough to be able to defy the force of gravity, they are then subject to another force known as the Brownian movements. Under the latter force the graphite particles are subject to what approaches perpetual motion; it is not a continued movement in one direction, but a zigzag course, caused by the free electrons striking the particles of graphite. A particle on being struck starts with a jerky movement and continues moving until arrested by the fluid friction of the oil, provided it has not already been struck by another electron causing it to bound off in another direction. An observer who saw this fascinating action for the first time expressed himself to the effect that the particles seemed to be on a St. Vitus dance. During these erratic movements the particles of graphite collide with each other and as a result adhere; they in turn are struck by other particles, and in this manner there is gradually built up a mass of adhering particles which is subject to the action of gravity and results in settling out.

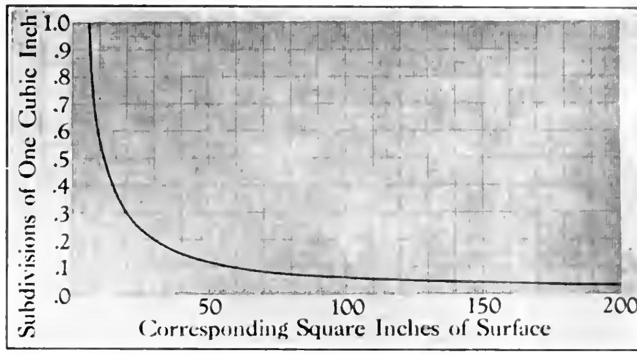

Fig. 22 Curve Showing Increase of Surface with Increased Subdivision

Size of cube, A	Number of cubes, A^{-3}	Aggregate surface, $6A^{-1}$	Surface of single cubes, $6A^{-2}$	Weight of single cube, A^{-3}	Specific buoyancy, A^{-1}
1.	1	6	6	1	1
0.1	10^3	6×10	6×10^{-2}	10^{-3}	10
0.01	10^6	6×10^2	6×10^{-4}	10^{-6}	10^2
0.001	10^9	6×10^3	6×10^{-6}	10^{-9}	10^3
0.0001	10^{12}	6×10^4	6×10^{-8}	10^{-12}	10^4
0.00001	10^{15}	6×10^5	6×10^{-10}	10^{-15}	10^5
0.000001	10^{18}	6×10^6	6×10^{-12}	10^{-18}	10^6

It is obvious, from what has gone before, that the greater the number of free electrons present in the oil, the more rapidly the coagulation and settling-out process should proceed, and such is the case. It is fully borne out by experience that the addition of a free acid or salt greatly accelerates the precipitation; in fact, any electrolyte present has this effect, such as the acid residue or its resultant neutralized salt re-

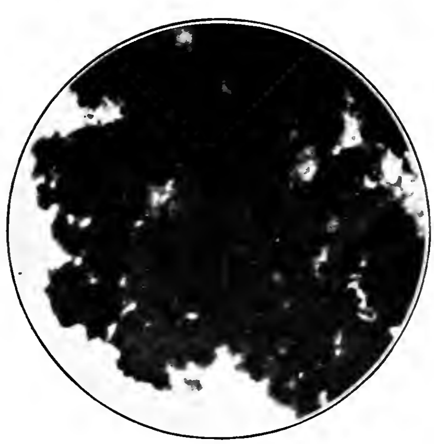

Fig. 23 Coagulation of Graphite in Oil (1200 Diameters)

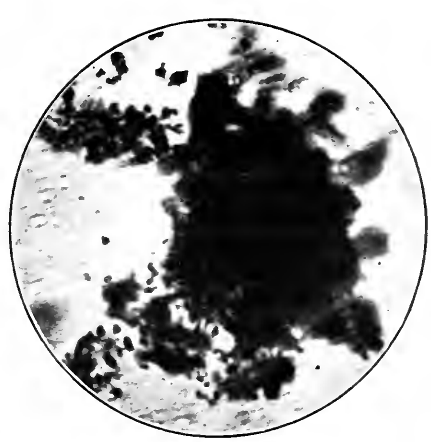

Fig. 24 Coagulation of Graphite in Oil (1600 Diameters)

maining in a lubricating oil after refining, or the rancidity of an oil, all tending to increase the number of free electrons and the precipitation of the fine particles of graphite.

Various expedients have been resorted to in order to effect so-called permanent suspension of graphite in oil. The one most commonly made use of is that of coating the finely ground particles with a foreign substance and then effecting a high dispersion of these coated particles throughout the oil. The coating material is usually a vegetable compound; if an oil it should be one insoluble in the mineral oils, such as castor oil, or it may be tannic acid or an allied tannin compound. Fig. 23 shows the precipitation of a commercial variety of oil-coated suspended graphite. Fig. 24 shows one more highly magnified, it being the precipitation of a commercial variety of tannin-coated suspended graphite, the largest particles of which do not exceed 1/250,000 in. in diameter.

The value of a so-called permanent suspension of graphite in oil is more fanciful than real, for the reason that in all such attempts the graphite is ground to such an extreme degree of fineness that this very fineness mitigates against its being useful. In a bearing properly constructed, lubricated and in operation the bearing surfaces are completely separated by the oil film and the extremely fine particles of graphite simply float in the film, exerting no appreciable effect either beneficial or otherwise.

The time, however, when graphite can be of benefit and perform its only and supreme function is when the oil film between the bearing surfaces is destroyed and the graphite serves as a solid lubricant. The graphite is carried between the bearing surfaces by the oil, and in the same manner, when the oil film is destroyed by being squeezed out, the graphite particles are carried along with the oil from between the bearing surfaces until the film is reduced to a thickness corresponding to the dimensions of the largest particles of graphite which at this stage will be arrested and held between the surfaces. Upon the complete destruction of the film these particles so held are crushed and imbedded into the grain and pores of the surfaces and thus are made to perform their function of solid lubrication. It is evident that the smaller the particles are, the less will be the amount of graphite so intercepted between the bearing surfaces; therefore, a given amount of graphite is most efficient if it exists in particles of the largest possible size. The more nearly permanent a graphite suspension is, the more nearly does it approach the colloidal state and the more completely is it carried out from between the bearing surfaces when the oil film is being destroyed.

This can be demonstrated in a most striking manner by taking a light-colored lubricating oil, thoroughly mixing with it a definite amount of graphite, and then placing it between two highly accurate glass surfaces and observing the amount of color left after a definite pressure has been applied for a definite time, while maintaining a fixed temperature. An amorphous natural graphite ground so that its coarsest particles did not exceed 0.0002 in. showed under the foregoing conditions an almost opaque surface, while a commercial graphite suspended in tannin and whose largest particles did not exceed 1/250,000 in., showed a substantially colorless surface. This is readily accounted for by the fact that the largest particles in the one graphite contained 125,000 times the bulk of those in the other, a condition existing at the time the glass surfaces in each case had approached each other near enough to arrest the flow of the respective particles.

The carbon content of graphite is not an indication of its lubricating value or its purity, for the reason that the percentage of amorphous carbon in some varieties is comparatively high. Amorphous carbon, or carbon not completely graphitized, can best be classed as an inert impurity; its presence always shows extreme blackness. The same is true of another common impurity, hydrogen, or a hydrocarbon; this is also black, whereas the purest graphite is a dark steel-gray when mixed with a clear white oil. The chemical laboratory can only give valuable information on the subject of the graphites when the work is done by an expert or specialist.

Advisory Committee for Aeronautics

The report of the Advisory Committee for Aeronautics (British) for the year 1916-1917 has just been issued. Following the rule of the immediately preceding years, it omits the technical appendices which in peace time were the principal and most interesting parts of the reports.

Strength of Construction. A number of questions relating to strength of construction have been investigated, and some general conclusions have been reached tending to simplification of strength calculations. The basis is to be adopted in design to secure adequate strength in high-speed machines, with the power to rapid maneuvering essential in aerial fighting, is a matter demanding the most careful consideration. To secure the highest possible speed it is necessary to keep down the weight to a minimum, and the best compromise between these two opposed conditions does not admit of precise determination. This question has received attention, and the manner in which strength varies with increase of dimensions has also been made the subject of investigation. Cases in which vibration has been set up have been examined, and calculations relating to the strength of the body structure have been made.

Engines. A number of questions relating to engines and engine design have been submitted by the Air Board for consideration by the Engine Sub-Committee. These have required very careful investigation, and the sub-committee has been closely occupied since its formation with the various problems which have arisen. Experimental work has been carried out, by request of the sub-committee, at the Royal Aircraft Factory; and the sub-committee has received much assistance in the examination of special questions both from manufacturing firms whose works have been visited.

Light Alloys. The use of light alloys in the construction of aircraft and aircraft engines is becoming of rapidly increasing importance, and improvements in the production of light alloys will have great effect on future development. The investigations relating to light alloys which have been in progress for many years at the National Physical Laboratory have been continued, and results of special interest have been achieved during the past year. Suggestions have been made to the Air Board by the Committee which may, it is hoped, help to secure the best conditions in manufacture for the development of such alloys. The formation of the Light Alloys Sub-committee will be of great assistance in coördinating the work on light alloys which is being done in various quarters, and in collecting the information resulting from experimental investigation and manufacturing experience. Experimental work has been carried out for the sub-committee at the Royal Aircraft Factory, the University of Birmingham, the National Physical Laboratory, and elsewhere, and arrangements have been made for placing the information obtained at the disposal of manufacturers.

Other subjects treated in the report are: Experimental work in aerodynamics; fabrics, dopes, etc., and investigations relating to seaplanes.

SYMPOSIUM ON STEAM LOCOMOTIVES HELD BY THE MINNESOTA SECTION

A SYMPOSIUM on steam locomotives was held by the Minnesota Section of the Society on the afternoon and evening of March 10, 1917, at the Main Engineering Building of the University of Minnesota. Seven papers were presented, as well as a discussion on Metal Alloys Used in Locomotives, by Prof. G. L. Hoyt, and a short address by Dr. Ira N. Hollis, President Am.Soc.M.E. J. V. Martenis, Mem.Am.Soc.M.E., opened the afternoon session with an address on the Historical Development of the Locomotive, which was profusely illustrated with lantern slides and later illuminatingly discussed at some length by J. J. Flather, Mem.Am.Soc.M.E. Papers were then read which had been prepared by Messers. Foque, Toltz, Bourne, Muhlfeld, Ostermann, and Basford, extended abstracts of which immediately follow.

MODERN LOCOMOTIVE PRACTICE

By T. A. FOQUE, MINNEAPOLIS, MINN.

Member of the Society

IN passenger service the locomotive best suited to present-day requirements is the 4-6-2, or Pacific type, which is almost universally used where a tractive effort of from 42,000 to 45,000 lb. is required. Where very heavy grades are encountered, or where long, heavy trains are operated on even moderate grades, the 4-8-2, or Mountain type of locomotive, is becoming popular.

In freight service the 2-8-2, or Mikado type, is now largely used in place of the 2-8-0, or Consolidation engine, where a tractive effort of from 50,000 to 60,000 lb. is required. With a 63-in. driving wheel it is not only good for heavy freight service, but is well adapted to fast freight work. On lines with very heavy grades this type of engine, with the addition of a fifth pair of driving wheels, is designed for a tractive effort of from 65,000 to 83,000 lb. and is known as the Santa Fe type. Increased boiler capacity and factor of adhesion make this type of engine better for heavy slow service than the Mikado type.

On exceptionally heavy grades, extending over a large portion of a division, Mallet compound engines are quite generally used in 2-8-8-0 and 2-8-8-2 types. The tractive effort of existing engines runs from 91,000 to 103,000 lb.

For pusher service over heavy grades triple-compound types, 2-8-8-8-2 and 2-8-8-8-4, are now being used by two railroads. These have two high-pressure and four low-pressure cylinders, and the rear set of driving wheels and truck are located under the tender.

One road is now experimenting with a 2-8-2-2-6 type of engine, consisting of the application of the running gear and machinery from a retired Mogul locomotive to the tender of an existing Mikado locomotive.

In switching service the ordinary or 0-6-0 type is in most common use, but some 0-8-8-0 Mallets with a tractive effort of 100,000 lb. are now being used in hump-type classification yards. Considerable time is saved on account of taking trains just as delivered by road engines and putting them over the hump and classifying. For heavy general switching service the 0-8-0 type, running up to 70,000 lb. tractive effort, is used with success.

Comparative few locomotives are now built without a superheater. The economy following the use of this device is very marked and existing engines have been greatly improved by the addition of the device. To reduce the fuel consumption further the use of brick arches supported on water tubes is very common, and modern improvements in the design of the arches have made their use practical where formerly they gave considerable trouble.

On all road locomotives and some switching locomotives, outside valve gear of the Walschaerts type is used almost altogether. Accessibility, better distribution of steam and freedom from breakdowns make outside gear very desirable. On the Soo Line we have modified the ordinary type of gear by taking our motion for the lap-and-lead lever from the main rod instead of the crosshead. This is quite a marked improvement in that it gives us much better port openings.

The majority of engines now built are so heavy that the usual form of reversing mechanism is not suitable, and power reverse gear, either of the screw pattern or operated by steam, has been introduced with very satisfactory results.

Pneumatic fire doors relieve the fireman of much work and are beneficial to an engine in that they greatly reduce the time in which a door is kept open.

One of the great troubles with heavy locomotives is found in the design of the main driving boxes, and the brass in the ordinary type of box may be renewed two or three times before an engine requires a general shopping. To eliminate this expense and wear on an engine, boxes 20 in. long or longer are now used on the main journals.

The old practice of keeping steam pipes within the smokebox has nearly been done away with, and we now use outside pipes to the steam chest, eliminating in a large measure the trouble with leaky joints and giving us easier access to the smokebox appliances.

The advent of long freight trains called for air compressors of much greater capacity, and we now use two single-stage pumps or one compound pump.

In recent years much more attention has been given to proper air openings in the ashpans and dumping mechanisms which will allow of frequent and easy disposal of the cinders. On some large locomotives, especially where a low grade of fuel is used, the work of firing has become too much for one man and mechanical stokers are now being used, and some of them are now doing very good work.

Within a year or two a few roads have experimented with an apparatus for burning pulverized fuel. The question is one of much interest, for there are in certain parts of the country large deposits of fuel wholly unsuited to locomotive use in its present form, but which may in powdered form prove not only satisfactory but very economical.

In locomotive tenders the tendency today is toward those of large capacity, which frequently permits of the avoidance of water supplies which are exceedingly bad. To save labor and because of legislation, tenders are now constructed with coal hoppers of such design that the coal will automatically be placed within easy reach of the fireman. Hoppers which cause the coal to come down and forward by gravity are the cheapest and best, but in some cases mechanical coal pushers have been installed.

Special attention has been given for a number of years to truck design, with a view to eliminating dangerous roll at high

speeds. In many derailments the forward tender truck is the first to leave the track. Comparatively slight depressions in the track may set up a rolling of the tender, which, accompanied by a reverse roll of the locomotive, will cause the forward tender wheels to jump. The connections between the locomotive and tender also have a bearing on this, and one connection has been designed which is a vast improvement over anything used before.

Important as is the design and construction of a locomotive, the vast majority of troubles in locomotive operation may be found in lack of maintenance. In certain parts of the country we are sorely tried with water heavy with incrusting salts. It is not an easy matter to handle bad water successfully, but in most cases it can be done. In repairs to machinery there is but one sensible and economical course to follow: when defects appear, apply the remedy. It has been demonstrated without question that it is more economical to keep up the running repairs and not wait until a locomotive needs a general shopping.

THE LOCOMOTIVE OF TODAY

By MAX TOLTZ, ST. PAUL, MINN.

Member of the Society

The steam locomotive is a power plant which has to be admired, because if the same amount of power is developed in a stationary plant it will take up from five to ten times the amount of space. Modern large locomotives are developing now as high as 3000 hp., with a drawbar pull of very nearly 105,000 lb.

Ten years ago wide fireboxes were already used to a considerable extent, also brick arches supported by water tubes. Moreover, extra water tubes were added in the firebox to improve the water circulation and to increase the heating surface of the boiler.

The Walschaerts valve gear succeeded the Stephenson not because the Walschaerts gives the better steam distribution but because it facilitates the strengthening of the frame of the locomotive. The use of metal alloys has also been introduced for the purpose of strengthening parts of the locomotive.

In 1905 the writer pointed out that in applying superheaters to locomotives a high superheat should be employed to obtain economy in water and coal consumption. At that time it was the general consensus that 100 deg. of superheat would be all that was necessary for this purpose.

In 1906 he applied the first Schmidt fire-tube superheater to the locomotives in the States. Not less than 250 deg. of superheat were obtained, which resulted in an average saving of 25 per cent of coal and 35 per cent of water. Since 1908 or 1909 the fire-tube superheater has come to stay with us.

To improve the combustion and at the same time to force the capacity of the locomotive boilers by burning more coal per square foot of grate surface, automatic stokers have been applied to locomotives with great success. The present stoker has given good satisfaction, yet the combustion of coal can still be improved and is being improved by the adoption of pulverized coal on locomotives. Although the latter is in an experimental stage at present, there is no doubt but that it will be a success.

Another improvement on the locomotive, which will no doubt be perfected, is the heating of the feedwater, either with the waste gases or with the exhaust steam.

If we compare the economy of the locomotive of twenty years ago with that of the locomotive of today we know that we are getting over 50 per cent more work than we did then. Yet we should not be satisfied with this, but should strive to make the locomotive a power plant second to none.

METAL ALLOYS USED IN LOCOMOTIVES

By G. L. HOYT[1]

Every railroad man who is concerned with the design of a locomotive knows that heat-treated steel has better properties than annealed, for by heat treatment we are able to produce certain properties that can be produced in no other way. I have found out, however, in talking with various railroad men, that the chief reason why they are not ready to adopt heat-treated parts is that heat-treated steels do not stand up any better than ordinary carbon steels, and that in some cases special steels give more trouble than ordinary carbon steels. The reason given is that the producers of these parts are not in a position to heat-treat material of that quality on a commercial basis to sell for such a price that the railroads can effect an economy in buying. The practice at present seems to by merely to anneal these various parts. A locomotive axle will be forged out, the steel used being the ordinary good grade of open-hearth steel; it is then heated up to the critical point and air-cooled down slowly. The object, I take it, is to insure uniformity and absence of internal strains. Whether or not a satisfactory structure is produced is of entirely secondary importance. When I mention internal strains, I hit the nail on the head as to why heat-treated steels are not used generally in locomotive practice. There can be no doubt about the advantages which they possess over ordinary carbon steels, and if it is impossible at present to obtain heat-treated steels for locomotive construction, something should be done about it.

If I can see the signs of the times correctly, there is a necessity for all the economy possible in railroad operation, which is why the question of using heat-treated steels in locomotive construction is becoming more and more important. It is possible to produce steels that far surpass those entering into locomotive construction. In gun construction the United States Government and the steel plants got together and are now successfully manufacturing heat-treated gun parts. Hadfield projectiles are probably the most difficult of all materials made of steel to produce satisfactorily, the internal strain serving to weaken the resistance of the material.

What has been done in other cases can be done in regard to any part about a locomotive. I can see nothing inherently difficult about heat-treating locomotive parts. Whether or not those methods are developed depends upon the demand made upon the steel plants by the railroads to produce the desired material. If the roads feel that there would be an economy in using heat-treated parts, undoubtedly there would be a great attempt on the part of the steel plants to produce that material.

When you are getting a certain grade of steel, you may have certain specifications, but 30 per cent elongation, etc., tell almost nothing about the steel, that is, so far as whether the axle is going to stand up in service, for the tests which are used to bring out the superiority of heat-treated steels are of an entirely different character. Take a locomotive frame, or the axle. Its parts are subjected to vibratory strains and stresses. Say that the locomotive axle runs hot, and that it is cooled off by water, ice, or snow, and a crack is started. What is the effect of the presence of a crack in a locomotive axle, in

[1] Assistant Professor of Metallurgy, University of Minnesota.

one having a fine-grained structure, and one having a coarse grain? In considering this, the real value of heat treatment is brought out, and something that is not shown by ordinary tensile tests. A crack is of much less consequence in the case of softened steel than in the case of annealed steel. Internal strains are eliminated in annealed steel, but the same treatment which produces the fine-grained structure also eliminates internal strains. It is a question of properly conducting the heat treatment, and the trouble is that the steel plants either work carelessly or for some other reason do not take particular pains to heat-treat the material. If the railroads as a whole would take up this question and push it as they pushed the question of steel rails a few years ago, I have no doubt but that they would be getting properly heat-treated steels.

As far as special steels are concerned, the problem is different. Their cost at present is almost prohibitive. Nickel steels, etc., are now in such demand on account of their use in the manufacture of munitions and automobiles that no considerable portion or amount of them can be diverted to such a use as this, and unless they are heat-treated they are not at all worth the additional cost.

When using special steels which have been heat-treated, why do those in charge of locomotive construction insist on using the same designs? A certain part is made of ordinary carbon steel annealed. As an experiment, a railroad will buy that part made out of special steel, heat-treated, and expect to effect an economy. No metallurgist would advise leaving the design the same: if it is correct for carbon steels, it is not correct for special steel. If you leave the cross-section the same, you leave the weight of the section the same, and the price of the heat-treated part consequently seems exorbitant. The management, however, probably takes the stand that it is better to leave the section the same and get the improvement by substituting a good steel, but this does not give a satisfactory basis for comparison.

Another point I want to bring out is the service you can expect from special steel as compared with carbon steel. A locomotive equipped with special-steel heat-treated parts is usually found in the shops as frequently as other locomotives, but the reason is that the heat treatment has not been carefully done. I am convinced of that when told of the failures of the heat-treated parts.

In closing, let me compare the service of annealed carbon steel with the service of special steel properly treated. The carbon steel is ductile and has a certain amount of strength, but in practically every other way it is weak, and particularly so if a flaw develops. If a small crack starts working its way through the axle, right there the annealed axle is weakest. It is on account of the large percentage of free iron. One of the worst things that could be done for a steel axle from that point of view would be to anneal it, for this would produce the free iron. One thing that counteracts this is the removal of internal strains. A heat-treated steel axle, whether carbon or special, designed so that it will have the same static strength, if injured in any way has several times the resistance of annealed steel. The heat-treated steel is less apt to be tricky than the annealed.

The saving effected by using special steels results chiefly from cutting down the weight of the reciprocating parts; but unless these are designed with the properties of the heat-treated steel in mind, there can be no real comparison drawn. The work done up to the present time does not lead to a reasonable comparison between special and annealed steels, and until that is done properly, we are not in a position to say whether the special steels should be condemned.

SUPERHEATER DEVELOPMENT IN AMERICA

By GEORGE L. BOURNE, NEW YORK, N. Y.

Member of the Society

Of all the devices or improvements which have been introduced in American locomotive practice, the fire-tube superheater is by far the most notable. By its economy in fuel and water it brought the heaviest locomotive well within the capacity of the average fireman. Here was a device exactly suited to American practice—one with a low maintenance cost to fit in with the high wages of American mechanics; with increased boiler capacity of approximately 35 per cent, to act as a reservoir of power, ready for use when most needed; and finally, with a fuel economy of from 20 to 25 per cent.

As a result of the suitability of the superheater to American railroad requirements, there are today over 21,000 superheated locomotives in service or under construction in the United States and Canada. During the past year superheaters were applied to approximately 95 per cent of all the standard-gage steam locomotives built in the United States.

The general trend of superheating engineers has been toward a higher superheat—increasing the gas area available for superheat at the expense of the boiler tubes. This, it is true, tends toward a lower boiler efficiency on account of the necessary loss in water-heating surface, but the resultant increase in the efficiency of the entire machine offsets this many times over.

The results obtained on the Long Island and Lehigh Valley Railroads, which have used steam at a temperature in excess of 750 deg. fahr., have clearly demonstrated the possibilities of higher steam temperatures. As 200 deg. of superheat is amply sufficient to overcome condensation losses in the steam pipes, valves and cylinders, it is evident that the increased efficiency obtained by any superheat in excess of 200 deg. fahr. must be entirely due to increased volume of the steam per unit of weight. This is an almost constant increase in volume for each degree of temperature, and as far as calculations have been worked out for superheated steam, there is no limit to this increase. There can be no doubt that the limit of superheated steam temperatures for the most economical and efficient operation is only fixed by the ability of the exposed machine parts to withstand the higher temperatures.

While superheated steam was originally regarded as of benefit, primarily, to heavy road locomotives using steam for long, continuous periods, later developments have proved its desirability for the more efficient operation of locomotives in all classes of service. Perhaps the most notable example of this tendency is in the superheating of switching locomotives. While the degree of superheat obtained in switching service is naturally not as high as on road engines, it is, nevertheless, enough to reduce condensation losses greatly, which in this class of service amount to over 40 per cent of the total energy developed by the boiler.

As a result, there are today over 1300 switch engines which have been equipped with superheaters, and a steadily greater proportion of the switching locomotives built are being superheated. It is significant in this connection to note that those railroads which have made a trial of superheated switch engines are now foremost in applying superheaters to their existing yard power.

The original design of the fire-tube superheater was so sound that comparatively few changes have been necessary in adapting it to the peculiar requirements of American railroads. But there have been certain modifications which, although of a minor character, are nevertheless worthy of attention.

The first important change was in the redesign of the through-bolt header. Experience showed that the original design gave entire satisfaction when correctly manufactured, but to furnish insurance against inferior material or improper methods in casting, a new design was prepared in order to counteract, as far as possible, the results of possible errors made in manufacture. In the new through-bolt header an additional air space has been provided between the walls of the superheated and saturated compartments in order to protect the casting from the rapid transfer of heat between these compartments, as insurance against the development of cracks between the unit seats in the lower face of the header.

The second great advance was the improvement in the design of the unit return bend. This consisted in producing a welded return bend to replace the original cast-steel bend, with consequent elimination of all mechanical joints in the unit. This machine-forged return bend, which is now almost ready for the market, will have a heat resistance equal at least to that of the old cast-steel return bend. At the same time it will have all the advantages which go with freer steam passages and a minimum restriction to the flow of gases through the superheater flues, with the complete elimination of all leakage due to threaded connections in the unit.

THE USE OF PULVERIZED FUEL ON LOCOMOTIVES

By JOHN E. MUHLFELD, NEW YORK, N. Y.

Member of the Society

As the limiting factor of a modern steam locomotive is the evaporation and superheat production capacity of the boiler, the rate and effectiveness of the combustion become the controlling elements. While there is no limit to the amount of fuel that may be mechanically supplied to a locomotive firebox, there is a decided limitation to the amount of fuel that can be burned on a given grate area and effectively utilized.

When coal is burned on grates a rate of about 50 lb. of run-of-mine grade,—or about 60 lb. of lump grade of bituminous coal,—is the maximum allowable per sq. ft. of fire surface per hr. for the greatest practical boiler efficiency. However, as this rate of firing limits the consumption to a total of from 3000 to 6000 lb. per hr. for the average modern locomotive of great power, and as the actual coal that must be supplied to the firebox by mechanical stoking in order to maintain the boiler pressure frequently reaches a rate of 150 lb. per sq. ft. of grate area per hr., or a total of from 9000 to 15,000 lb. per hr., the boiler efficiencies often run as low as from 55 to 45 per cent and even less.

The necessity for eliminating grates if much over 12 lb. of water is to be evaporated per sq. ft. of water-heating surface per hr., is therefore quite apparent provided reasonable efficiency is to be obtained, and this brings us to the problem of burning solid fuel in a manner that will overcome the principal deficiencies in the steam locomotive and enable it to maintain its present position in the steam-railway field and to assist further in reducing the high cost of railway living.

As I presented before the 1916 Annual Meeting of the Society an exhaustive report on Pulverized Fuel for Locomotives, which, with the discussion, was abstracted in THE JOURNAL,[1] I will make this paper quite brief.

When solid fuel is burned on grates in a modern locomotive, from 45 to 70 per cent of the heat is absorbed by the boiler. Of that which is wasted the majority is due to incomplete combustion, sparks, cinders, smokebox gases and combustible in the ash. Owing to the necessarily limited grate area, the high draft essential to induce sufficient air through the grates for combustion causes these enormous losses through unburned gases and fuel that are exhausted from the stack or carried into the smokebox and ashpan.

Generally speaking, it is necessary to break up any fuel to such uniform size that the oxygen in the air can unite perfectly for combustion. A deficiency in this respect results in some portions of the fuel passing off as unburned hydrocarbons, and other portions being left as incompletely burned coke. For the best results coal should be sized to about 3-in. cubes for burning on locomotive grates, but as this is now quit impracticable, due to the methods of mining and the cost, a mixture of fine and large coal is usually supplied, which tends to burn irregularly and results in a reduction of boiler capacity and efficiency.

As a 1-in. cube of coal exposes but 6 sq. in. of area for absorbing oxygen and liberating heat, but when pulverized to the proper fineness will expose from 20 to 25 sq. ft., the first essential for complete combustion is the breaking up of the fuel into dry minute and uniform particles. Then, by diffusing these so that each may be surrounded with the right quantity of air for complete combustion, it will be possible to burn practically all of the available combustible, regardless of the percentage of non-combustible.

Any solid fuel that, in a dry pulverized form, has two-thirds of its content combustible, is suitable for pulverizing, and to produce the best results should be mechanically dried and milled so that it will be of about the same dryness and fineness as portland cement. The total cost to prepare pulverized fuel properly in a suitably equipped plant will range from 15 to 45 cents per ton, and for a railway coaling station of average capacity will be less than 25 cents per ton.

In the process of burning pulverized fuel the fuel in the enclosed tank gravitates to the conveyor screws which carry it to the fuel and pressure-air feeders where it commingles with the air. It is then blown through the connecting hose to the fuel- and air-delivery nozzles and blown into the burners. Additional air is supplied and the mixture is drawn into the firebox by the front-end draft. Additional air is supplied in the furnace where complete combustion of the fuel in suspension takes place. The liquid ash runs down the under side of the roof and the sides and ends of the furnace and is precipitated into the self-cleaning slagpan, where it solidifies into a mass that can be readily dumped.

The blower is driven by a constant-speed steam turbine which requires no regulation or control. The fuel conveyors, feeders and comminglers are driven by a variable-speed steam turbine which is controlled by the fireman by means of a handwheel conveniently located in the cab.

The smokebox-gas analysis will average between 13 and 14 per cent of CO_2 when coal is fired at the rate of 3000 lb. per hr.; between 14 and 15 per cent at the rate of 3500 lb. per hr., and between 15 and 16 per cent at the rate of 4000 lb. per hr., so that as the rate of combustion increases there is no falling off in the efficiency, as obtains when coarse coal is fired on the grates.

The waste of fuel from the stack, where coal having a large percentage of dust and slack is used; the lowering of the firebox temperature and draft, due to opening of the fire door; and the resultant variation in steaming and general results under high rates of burning fuel on grates, where all of the foregoing factors are involved, are entirely eliminated.

[1] THE JOURNAL, December 1916, p. 983; January 1917, p. 48; February 1917, p. 141.

The uniformity with which locomotives can be fired is indicated by the fact that the regularly assigned firemen can maintain the steam within a variation of 2 lb. of the maximum allowable pressure, without popping off.

While the smokebox temperatures have varied between 425 and 500 deg. fahr., the superheat in the steam will vary between 200 and 325 deg. fahr., depending upon the rate of working.

With pulverized fuel a locomotive having the boiler filled with cold water may be brought under maximum steam pressure within an hour, and the fuel feed then stopped until it is called for service. When standing or drifting at terminals or on the road the fuel feed can also be discontinued, as the steam pressure can always be quickly raised. After the trip or day's work the locomotive can be immediately stored or housed, the usual ashpit delays being entirely eliminated.

From the actual operation of steam locomotives in regular train service, the use of pulverized fuel has demonstrated in particular the practicability of eliminating smoke, cinders, sparks and fire hazards; increasing drawbar horsepower per hour per unit of weight; reducing non-productive time at terminals; improving the thermal effectiveness of the steam locomotive as a whole; utilizing otherwise unsuitable or waste fuels; eliminating arduous labor; providing greater continuity of service, and producing more effective and economical operation and maintenance.

ECONOMY OF THE LOCOMOTIVE SUPERHEATER

By R. M. Ostermann, Chicago, Ill.

Member of the Society

In the fire-tube superheater the superheater heating surfaces are interspersed with the evaporating surfaces of the boiler, and a very compact arrangement is thereby created with numerous parallel gas passages, resulting in best utilization of the heat contained in the gas. As a matter of fact, at large loads relatively low smokebox temperatures—that is to say, a high heat absorption of the combination—are readily obtained.

In the locomotive the superheat increases at a nearly constant rate with the indicated horsepower, and varies in a generally similar manner with the draft and the rate of evaporation, both of which are automatically regulated to suit the load by the smokebox exhaust. The superheater is therefore what might be called a "power booster" for the locomotive, and this is a very valuable feature from an operating point of view. The more steam demand there is made upon the boiler—the higher the rate of evaporation, the more intense is the action of the superheater in decreasing the specific steam consumption of the locomotive. The boiler without the superheater does not possess this feature; on the contrary, the priming rather increases the steam rate very fast when the boiler is forced.

The action of the superheater in boosting the steam temperature and power of the locomotive probably finds its limit of benefit when too great an increase of cut-off halts a further reduction of specific steam consumption. Just at what speed and power this takes place naturally depends upon the proportions of the boiler as compared with the cylinders and wheels, and it is a problem of the designer to provide the boiler with its proper share of evaporating and superheater heating surfaces so that the largest possible amount of sustained horsepower can be had at the speed at which the engine is required to operate normally.

In the superheater locomotives that are operated in this country, only part of the tube-sheet area is occupied by the enlarged smoke tubes in which the elements or units of the fire-tube superheater are located. It goes without saying that when an existing locomotive boiler is given a superheater and when, for the purpose of installing the superheater, a part of the tube evaporating surface in the shape of the small smoke tubes has to be removed and enlarged smoke tubes substituted therefor, a certain part of the total evaporating surface must be sacrificed. Given a certain tube-sheet area, the total evaporative heating surface of course increases the smaller the diameter of the smoke tubes selected. That feature is the one which will limit the number of superheater units which can be installed in a given boiler, and with it the capacity of the superheater. The only way in which the capacity of smoke-tube boilers with fire-tube superheaters can be further increased is to subdivide more finely the gas stream to provide a still closer intermingling of superheater and evaporative heating surfaces, for the installation of superheater units of still smaller diameters within smaller smoke tubes. The large smoke tubes which are now used in this country are $5\frac{1}{2}$ in. and $5\frac{3}{8}$ in. in outside diameter, with $1\frac{1}{2}$-in. outside-diameter superheater-unit tubes. These dimensions can be successfully reduced, as has been demonstrated on European locomotives and also in power plants of steamboats with Scotch marine boilers.

Substantial savings in coal and water per unit of power developed are now being obtained in every-day operation. As a rough average, a coal saving of 25 per cent and a corresponding water saving of 35 per cent can be expected and thermally accounted for with the knowledge that we have of the average amount of cylinder condensation that exists in saturated-steam locomotives. Inasmuch as the operating value of a locomotive depends upon the maximum amount of horsepower which it can develop, and inasmuch as a great many railroads when they install superheaters are more vitally interested in an increase of the locomotive's capacity than in the fuel saving, it frequently happens that the excess of boiler capacity which becomes available after reducing the specific steam consumption of the engine is reutilized by making greater demands upon the engine's hauling power, that is to say, by lengthening the cut-off or operating it at a higher speed than before it was superheated.

Comparing, then, two locomotives with identically the same engine and wheels, and assuming further that it would be possible to take sufficient horsepower out of the superheater engine in order to make it burn the same quantity of coal as the saturated engine per hour without an appreciable increase of coal consumption per indicated horsepower developed, then, on the basis of the fact that the superheater engine can produce 1 hp-hr. at 25 per cent less fuel than the saturated engine, one can inversely figure that the superheater engine has 33 1-3 per cent more cylinder horsepower and from 45 to 55 per cent more drawbar horsepower than the saturated engine. The superheater engine could, then, haul 45 to 55 per cent more tonnage at the speed of the saturated locomotive, working at a correspondingly larger cut-off. In practice, however, such an increase of tonnage is rarely possible, for the reason that the superheater locomotive has no more starting effort than the saturated locomotive of the same engine dimensions, and particularly on heavy grades the starting feature governs the tonnage that can be handled. An increase in speed, in order to utilize the greater sustained boiler capacity available, is often possible, but hardly ever to the extent that all the excess of boiler capacity potentially existing can be utilized. It can

be taken for granted that part of the benefits of superheating are always reaped in the form of fuel and water saving, and all data from comparative runs, where the superheater locomotive was called upon to develop haulage effort greatly in excess of the saturated locomotive, show a substantial fuel and water saving.

LOCOMOTIVE FEEDWATER HEATING

By GEO. M. BASFORD, NEW YORK, N. Y.
Member of the Society

Heating the feedwater of a locomotive by heat otherwise wasted is a fairly general practice in all the more progressive European countries, but experiments along these lines have been but spasmodic in this country up to a very recent period. This does not mean that the motive-power officers of American railways are not alive to the possibilities offered in the shape of economy or increased capacity by a practical feedwater heater, but it simply indicates that the tremendous development of the locomotive in this country in the past fifteen or twenty years has made it necessary to neglect many features for the time being which are known to be well worth while. It appears, however, that the time is now about ripe for taking up the subject in a systematic and thorough manner, and a discussion of the principles and possibilities of feedwater heating on locomotives will not be amiss at this time.

The following table gives the general distribution of the heat in a locomotive, and these figures, we believe, are fairly typical of good practice and average results.

Total heat in the coal, per cent		100.0
Loss in unconsumed coal and heat in ashes in the ashpan, per cent	5.3	
Loss in dry smokebox gases and vapor of combustion, per cent	18.0	
Heat through boiler heating surfaces (includes superheater), per cent	76.7	
	100.0	100.0

Investigating further the distribution of the heat after it has entered the steam, it will be seen by the table following that 65.2 per cent of the total heat of the coal is discharged in the exhaust steam, mostly in the form of latent heat.

Heat in steam as shown above (boiler efficiency), per cent	..	76.7
Loss by radiation, per cent	3.5	
Loss in friction of locomotive, per cent	1.0	
Useful work at drawbar (thermal efficiency of locomotive), per cent	7.0	
Heat discharged in exhaust steam, per cent	65.2	
	76.7	76.7

The exhaust steam of course does some work in producing draft and cannot all be considered as a loss, but calculations can be made which will easily show that it is very largely loss and that a small proportion of this heat could perform the work of producing draft satisfactorily.

A locomotive to give the results presented in the above tables would be working at an economical rate, probably burning about 60 lb. of coal per sq. ft. of grate area per hr. Having 76 sq. ft. of grate area and coal of 14,000 B.t.u. heat value, this would make the total heat available in the coal equal 63,840,000 B.t.u. per hr.

As the boiler efficiency is 76.7 per cent, there will be 48,965,280 B.t.u. used to heat, evaporate and superheat the steam. Deducting the amount of heat lost in radiation there will be 46,092,480 B.t.u. in the steam going to the cylinders.

Assuming the feedwater to have a temperature of 60 deg. fahr. and the steam to be at 200 lb. pressure with 200 deg. superheat and the injector to be 100 per cent efficient thermally, about 36,000 lb. of water will be used by the cylinders of this locomotive per hour.

Of the heat going to the cylinders 41,623,680 B.t.u. is discharged up the stack in the exhaust steam. If the steam is exhausted in a dry and saturated state it will then have a pressure of about 5 lb. and a temperature of 228 deg. fahr.

From this brief analysis it is seen that there are 11,461,200 B.t.u. discharged up the stack in the products of combustion, and 41,623,680 B.t.u. in the exhaust steam. The total is 53,084,880 B.t.u. or 83.2 per cent of the total heat of the coal in question.

Necessarily, any part of this heat that is reclaimed and returned to the boiler will allow a reduction by the same amount in the quantity of heat supplied by the coal to produce the same cylinder horsepower.

The most natural and feasible method of collecting part of this waste and again delivering it into the boiler is by using as much of it as is practicable to heat the feedwater before it enters the boiler. All of the heat that can be reclaimed in this way is a net saving.

Two different sources of waste heat are available, viz., exhaust steam and products of combustion or smokebox gases; but because of the size of apparatus and maintenance difficulties in the latter case, it is advisable to absorb all the heat possible from the exhaust steam before attempting to use the hot gases.

A careful study of the experiments that have been made on the heating of water will show that the amount of heat transferred across the unit area will vary greatly with the scouring action of the water as well as the heating medium. In the case of exhaust-steam heaters, however, where it is necessary to condense the heating medium in order to abstract its heat, the problem of a high heat transfer resolves itself largely into obtaining a high rate of agitation of the water. The efficiency of each unit of area will increase as the agitation is increased. Great agitation of the water necessarily implies the employment of energy, and the problem becomes the selection of a suitable form of apparatus which will give the highest rate of agitation of the water with the least cost for power.

One form of apparatus that has been in very successful use and is based on these principles is the Lovekin film heater, which has been applied extensively in marine practice, where the requirements demand minimum size and weight for the greatest efficiency.

In this heater the water is in a thin film between two spirally corrugated copper tubes. See Fig. 1. The heating medium, which is exhaust steam taken from the exhaust passages in the cylinders, is present on the inside of the inner tube and the outside of the outer tube, or on both sides of the water film. The water passing through this tortuous passage acquires a very high rate of agitation, and heat transfers greater than 900 B.t.u. per sq. ft. per hr. per degree average temperature difference are obtainable with a reasonable frictional resistance through the heater.

This design of heater, when arranged for a locomotive using 30,000 lb. of water an hour, forms an apparatus measuring $17\frac{1}{2} \times 21\frac{1}{4}$ in. in section outside and 82 in. in total length. It is easily fitted on the front deck, close to the cylinders, and

under the extension on the front end where it in nowise interferes with any other part of the locomotive and is entirely accessible for inspection or cleaning, if necessary. Fig. 1 shows this heater in section. It has been giving excellent results on a high-speed passenger locomotive during the past seven months, and has shown itself able to heat water from 45 deg. fahr. to 225 deg., or a temperature rise of 180 deg., with an exhaust-steam temperature of 240 deg.

If the conditions assumed for the locomotive above with feedwater temperature of 60 deg. and exhaust-steam temperature of 228 deg. are considered, it will be seen that a temperature rise of 153 deg. can be obtained in the feedwater, or an absorption of 5,508,000 B.t.u., or 13.4 per cent of the heat from the exhaust steam which had previously been wasted. This would be returned to the boiler as a saving from the feedwater heating.

If the feedwater is discharged from the exhaust-steam heater at more than 225 deg., which implies a back pressure of 10 lb. and is as hot as could normally be expected with that temperature of heating medium, there is still a range of 166 deg. that it can be raised before reaching the temperature corresponding to the boiler pressure. This would then have to be done by the exhaust gases, which have a temperature suitable for the purpose, frequently being 700 deg. or more. This would require, in this instance, the absorption of 5,868,000 B.t.u., or about 51 per cent of the heat contained in the exhaust gases.

There are no reliable figures available in regard to the transfer of heat from front-end gases of a locomotive to water on a unit basis, but it is quite probable that with any practical form of apparatus a heat transfer greater than 15 B.t.u. per sq. ft. per hour, per deg. average temperature difference will not be exceeded. If we accept this figure for the purposes of investigation and assume that there will be an average temperature difference between the hot gases and the water of 250 deg., it develops that over 1500 sq. ft. of heating surface will be required to raise the water 163 deg. in temperature. It is evident, therefore, that a form of construction which will give a higher heat transfer per square foot than that assumed will have to be developed and perfected, or it will be necessary to be satisfied with the lower temperature of feedwater.

Another feature of the subject which should not be overlooked is the effect of feedwater heating on the boiler efficiency. As the rate of combustion is decreased, the boiler efficiency increases, and when a feedwater heater is applied to the locomotive it allows the production of the desired amount of steam with a reduction in the amount of coal fired, which increases the boiler efficiency, in turn requiring still less coal to produce the results desired. In this way a very material saving is accomplished in the whole locomotive, which, while not produced by the feedwater heater, results from its application. In the case of a large passenger locomotive a reduction of 10 lb. of coal per sq. ft. of grate area per hour gives an increase in the boiler efficiency of about 3 per cent, which should be credited to the heater.

In order that the maximum amount of heat may be absorbed from the exhaust steam, it is necessary that the water shall enter the heater at the lowest possible temperature, which requires the use of a pump to force the water through the heater in the case of a closed heater similar to the one illustrated, or draw it from the heater in the case of an open type of heater. In the case of the open type of heater, temperatures greater than 212 deg. will not be obtainable, and this fact, in addition to the well-known difficulties that accompany the practice of pumping hot water, make it advisable to place the pump between the water supply and the heater and use the closed-type or pressure heater.

A satisfactory pump for this purpose should not only be reliable, durable and suitable for operating under the highly difficult conditions present on a moving locomotive, and also require an absolute minimum of attention for its maintenance, but it must also give a very high efficiency since the steam it requires for operation is practically a net loss to the locomotive as a whole. It is of course good practice to discharge the exhaust from the feed pump into the heater and there condense it, but the amount of heat taken up from this source reduces the amount that can be absorbed by the feedwater from the exhaust steam of the cylinders, and therefore, so far as economy is concerned, it gives no advantage.

A pump has recently been perfected by the Westinghouse Air Brake Company for use on locomotives which appears to answer the requirements in a very satisfactory manner. It is able to deliver more than 50 lb. of water against a pressure of 240 lb. for each pound of steam, at 150 lb. pressure, and will handle about 65,000 lb. of water per hour as a maximum. The amount of water pumped is controlled by the steam pressure on the pump through the medium of a simple throttle valve located in the cab and operated by the engineer.

A rule of thumb that has long been used in stationary and marine practice is that for each 11 degrees the feedwater is heated by a source otherwise wasted, there will be 1 per cent saving in fuel. Such experiments as have been made on locomotives indicate that this amount is conservative and can be easily attained. When the maximum capacity of the locomotive is being used, savings considerably in excess of this are indicated. It appears that an economy of at least 10 per cent can be reasonably expected even at light rates of working.

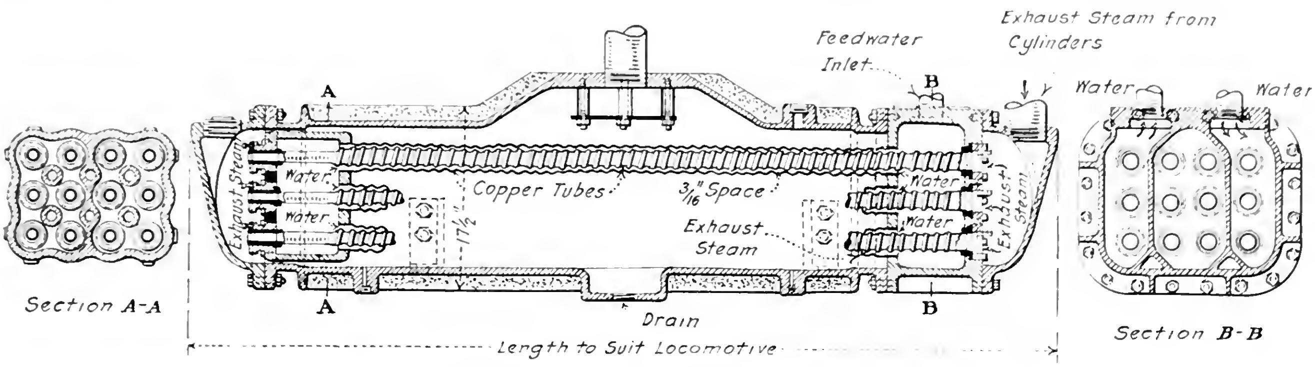

FIG. 1 LOCOMOTIVE FEEDWATER HEATER SHOWN IN SECTION

THE LOCOMOTIVE FIREBOX AND COMBUSTION CHAMBER

By J. T. ANTHONY,[1] NEW YORK, N. Y.

THE growing demands and economic problems confronting the railroads have resulted, among other things, in increased train loads. This has necessitated a large increase in the capacity of motive power units required, which has been obtained by increasing the size of the locomotive and the steaming capacity of its boiler. Since the sustained hauling capacity of a locomotive depends upon the ability of its boiler to deliver steam, and the steam generation depends upon the amount of coal that can be burned and heat liberated, the firebox has been the controlling factor in the successful operation of high-capacity locomotives.

The operating conditions of the future are problematical, but the indications are that in addition to present demands

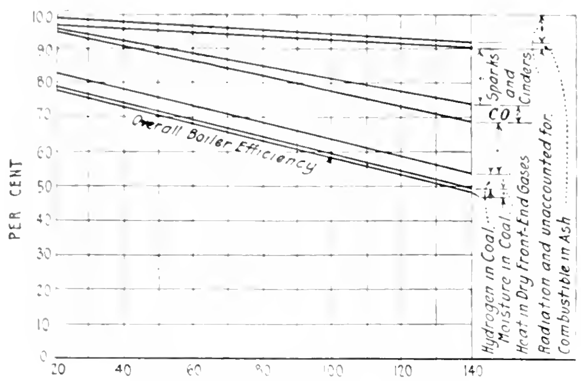

FIG. 1 HEAT LOSS AND BOILER EFFICIENCY AS AFFECTED BY RATE OF COMBUSTION

for high hauling capacity there will be a demand for higher speeds. The average locomotive is in service doing useful work 4 hr. and 17 min. out of each 24 hr., with a daily average of about 75 miles. It is highly probable that strenuous efforts will be made in the future to increase the amount of time the locomotive is engaged in useful work, and to increase the length of the runs and locomotive mileage per day by changing crews when necessary.

If these conditions arise, the controlling factor will be the firebox and its ability to burn the coal properly and liberate the heat required over long periods of time. Regarded from the standpoint of present operating conditions or possible future conditions, the locomotive firebox is a vital factor; and no operating or mechanical official can afford to neglect the study of its present defects or future possibilities.

The firebox has two functions to perform. The first and most important is the burning of the coal and liberation of the heat contained. The second is the absorption of heat by the firebox heating surfaces.

Only a part of the coal burns on the grates. Under normal conditions at least 50 per cent of the heat is liberated by the burning of gases above the fuel bed. Ample air supply, thorough mixing of the gases, and combustion space are necessary for the complete burning of the gases. For efficient firebox performance, combustion chambers and mixing devices are as necessary as the grates.

The firebox furnishes only 5 to 10 per cent of the total heating surface, but is responsible for 25 to 50 per cent of the total evaporation, due to the fact that its heating surfaces are ideally disposed for the absorption of radiant heat. Maximum boiler capacity and efficiency cannot be obtained without providing for the generation and absorption of this radiant heat.

Fig. 1 shows a fair average of boiler efficiency and heat losses on modern locomotives equipped with brick arches and superheaters. It will be noted that the boiler efficiency drops from about 78 per cent down to 48 per cent as the rate of combustion increases from 20 to 140 lb. of coal per sq. ft. of grate per hour. It will also be noted that the greatest heat losses are those due to the heat carried away by the front-end gases and the heat loss in sparks and cinders; the former remaining nearly uniform throughout the range of tests, while the latter increases rapidly as the rate of combustion increases.

It is common practice to design locomotives to deliver their rated tractive effort when burning 120 lb. of coal per sq. ft. of grate per hour. Fig. 2 shows the average heat distribution and losses at this rate of combustion. Fifty-three per cent of the heat contained in the coal is absorbed by the boiler and 47 per cent lost. Of the heat lost, 27 per cent is chargeable to the furnace, 6 per cent to the heating surfaces, and 14 per cent is unavoidably lost in the front-end gases.

A comparison of *D* and *I* in Fig. 2 indicates clearly that the furnace (or firebox) is responsible for four times as much heat

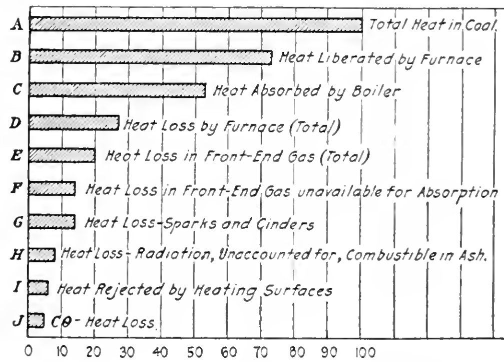

FIG. 2 HEAT DISTRIBUTION AND LOSSES WHEN FIRING COAL AT THE RATE OF 120 LB. PER HOUR PER SQ. FT. OF GRATE

waste as the boiler heating surfaces; and it becomes very evident that the largest field for improvement lies in the locomotive firebox, and not in the heat-absorbing surfaces. This is an all-important fact and one that should be borne in mind: that it profits us little to provide large areas of heating surfaces if proper provisions for burning the coal are not made in the firebox.

FIREBOX LOSSES

Firebox losses consist of:

1 *Combustible in Ash,* due partly to character of coal and to grate design and method of firing. Loss of this nature

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[1] Assistant to the President, American Arch Company.

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is generally small, not amounting to more than 1 to 1½ per cent.

2 *Carbon Monoxide.* This gas is unavoidably formed in large quantities in the fuel bed, and must be burned in the combustion-chamber space. Its formation can be reduced by providing grate area sufficient to prevent high rates of combustion and to allow a light fire to be carried, thereby insuring an ample air supply, both in the fuel bed and in the firebox space above. Once formed, the gas can be completely burned only by *mixing* with an excess of oxygen and providing ample combustion-chamber space.

3 *Unburned Hydrocarbons*, which account for a large part of the so-called "unaccounted-for" losses. These gases are distilled off from the green coal and burn above the fuel bed. To burn them completely it is necessary to provide an excess of oxygen above the fuel bed, to mix thoroughly, and to have a large combustion chamber and long flameway. Even with these provisions it is very difficult to burn some of the heavy hydrocarbons, which are driven off in the form of tarry vapors.

4 *Sparks and Cinders* are responsible for the largest heat loss at high rates of combustion. This loss can be greatly reduced by increasing the grate area and reducing the velocity of the draft through the fuel bed. Refractory baffles to break up and deflect the cinders, and combustion chambers of ample volume and length wherein the fine particles can burn, will cause a further reduction in these losses.

Summed up, the elimination or reduction of the firebox losses can be brought about by increasing the grate area, firebox volume and combustion-chamber space by providing effectual baffles and mixing devices, and supplying at least 33 per cent excess air, or approximately 16 lb. of air per lb. of coal.

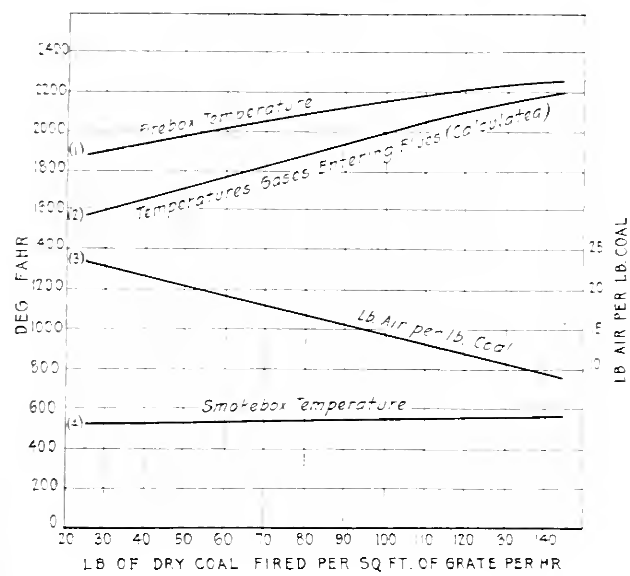

FIG. 3 CHART SHOWING EFFECT OF RATE OF COMBUSTION ON FIREBOX AND SMOKEBOX TEMPERATURES, TEMPERATURE OF GASES ENTERING FLUES, AND AIR SUPPLY PER POUND OF COAL

Air sufficient for complete combustion can be drawn into the firebox at low and moderate rates of combustion if sufficient openings are provided in ashpans and grates. At high rates of combustion it is impossible to get enough air into the firebox to complete combustion, and this is always found to be the controlling factor when driving locomotives to their maximum capacity.

COMBUSTION CHAMBERS

Ordinarily, we are apt to think of coal as burning on the grates, when as a matter of fact a large part of the coal burns above the fuel bed in the form of gas. Consider the case of the large boiler, such as is used on the Pacific- and Mikado-type engines, with 70 sq. ft. of grate, 311 cu. ft. of firebox volume, 232 sq. ft. of firebox heating surface and 5280 sq. ft. of flue and superheating surface, the firebox being without a combustion chamber and equipped with a brick arch. The coal used was high-volatile Westmoreland with a heat value of 14,430 B.t.u. per lb. and having the following composition:

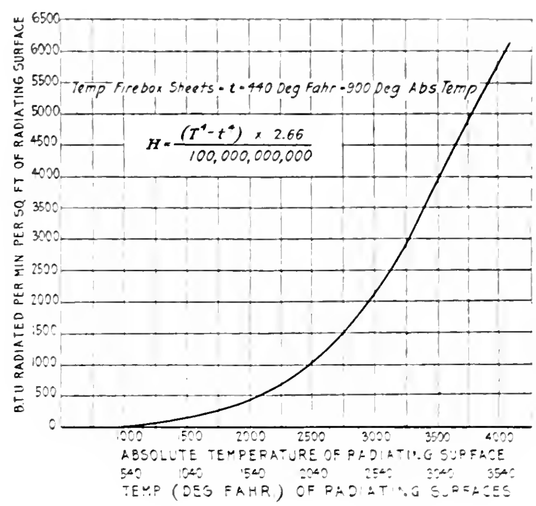

FIG. 4 AMOUNT OF HEAT RADIATED PER MINUTE PER SQUARE FOOT OF RADIATING SURFACE WHEN TEMPERATURE OF FIRE SIDE OF FIREBOX SHEETS IS 440 DEG. FAHR.

	Per cent		Per cent
Fixed carbon.......	57	Carbon	78
Volatile matter.....	35	Hydrogen	5¾
Moisture	1	Nitrogen	1½
Ash	7	Sulphur	1½
	—	Ash	7
	100	Oxygen	6¼
			—
			100

At a rate of combustion of 120 lb. of coal per square ft. of grate per hour, 8400 lb. was fired (which is equivalent to 140 lb. per min., or 2.33 lb. per sec.). The coal contained 57 per cent of fixed carbon; and if all this burned on the grate, there would be liberated 8350 heat units—or 58 per cent of the heat contained in the coal—while 6080 heat units (or 42 per cent) would be liberated by the volatile combustible burning above the fuel bed.

However, all of the fixed carbon does not burn on the grate. The oxygen, on coming in contact with the glowing coals next to the grate, combines with the carbon to form carbon dioxide, and this, passing up through the fuel bed, comes in contact with other glowing coals and is reduced to carbon monoxide; and there is a large percentage of the latter gas mixed with the carbon dioxide and other gases arising from the fuel bed.

Tests indicate that often there is as much as 80 per cent of the fixed carbon incompletely burned to carbon monoxide,

and in order to avoid a large heat loss, this carbon monoxide must be mixed with sufficient oxygen to enable it to be completely burned in the combustion chamber space above the fuel bed.

Assume, for example, that 50 per cent of the fixed carbon is completely burned on the grates and 50 per cent is incompletely burned to carbon monoxide. The gases arising from the fuel bed will have the composition, weight and volume shown in Table 1.

TABLE 1 COMPOSITION AND VOLUME OF GASES IN FIREBOX

WHEN BURNING 120 LB. OF COAL PER SQUARE FOOT OF GRATE PER HOUR, WITH AN AIR SUPPLY OF $12\frac{3}{4}$ LB., AND ONE-HALF OF FIXED CARBON COMPLETELY BURNED ON THE GRATES. FIREBOX TEMPERATURE = 2200 DEG. FAHR.

Gas	Symbol	Arising from Fuel Bed			Combustion Completed	
		Lb. per Sec.	Cu. Ft. per Sec.	Per Cent Vol.	Cu. Ft. per Sec.	Per Cent Vol.
Ethane [1]	C_2H_6	0.50	38	1.87	0	0
Carbon monoxide	CO	1.55	107	5.27	0	0
Carbon dioxide	CO_2	2.44	107	5.27	290	14.53
Nitrogen	N_2	21.96	1517	74.73	1517	76.06
Oxygen	O_2	3.99	242	11.92	55	2.75
Water vapor	H_2O	0.16	17	0.84	131	6.56
Sulphur dioxide	SO_2	0.07	2	0.10	2	0.10
Totals	....	30.67	2030	100.00	1995	100.00

[1] Ethane assumed to represent average composition of the hydrocarbons.

Under these conditions, only 40 per cent of the heat contained in the coal would be liberated on the grate, while 60

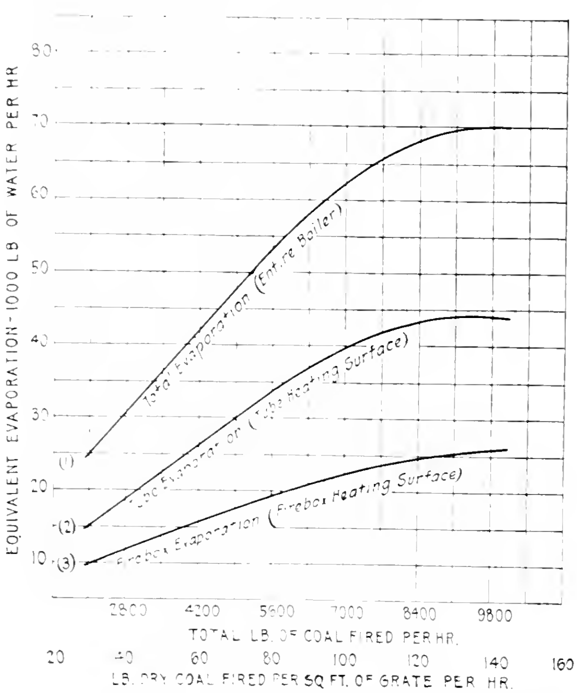

FIG. 5 EQUIVALENT EVAPORATION PER HOUR FOR VARIOUS RATES OF FIRING

per cent would be liberated by the burning of the gases in the combustion-chamber space.

We have assumed that the combustion in the firebox is complete and that there is no hydrocarbon or carbon monoxide contained in the gases entering the flues, as shown by the right-hand column of the table. Under the conditions, however, perfect combustion could not be obtained, as the air supply, $12\frac{3}{4}$ lb. per pound of coal, is insufficient. Table 1 shows that there is an excess of 2.75 per cent free oxygen in the final products of combustion; but this is not sufficient to guarantee complete combustion, on account of the presence of the large volumes of inert gases, which interfere with the mixing of the oxygen with the combustibles; and also on account of the short time available for combustion of each particle of gas.

The velocity with which the combustible gases burn depends upon the volume percentages of the combustible and the oxygen present. For instance, with the gases arising from the fuel bed containing 5 per cent carbon monoxide and 12 per cent oxygen, the velocity of combustion would be proportional to $5^2 \times 12 = 300$.

Where combustion is nearly complete and the gases contain, say, 1 per cent carbon monoxide and 3 per cent oxygen, the velocity of combustion would be proportional to $1^2 \times 3 = 3$; or it would be 100 times more rapid in the first than in the second case. This slowness of combustion can be partially offset by providing long flameway and combustion-chamber space; but in addition combustion must be speeded up by increasing the supply of oxygen if perfect combustion is to be obtained.

As shown, the total volume of gases evolved per second is more than 2000 cu. ft. The firebox has a volume of 311 cu. ft., which means that the firebox is being filled and refilled with gases about six and one-half times per second; or that the time available for the combustion of each particle of gas will average less than one-sixth of a second.

It is evident from the above that it is a very difficult matter to burn completely the combustible gases in an ordinary firebox, although, as a rule, front-end-gas analyses fail to account for these losses. This is due to our method of making these analyses, no provision being made ordinarily to detect the presence of unburned hydrocarbons; while the presence of a small percentage of carbon monoxide may often pass undetected, owing to methods employed in collecting gas samples and to chances for error in gas analyses.

The presence of 0.1 per cent of unburned hydrocarbon in the front-end gas under the above conditions would indicate a loss of more than 2 per cent of the entire heat contained in the coal; and such losses, and much larger losses, are constantly occurring.

The large volume of gases evolved and the amount of heat generated by the burning of these gases emphasize the importance of firebox volume and combustion-chamber space. The fuel bed is little more than a gas producer, and adequate provisions must be made for burning these gases if perfect combustion is to be approximated.

FIREBOX HEATING SURFACE

Fig. 3 shows the firebox and smokebox temperatures and air supply per pound of coal, obtained in tests of the locomotive under consideration. It will be noted that as the rate of combustion increased from 30 to 140 lb. of coal, the firebox temperature rose from 1900 to 2240 deg. fahr., while the smokebox temperature increased from 520 to 580 deg. At the same time the air supply per pound of coal decreased from $22\frac{1}{2}$ to 10 lb. The firebox temperature shown is probably higher than that generally obtained in road service; but high

firebox temperatures are much to be desired, as the evaporation increases rapidly with the rise in temperature.

Firebox heating surfaces receive practically all of their heat by radiation, the heat being radiated directly from the luminous fuel bed, flames and brickwork, traveling from these radiating surfaces by "rays" to the firebox heating surfaces.

The locomotive firebox is ideally suited to the absorption of radiant heat, having the radiating bodies, such as the fuel bed and flames, surrounded by the cooler, soot-covered heating surfaces, which absorb all the radiant heat and reflect none of it away.

The curve in Fig. 4 shows the amount of heat radiated per minute per square foot of radiating surface for various firebox temperatures when the temperature of a firebox sheet on the fire side is 440 deg. fahr. The points determining the curve were figured from the formula (Stefan-Boltzmann) shown, absolute temperatures being used. With a firebox temperature of 1540 deg., each square foot of radiating surface gives off about 400 heat units; whereas, if the temperature is increased to 2040 deg., more than 1000 heat units are radiated per minute; while a temperature of 3000 deg. would give a radiation of almost 4000 heat units per minute per square foot of radiating surface.

High firebox temperatures are necessary if high firebox evaporation is to be obtained; but temperature is but one of the two controlling factors, the other being the area or extent of the radiating surfaces. The fuel bed is a radiating body, and the area of the radiating surface of the fuel bed is readily determined. Flames also radiate heat, but the amount of flame in a firebox is very variable and the amount of heat radiated therefrom is difficult to determine. If the firebox is completely filled with a mass of flame, the effective flame-radiating surfaces will be equal to the exposed firebox heating surfaces. If the firebox is not completely filled with flame, the flame-radiating surfaces will be less.

Assuming that the firebox was completely filled with flame when burning the high-volatile coal at a rate of 80 lb. per square foot of grate per hour and was 50 per cent filled at the low rates of combustion. Curve 3 in Fig. 5 was plotted, the flame temperature being assumed to equal that of the firebox. The curve showing the total equivalent evaporation from the boiler was plotted from actual test data. The curve of firebox evaporation was calculated from the curve in Fig. 4, using the firebox temperatures shown in Fig. 3. The curve showing tube evaporation was obtained by subtracting the firebox evaporation from the total.

At the lowest rate of evaporation the curve indicates that the firebox evaporated 40 per cent of the total, and at the highest rate, 37 per cent. An equivalent evaporation of 26,000 lb. per hour from 230 sq. ft. of heating surface means an evaporation of 105.6 lb. per hour per sq. ft. of heating surface. In order to get such an evaporation, each square foot of heating surface would have to transfer 102,400 heat units per hour, and the temperature on the fire side of the sheet would be about 536 deg. if the sheets were clean. These figures will serve to show what can be expected when high firebox temperatures and large radiating surfaces are to be had; for firebox evaporation depends principally upon these two factors, and only indirectly upon the extent of the firebox heating surfaces.

Increasing the firebox heating surfaces by the addition of a combustion chamber increases the firebox evaporation only to the extent that the combustion chamber is filled with flame or heat-radiating surfaces. If the combustion chamber is not filled with flame, there will be practically no increase in firebox evaporation; for the combustion-chamber heating surface is so arranged that it can take up but an inappreciable amount of heat from the gases by convection.

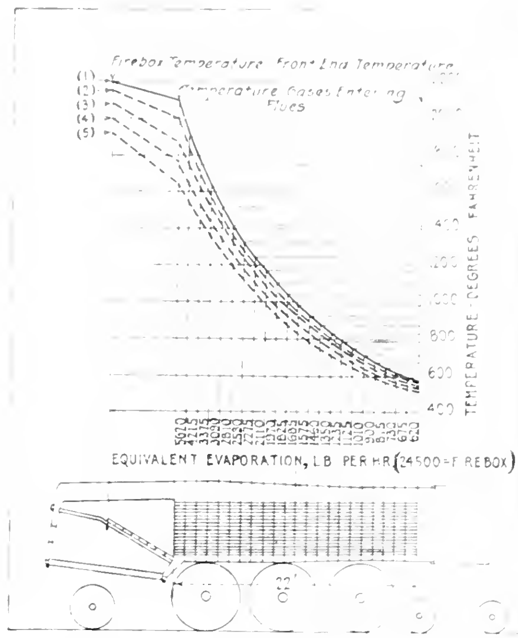

FIG 6. TEMPERATURE DROP FROM FIREBOX TO FRONT END AT VARIOUS RATES OF COMBUSTION

(1), 120 lb. per sq. ft. of grate per hour; (2), 100 lb.; (3), 80 lb.; (4), 60 lb.; (5), 40 lb. Evaporation for each 1-ft. section of tubes calculated from temperature drop shown by Curve (1)

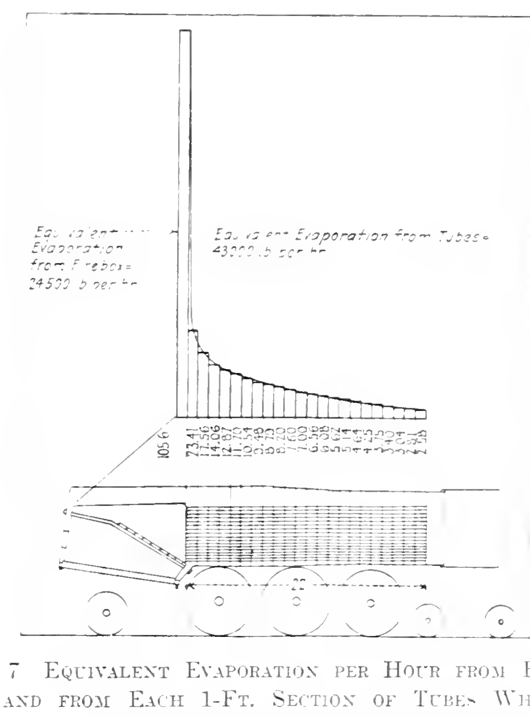

FIG. 7 EQUIVALENT EVAPORATION PER HOUR FROM FIREBOX AND FROM EACH 1-FT. SECTION OF TUBES WHEN BURNING 120 LB. COAL PER SQ. FT. OF GRATE PER HOUR

Figures show equivalent evaporation per sq. ft. of heating surface per hour. Grate area, 70 sq. ft; firebox heating surface, 232 sq. ft.; tube-heating surface, 5280 sq. ft. = 240 sq. ft. per 1-ft. section.

The curves in Fig. 6 show the characteristic drops in temperature of the gases in passing through the flues when burn-

ing coal at varying rates per square foot of grate per hour, with the air supply shown in Fig. 3

Suppose the flues to have been divided into 22 equal sections, each 1 ft. in length and containing 240 sq. ft. of heating surface. With a constant weight of gases passing through, the drop in temperature through each 1 ft. section becomes a measure of the evaporation in that section; and the figures per square foot of flue heating surface would be 8.14 lb. per hour, this evaporation ranging from 23.4 lb. in the section next to the firebox down to 2.58 lb. per sq. ft. in the section adjacent to the front flue sheet. It will be noted that the first four sections from the front end have a total equivalent evaporation of only 2840 lb. per hour, or about half that produced by the one section adjacent to the back flue sheet.

Fig. 8 Ordinary Firebox without Baffle or Other Gas-Mixing Device

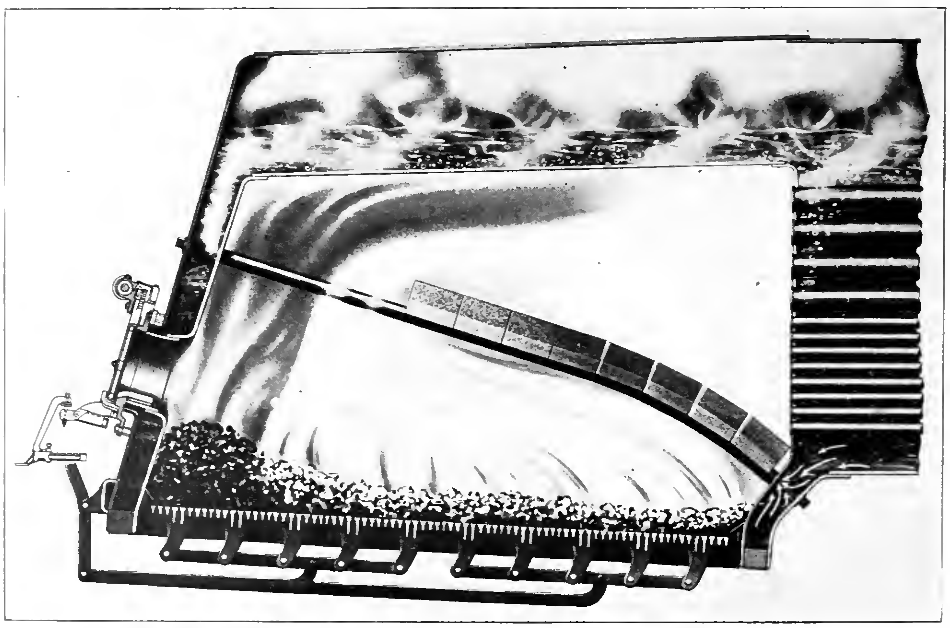

Fig. 9 Ordinary Type of Firebox Equipped with an Arch

showing the total equivalent evaporation from each section and the equivalent evaporation per square foot of heating surface were calculated from the temperature drops and the weight of the gases, assuming the specific heat to be constant throughout. This assumption introduces a small error into the calculations, but it is not sufficient to affect the results greatly.

With an equivalent evaporation per square foot of firebox heating surface of 105.6 lb. per hour, the average evaporation

A reduction of the flue lengths to, say, 18 ft. by the application of a 4-ft. combustion chamber would reduce the flue heating surface 960 sq. ft., increase the firebox surface by 76 sq. ft., and add 108 cu. ft. to the firebox volume. What effect would such a change have upon the boiler evaporation and efficiency?

As shown in Fig. 2, more than 25 per cent of the heat contained in the coal is lost through imperfect combustion. If

the additional firebox volume obtained by the use of the combustion chamber effected a saving of one-fourth of this heat loss, the resulting combustion would cause an increase in firebox evaporation of approximately 8025 lb. to offset the 2840 lb. lost by shortening the flues.

Boiler tests show even larger increases in efficiency brought about by the introduction of the combustion chamber; and a study of the questions of furnace losses and heat generation by the burning gases will make it clear why the application of a combustion chamber to a locomotive does increase fire-

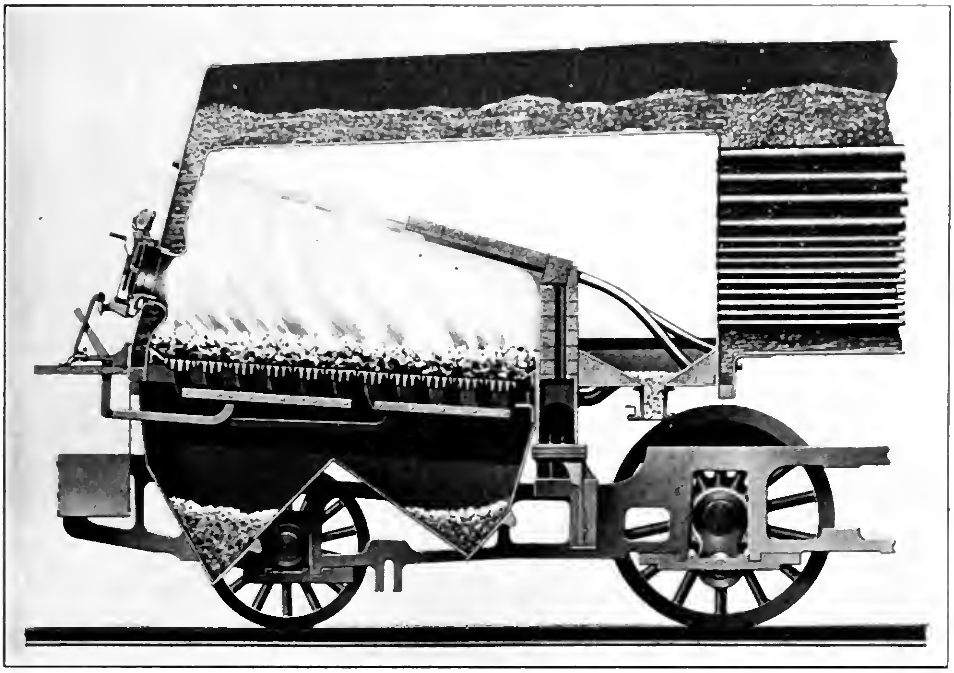

Fig. 10 Firebox Equipped with the Gaines Locomotive Furnace

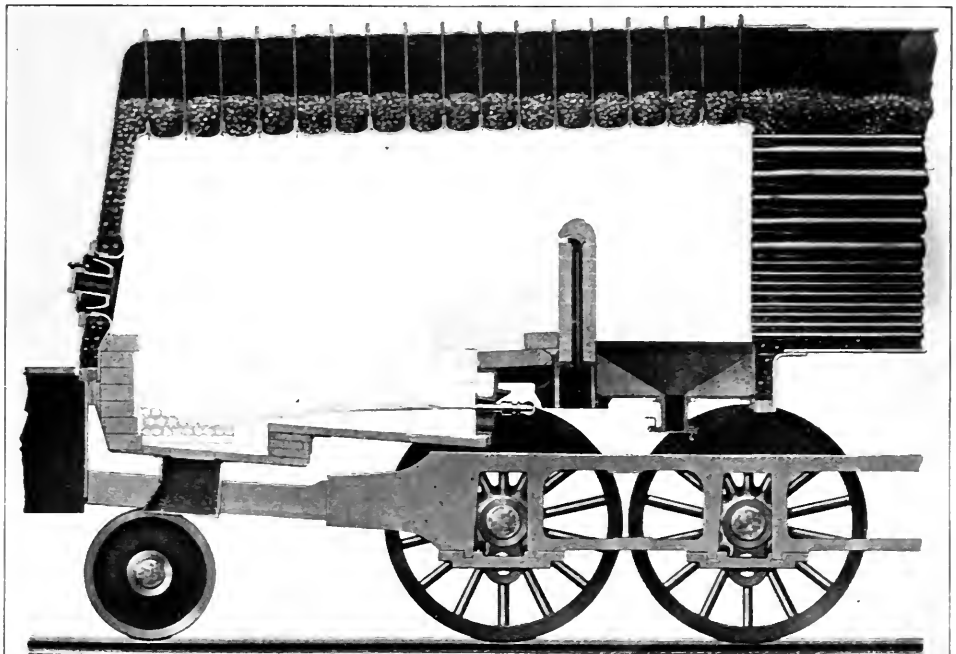

Fig. 11 Straight-Wall Type of Gaines Combustion Chamber as Applied to an Oil-Burning Locomotive of the 2-10-2 Type

This increased firebox evaporation would be obtained by the generation of heat that would otherwise have been lost, and there would be little or no reduction in the temperature of gases entering the flues. The front-end temperature would be increased, but there would be a net increase of $7\frac{1}{2}$ per cent in boiler efficiency, due to the combustion chamber.

box evaporation and decreases the heat losses caused by the escape of unburned volatile combustibles and fine particles of coal.

While comparatively few reliable tests have been made for the purpose of determining the effect of a combustion-chamber installation upon boiler efficiency, the three shown in Table 2

give a clear indication of the value of firebox volume and combustion chamber space.

TABLE 2

Locomotive Type	Cylinder Size	Fuel Used	Relative Boiler Efficiency, Per Cent.	
			With Gaines Combustion Chamber	Without
[illegible]	[illegible]	Coal	100	62
[illegible]	[illegible]	Coal	100	78
2-10-2	[illegible]	Oil	100	80

The variation in boiler efficiencies in the table is due partly to the character of the fuel and partly to the difference in lengths of combustion chambers and peculiarities of firebox design.

The relative efficiency of the firebox heating surfaces as compared with the flue heating surfaces is shown by the curve in Fig. 7. The base of the rectangle represents the heating surface, 240 sq. ft. for each section of the flues and 232 sq. ft. for the firebox. The height of the rectangle indicates equivalent evaporation per square foot of heating surface per hour from each of the flue sections, while the area of each rectangle represents the total evaporation per hour.

The principal function of the firebox is to burn coal and liberate the heat; but the amount of water evaporated by the firebox heating surfaces, as shown by the chart, is quite considerable, and full advantage should be taken of the opportunities offered for producing and absorbing radiant heat. Whether considered as a furnace or as a part of the boiler evaporating surface, the firebox is the chief factor in successful boiler performance, on which depends successful locomotive operation.

The value of baffling and gas-mixing devices, firebox volume and combustion-chamber space is becoming more generally recognized, although the engines with long wheelbases and boilers now in vogue present opportunities for combustion-chamber installations of which full advantage is not being taken by many of the American railroads. The advance that has been made along these lines during the past few years is shown by the following illustrations.

Fig. 8 shows the ordinary firebox without a baffle or gas-mixing device of any description. The picture shows clearly the disadvantages of such a firebox and the possibilities of large heat losses due to the escape of unburned hydrocarbon gases distilled off from the bank of green coal under the door, and to the heat loss and flue trouble occasioned by the inrush of cold air through a possible hole in the fire.

Fig. 9 shows the same type of firebox equipped with an arch, and illustrates the advantages of the baffling and mixing obtained by the arch, as well as the protection afforded the flues.

Fig. 10 shows a firebox equipped with the Gaines locomotive furnace, in which the flue sheet is carried forward to a point directly over the rear driver, the mudrings being upset at the sides to provide sufficient clearance.

Fig. 11 shows a straight-wall type of Gaines combustion chamber, as applied to an oil-burning locomotive of the 2-10-2 type. This is the first installation of its kind that has been made on road engines.

These latter illustrations show the furnace layouts of locomotives that are in actual operation; and the results obtained in fuel economy, boiler capacity and low cost of maintenance give additional weight to the arguments advanced regarding the effect of heat radiation from fuel bed, flameways and brickwork, and the necessity of large firebox volume and long flameway.

Rhotanium—A Platinum Substitute

Rhotanium, a palladium-gold alloy in which the gold content varies from 60 to 90 per cent, is said to form a satisfactory substitute for platinum. It is malleable and ductile and can be welded without the use of a flux or other reagent. Its specific gravity ranges from about 16 to 18.5, according to composition, and its losses by volatilization at temperatures below 1300 deg. cent. are less than those of commercial platinum. It can be used, within its temperature limitations, in electric heating units, and is satisfactory for contact terminals in many forms of automatic electric devices. Its behavior when tested on certain magnetos was satisfactory, but experiments performed on a high-grade aeroplane-engine magneto gave negative results. It is not suitable for use with hot concentrated nitric acid nor for electrolytic anodes, but for all other chemical purposes it is entirely satisfactory if the proper composition is chosen and if properly manufactured. Certain of the alloys have given good service in dentistry when used for pins and baked into porcelain teeth and as thin foil and heavy sheet for other types of construction. Rhotanium is said to be superior to pure platinum for use in jewelry; it is harder, stronger, and takes a better finish. It does not tarnish, is non-corrodible, has practically the color of platinum, and can be worked as readily. Jewelry made with it passes the common jewelers' and platinum buyers' tests. (U. S. Commerce Reports, abstracted in *Machinery,* vol. 23, no. 12, August 1917, p. 1096)

Patent Merger in Aircraft

According to statements in the press, the manufacturers of aircraft have formed an organization under the name of Manufacturers' Aircraft Association. The most important feature of this association is an agreement entered into by the manufacturers composing it, with a view to cross-licensing the various patents held by the members.

According to a statement given out by the chairman of the publicity committee of the association, it is proposed that each member should pay a royalty of $200 on each machine built by him. Of this sum $135 will be paid to the Wright interests and $40 to the Curtiss interests until the Wright interests have accumulated $2,000,000. Thereafter $175 will go to the Curtiss interests until they have accumulated a similar sum. The residue of $25 on each machine is to go to the general fund of the association.

By the terms of the cross-licensing agreement any responsible manufacturer of aircraft, or one who intends to become a bona-fide producer of same, or any manufacturer to whom the United States Government has given a contract for the construction of ten or more aeroplanes, or any person, firm, or corporation owning or controlling United States patents relating to aeroplanes, may become a party to the agreement and can qualify as a member.

Under the terms of this agreement all patent litigation relating to aeroplanes between members of the association ceases automatically. From the text of the announcement and statements made by the officers, it appears that the agreement covers the aeroplane proper, but not the engine.

The office of the association is at 501 Fifth Ave., New York City. Frank H. Russell, of the Burgess Company, is president of the association, and Benjamin S. Foss, of the Sturtevant Aeroplane Company, is secretary.

THE POPPET-VALVE STEAM ENGINE

With Special Reference to the Present Status of the Poppet-Valve Uniflow, Semi-Uniflow and Return-Flow Steam Engine in the United States

By SIEGFRIED ROSENZWEIG, NEW YORK, N. Y.

Member of the Society

It was in the sixties of the last century that the first poppet-valve engine appeared on the market. It was designed by a young Englishman, Charles Brown, chief engineer of the famous firm of Sulzer Bros., of Winterthur, Switzerland.

This first Sulzer engine became, and still is, the standard design of modern poppet-valve engines. The engine has the side shaft driven from the main shaft by a pair of bevel gears; the two admission valves are mounted on the top, and the two exhaust valves placed at the bottom of the cylinder; and mounted on the side shaft are the four eccentrics, straps and rods for the operation of the valve mechanism. The whole arrangement is excellent and possesses many fine points, the consequence of thoughtful and careful design and workmanship.

While the Corliss engine was finding great favor in this country, and also in England and France, engineers in Germany, Austria and Switzerland pinned their faith to the poppet-valve engine, being convinced that, with the advent of higher steam pressures and higher steam temperatures in general, the poppet valve was more suitable for steam distribution than any other kind of valve. Present-day practice demonstrates that these engineers displayed sound judgment.

It is hardly necessary to enter into the subject of high steam pressures and superheat, but a few figures might be of interest. By increasing the steam pressure, the capacity of the engine is correspondingly increased while the additional heat expenditure is very small. For instance, steam at 100 lb. gage contains 1191 B.t.u. per lb.: at 200 lb. 9 B.t.u. more, and at 500 lb. 19 B.t.u. more, showing that the additional heat required for raising the steam pressure is insignificant.

In this respect the following statement may be quoted from a paper read by Robert Cramer on Higher Steam Pressures[1]: "It is apparent that high steam pressures will permit neither slide nor Corliss valves. The advent of higher pressure will cause the poppet valve to come into its own in America, where it is now seldom used, in spite of the great success it has had in Europe for many years, lately the flexible-seat type especially."

The advantages of the poppet valve are:

1 No rubbing surfaces, hence no lubrication, and its adaptability for high temperatures
2 Small weight and practical balance, hence its adaptability for high speed and high steam pressure
3 No possible wear, consequently the engine economy maintained for an indefinite period.

The comparison shown in Fig. 1 is taken from actual designs. The two valves have the same free area, 65 sq. in., while the weight of the four poppet valves is 72 lb. as against 824 lb. for the four Corliss valves.

In order to combine the advantages and disadvantages of simple and compound engines, the idea of passing the steam through the cylinder in a unidirectional flow, known for more than thirty years, was revived and successfully carried out in practice. Professor Stumpf, of Berlin, Germany, deserves the credit of having designed the first modern and practical uniflow engine.

In these engines the steam enters through admission valves at one end of the cylinder, follows the piston during the expansion period, and escapes through exhaust ports arranged in the center of the cylinder and controlled by the piston.

The steam has a tendency to travel always in the same direction in a unidirectional flow engine, as the rarefication of the steam in the cylinder will take place in a direction toward the central exhaust, cooling the cylinder walls next to the exhaust belt more than those at the other end, and causing a gradual decrease of the temperature of the cylinder walls from the hot cylinder cover to the cool exhaust port, corresponding approximately with the temperature of the expanding steam. The considerable losses caused by the cooling action of the cylinder walls during the admission period, and by reevaporation of steam during the exhaust period in ordinary steam engines, are thus almost entirely avoided.

It seems perfectly feasible that a stratification of the steam, with the wettest particles next to the piston, takes place during the expansion period, but it is doubtful whether, as claimed by Professor Stumpf, it can be maintained during exhaust in view of the rather violent action of the steam in the cylinder when the terminal pressure is suddenly reduced to the back pressure.

While it is true that the cylinder cover remains comparatively unaffected by the flow of steam, it has to be admitted that the piston surface is exposed to the action of the steam. However, on account of the circumferentially arranged exhaust ports, the pressure energy is converted into velocity energy within the exhaust ports to a great extent, without cooling the surface of the piston considerably.

When the exhaust port opens, all the moisture accumulated during the expansion period is completely removed and the possibility of water hammer eliminated.

Further advantages of the uniflow cylinder are due to the fact that the clearance surfaces and volume are considerably reduced as exhaust valves of the usual type are eliminated. The exhaust belt provides an exhaust area considerably in excess of that found in ordinary engines, thus making impossible the pressure difference so often encountered between cylinder and exhaust pipe.

Steam leakage through the exhaust port is rendered practically impossible, as the long piston separates it from the admission valves when the steam pressure is high.

It is evident that the unidirectional flow of steam reduces considerably one of the greatest losses encountered in the ordinary or return-flow engine, namely, the cooling of clearance surfaces, and hence initial condensation. The transformation of energy into power can be effected very economically in

Presented at a meeting of the New York Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS., May 8, 1917.

[1] Trans. Am. Soc. M.E., vol. 37, p. 597.

one cylinder without the necessity of employing compound and triple expansion engines as heretofore.

The advantages of the uniflow engines are:

1. Steam enters at one cylinder end and exhausts at the other end, leaving the hot end hot and the cold end cold, and avoiding clearance losses.
2. The exhaust valves with their large clearance surfaces and volumes are eliminated.
3. Large central exhaust ports are provided which are of about three times the area of those in standard engines.

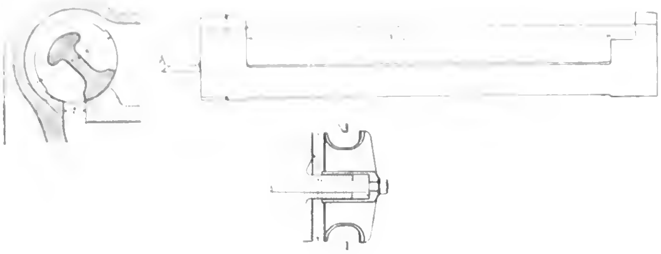

Fig. 1 Comparison of Corliss and Poppet Valves

Free area of Corliss valve	65 sq. in.
Weight of four valves	824 lb.
Free area of Poppet valve	65 sq. in.
Weight of four valves	72 lb.

4. Leakage past exhaust valves and piston is eliminated.
5. Flat steam-consumption curves are obtained for all loads above and below normal.

Comparative steam consumptions of Corliss, poppet-valve and uniflow poppet-valve engines are given in Fig. 2. Noteworthy is the good economy of poppet-valve engines, especially of the uniflow type, at the smaller loads.

An interesting comparison is afforded by the guaranteed steam consumptions of small turbines and uniflow engines for the new three-million-dollar pumping station of the city of Cleveland, Ohio, showing distinctly the great superiority of uniflow engines over turbines, running condensing and non-condensing.

The equipment consisted of an engine driving a 100-kw. generator at 80 per cent power factor. The steam conditions specified were: 200 lb. gage, 100 deg. fahr. superheat, 2 lb. gage back pressure, when running non-condensing, and a vacuum of 26 in. for the engine, 28 in. for the turbine, when operating condensing.

L. A. Quayle, Mechanical Engineer of the Cleveland Water Department, describing the performance of these engines in *Power*, June 6, 1916, says:

> The prices and economy guarantees received on bids from two engine and three turbine builders, as well as informal bids received from two other companies, one a turbine and the other one an engine builder, have been used in making the comparison given here. The prices and guarantee curves represent only the average of three makes of engines and four makes of turbines, including three different makes of generators, all of the bidders being well known.
>
> It is felt that the economy guarantees are conservative, as there was a penalty of $7 per pound of steam per kw-hr. for failure to meet the guaranteed economy, and no bonus was offered for exceeding the guarantees.

STATIONARY ENGINES

Careful experiments carried out by the best authorities during the last few years, on compound and single-cylinder engines of the return-flow and uniflow type, have clearly indicated to the designers of steam engines the principles to be observed in order to obtain highest economies with the simplest mechanical means.

It is essential that, for the sake of economy, clearance in volume and surface be reduced to the lowest possible minimum. In order to obtain the desired results, designers have not hesitated to adopt complicated cylinder and valve-cage designs. Simplicity and accessibility of cylinder and valve-gear parts were sacrificed to economy. A description of the different types of engines will show how an excellent cylinder design can be obtained while employing simple and mechanical means.

The question of valve gear to be used is also of great importance. Complicated mechanisms and trip gears are undesirable, as with them quiet and reliable operation without undue wear is impossible at high speeds. The modern type of steam engine with its steadily increasing rotative speed demands a valve gear of absolutely positive and noiseless operation.

Trip gears are particularly undesirable with poppet-valve engines, as the valve is brought to a sudden stop by coming in contact with the valve seats; such a gear should therefore not be used on engines operating above 100 revolutions.

In order to overcome the disadvantages of the trip valve

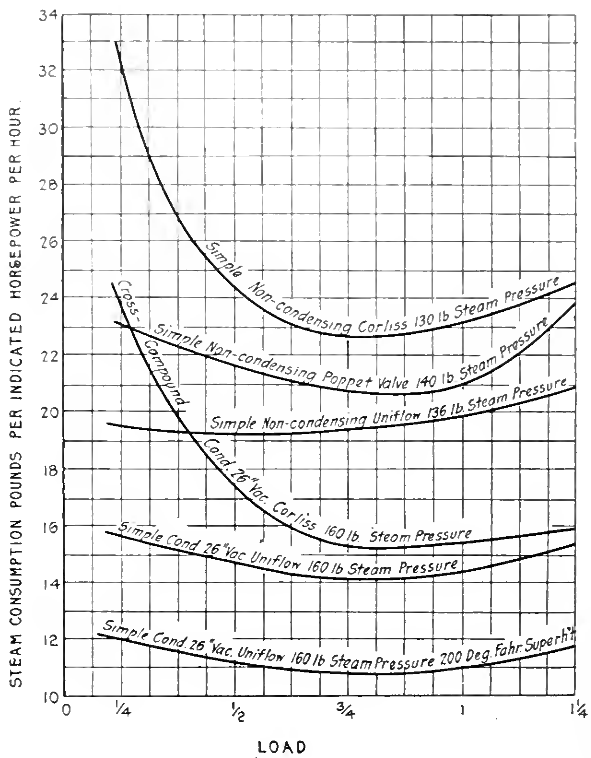

Fig. 2 Comparison of Engine Performances

gears, designs were adopted by means of which the valve was guided back to its seat without being released, avoiding the sudden impact between the metallic surfaces. These so-called positive valve gears were mostly of rather complicated nature and hence were not applicable to high rotative speeds.

The designs of Lentz which were introduced in 1900 and which in this country are manufactured by the Erie City Iron Works, of Erie, Pa., made possible the modern development of the poppet-valve engine. Cam motions such as employed first by Lentz were considered unsafe, as it was feared that the line contact which exists between roller and cam would produce excessive pressures and cause wear on the cam.

The practically universal adaptation of the cam motion for valve gears shows that no wear occurs when the valve-gear working parts are properly designed, made of steel and case-hardened.

Fig. 3 shows the valve gear as used on engines made from the author's designs and as built by the York Mfg. Co., of York, Pa.

In practically 90 per cent of the valve gears for poppet-valve engines, the closing of the valve is partly effected by means of a spring, which is of such strength as to produce not only the retardation forces during the opening but also the acceleration forces necessary during the closing period to keep roller and cam in contact.

A few designers have adopted a double-cam construction, one cam for opening and one for closing the valve, and the spring can thus be omitted. As not only the opening but also the closing is always positively effected by the external valve gear, a short and stiff spring has to be interposed between valve spindle and valve proper to avoid breakage in case foreign matter accumulates on the valve seats. Such valve gear is used by the Nordberg Mfg. Co., Milwaukee, Wis., from the designs of Prof. Doerffel.

All the valve gears mentioned are operated by eccentrics mounted on a lay shaft. It is obvious that the eccentrics may be arranged on the main shaft instead and the valves operated by oscillating levers of the type shown, or by reciprocating camshafts. This arrangement, however, is not as recommendable as the lay-shaft drive except on small engines, as the valve gear is affected by the expansion of the cylinder making resetting under operation conditions necessary. The long eccentric rods and their influence on the regulation are features to be avoided if possible, especially when high speeds are employed.

In several cases the regular Corliss valve gear has been used to operate the poppet valves as adopted in the designs of the Frick Co., Waynesboro, Pa., and in those of the Vilter Mfg. Co., of Milwaukee, Wis.

The high-pressure cylinders of the 6000-hp. engines built by The Hooven, Owens, Rentschler Co., of Hamilton, Ohio, and installed at the plant of the Ford Motor Co., of Detroit, are equipped with poppet valves and the regular Hamilton Corliss gear.

As previously mentioned, trip gears are not recommendable for poppet-valve engines operating at speeds exceeding 100 r.p.m.

As the designs of the author for poppet-valve engines of the return-flow and uniflow poppet-valve type are to a certain extent departures from any other engine of similar type, and as most other designs have been repeatedly described in publications, a more complete description of this engine may not be out of place.

The valve gear of the standard poppet-valve engine is operated by a lay shaft running alongside the engine and driven from the main shaft through a drag crank and shaft by means of a pair of spiral gears. See Fig. 3. The drag crank is self-adjustable and prevents unavoidable motion and jars of the main shaft being transferred to the gears, which for this reason run perfectly noiseless, and are not subjected to any undue wear.

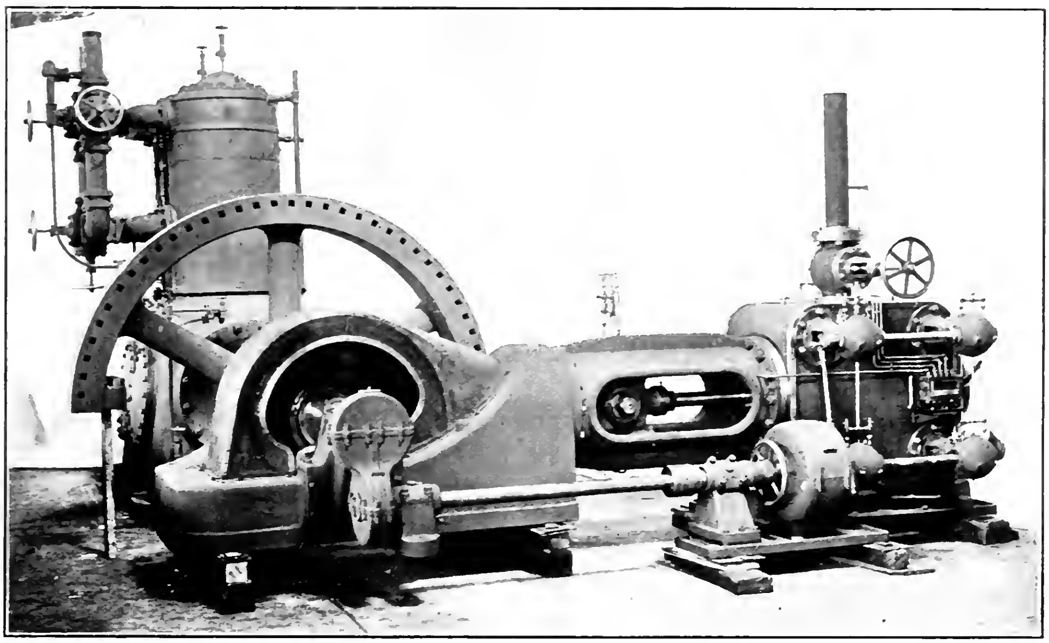

Fig. 3 Poppet-Valve Steam Engine Built by York Manufacturing Co.

The lay shaft is placed in line with the exhaust valves, the bonnets of the exhaust-valve gear being provided with bearings to support the shaft. The exhaust valves are operated by cams acting on anti-friction rollers, effecting a rapid opening and closing. The cams are clamped on the shaft and can be shifted into any position to give the desired release and compression.

The arrangement of lay shaft simplifies greatly the exhaust-valve gear, as eccentrics, straps, rods and levers are done away with.

The steam valves, as shown in Fig. 4, are operated by means of oscillating levers provided with rollers and curved cam pieces attached to the valve spindles, insuring, even at the smallest cut-offs, ample and quick valve openings as well as noiseless operation.

The oscillating levers for both valves are mounted on a single shaft which receives its motion from an eccentric rod and eccentric mounted on the lay shaft. It is noteworthy that this arrangement of the valve gear necessitates the use of but

a single eccentric instead of the four eccentrics usually provided in the standard type of poppet valve engines.

The valves are placed in a horizontal position, well supported by long spindles and guides. The pressure on the valve guide, neglecting spindle guide, amounts to about ½ lb. per square inch. The spindles are lubricated by means of forced lubrication, which passes the oil along the valve spindle through spiral grooves, on to the guide and then into the steam space, thus obtaining a triple effect besides preventing

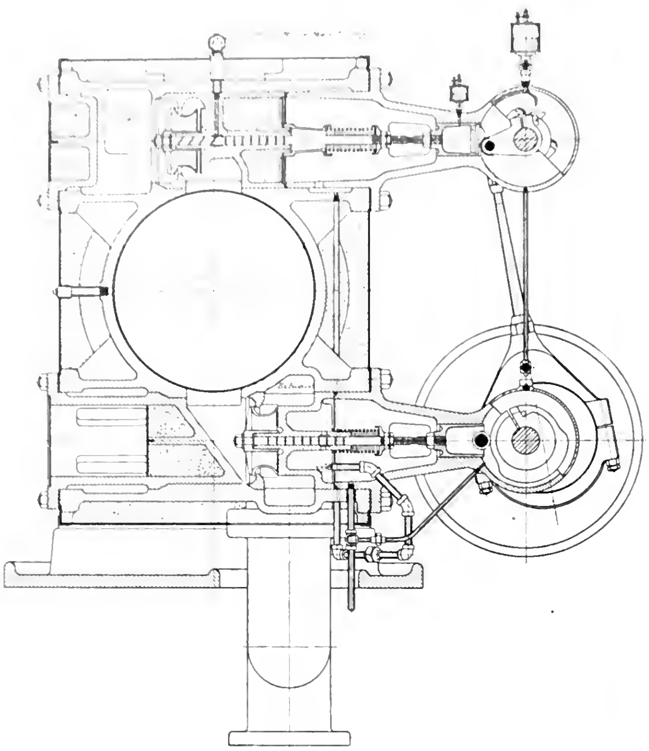

FIG. 4 STEAM VALVES AND VALVE MECHANISM

an escape of steam. The valve spindles are carefully ground into long bushings and provided with labyrinth packings consisting of small circular grooves.

The effective lubrication and the ample support of the valve spindles prevent any bending stresses and preclude the possibility of wear. The horizontal position of the valves and seats is of distinct advantage, as the accumulation of sediment and burnt oil is impossible, the seats being properly cleaned during every steam-admission period.

Of particular interest is the design of the valve cages, which contain not only the valve seats and spindle guides but also the complete structure of the ports. This is a distinct improvement over the usual rib design with its large clearance surface and volume and its unequal expansion. This cage design insures a perfect casting, with a reduction in clearance space not obtained in any other design.

The whole valve assembly is easily accessible by simply removing the back covers without interfering with the valve gear.

The valve-gear parts work in a removable cover, preventing the ingress of dirt, and operate in an oil bath through which the oil may be circulated continuously and used over and over again. Absence of wear and reliability of operation of the valve gear are insured by this arrangement, which is shown in Fig. 5.

A very important part of an engine is the cylinder, and a careful and correct design will prevent great trouble. Early designs, even as late as fifteen years ago, had cylinders in which steam and exhaust chests and cross-overs were cast integral with the cylinder, resulting in a very rigid construction which was not adaptable to high temperatures. As pressures and temperatures continuously increased, it became necessary to separate the two cylinder ends and connect them by means of flexible manifolds. This arrangement allowed a freer and better expansion of the cylinder.

However, it was found advisable also to remove the steam and exhaust chests from that part of the cylinder which was swept by the piston, as under working conditions at high temperatures these stays and ribs caused the cylinder to warp.

In order to meet these conditions, the so-called three-piece cylinder, wherein the valves are placed in a cylinder head and the cylinder proper becomes a barrel with two flanges, came into favor. This design is excellent, mechanically and economically, because it is not subjected to any undue stresses even under high temperatures and pressures, and the steam ports become straight and short, offering small resistance to the steam flow.

However, the cylinder heads constitute difficult, complicated and expensive castings; the erection is awkward and the piston is not very accessible, as steam and exhaust connections have to be broken and valve gears disconnected before the heavy cylinder head can be moved back, usually on slides provided on the extended bedplate.

The author has adapted a one-piece cylinder which it is believed possesses most of the advantages and none of the disadvantages of the three-piece cylinder.

The author's governor arrangement, mounted on a side shaft, is shown in Figs. 5 and 6, for return-flow and uniflow

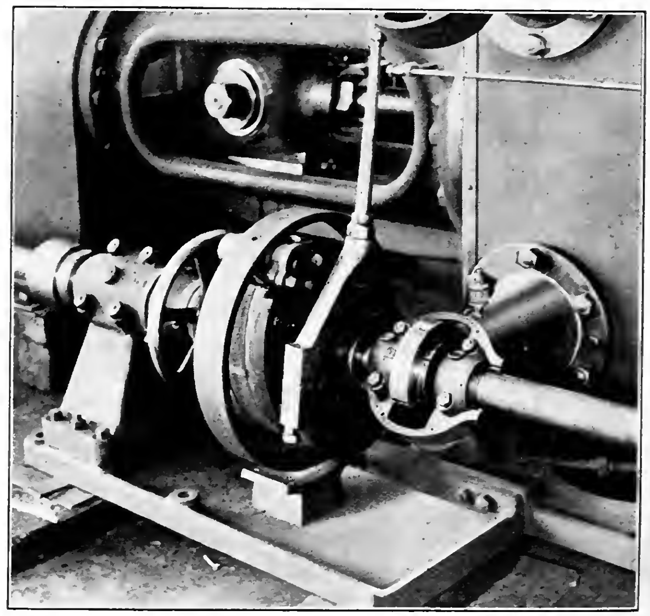

FIG. 5 VALVE GEAR, GOVERNOR AND HAND SPEED ADJUSTMENT

engines respectively. A hand speed adjustment is provided, by means of which it is possible to change the speed while the engine is in operation.

The arrangement of the uniflow engines is generally the same as that of the return-flow engines. The steam valves are operated and regulated in a similar manner as described in previous paragraphs.

A central exhaust port controlled by the piston is provided for the escape of the steam. As this port is of unusually large size—about three times as large as the valves and ports provided in return-flow engines—the release and exhaust of steam takes place very rapidly, and the pressure maintained within the cylinder will be as low as that in the exhaust pipe or condenser. This is a strong point in favor of uniflow engines, as high vacua can be utilized to fullest advantage.

As in the standard type of uniflow engine compression takes place during approximately 90 per cent of the stroke, provision has to be made to overcome excessive compression in case the engine is operated at such back pressures as to cause the final compression pressure to exceed the steam pressure.

The simplest method of decreasing the compression pressure, as used by most designers, is to increase the clearance volume.

After the main exhaust port is closed by the piston, steam is allowed to pass through the auxiliary exhaust valves into the exhaust pipe. The steam travels at a low velocity and is free of moisture, being relieved of pressure and water when the main exhaust port opens, and hence will have practically no cooling effect on the cylinder cover and walls.

The engine built by the Skinner Engine Co., of Erie, Pa., uses auxiliary exhaust valves, placed about 30 per cent of the stroke from the cylinder head, compression commencing as the piston covers up the auxiliary ports.

Several designs of a semi-uniflow type, one of them patented by the author, place the main exhaust valve in the center of the engine. An advantage of this type is that compression is reduced to about 50 per cent, while the clearance of the exhaust valve comes only into action when the steam pressure

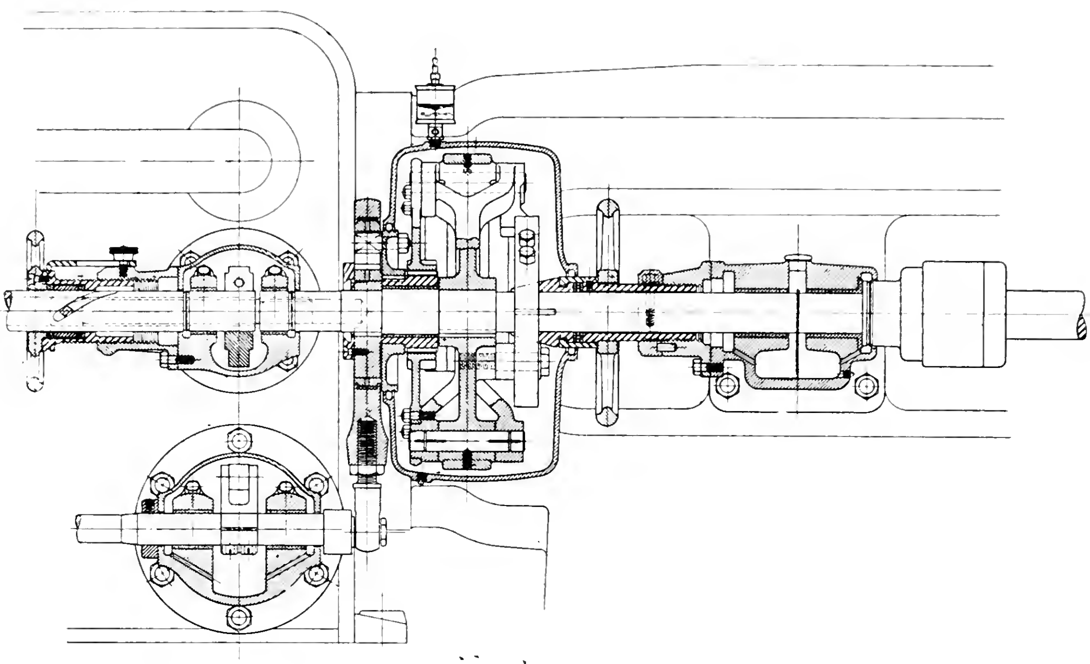

Fig. 6 Section of Valve Cams, Governor and Hand Speed Adjustment

An additional clearance chamber is provided, separated from the cylinder usually by means of a single-seated valve. This valve is operated either by hand or automatically, and the additional clearance chamber connected with the cylinder whenever required by the operating conditions. Such designs have been adopted by the Ames Iron Works, Oswego, N. Y., the Mesta Machine Co., Pittsburgh, Pa., and by most other builders of uniflow engines, being the simplest and easiest way of overcoming the excessive compression.

From an economical point of view, however, this added large clearance surface in particular is very detrimental, and such an arrangement is only permissible when in use temporarily. In case the engine has to operate continuously non-condensing, as, for instance, a locomotive, a concave piston is used which provides the necessary clearance volume, about 16 to 20 per cent of the cylinder volume, with only a slight increase in clearance surface. The added volume is wasteful, and especially so as the cut-offs increase.

In order to reduce the duration of compression, the original builder of uniflow engines, the Englishman Todd, conceived the idea as far back as the eighties of the last century to provide mechanically operated auxiliary exhaust valves, held open during a fixed period.

is low, and hence its detrimental effect is considerably reduced.

While a high compression is advisable and economical in uniflow engines, as amply demonstrated in many tests, it has also been shown that for practically all working conditions 90 per cent compression is excessive.

Stumpf, in his book entitled The Una-flow Steam Engine, says: "The constant compression, always held to be a desideratum in large engines, is fundamentally false. It further follows that the distribution obtained by link motion and shifting eccentric gear is fundamentally correct, as it gives large compressions with early cut-offs and small compressions with late cut-offs."

To what extent the 90 per cent compression in uniflow engines exceeds the most economical compression can be seen from diagrams replotted from the aforesaid book of Professor Stumpf. For example, for an engine working with 170 lb. gage pressure, 197 deg. superheat, 27 in. vacuum, and a cylinder clearance of 2 per cent, the most favorable compressions for different cut-offs as taken from such a diagram, adiabatic compression being assumed, are as follows:

Cut-off, per cent	10	15	20	25
Compression, per cent	70	58	50	45

For poorer conditions of exhaust, i.e., less than 27 in. vacuum, a compression of still shorter duration should be maintained for [illegible].

With these points in view, the author designed a uniflow engine and provided it with auxiliary exhaust valves and gear

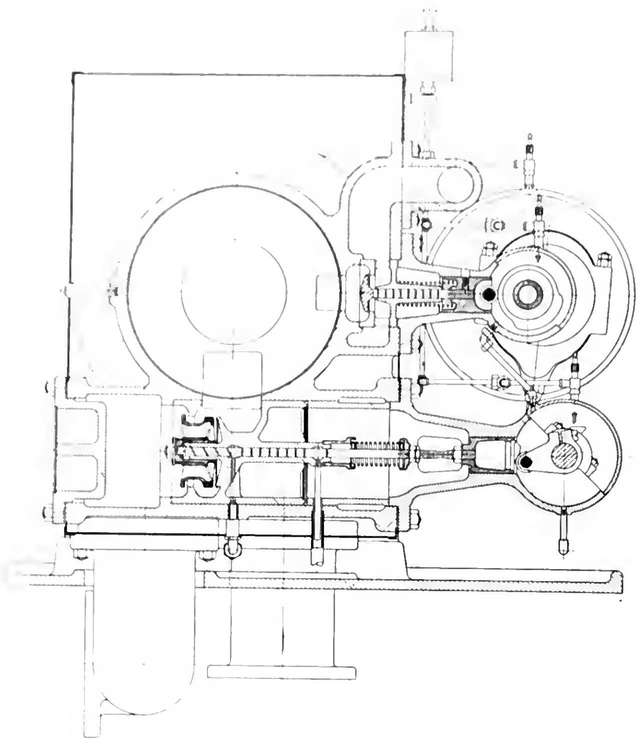

Fig. 7 Exhaust Valve, Auxiliary Exhaust Valve, and Valve Gear

controlling compression for any and all operating conditions.

The auxiliary exhaust valves are of small diameter, single-seated yet balanced, as they open under no difference in pressure on either side of the valve. The added clearance space due to these valves is negligible.

These auxiliary valves are operated by a continuously rotating camshaft (Fig. 7), an arrangement which has been adopted by the York Mfg. Co. The cams can be shifted on the shaft while the engine is in operation. A suitable disposition for exhaust port is still open) and closes about 15 per cent before the other dead center is reached. A compression ranging between 70 per cent and 15 per cent of the stroke is suitable for practically any working condition.

The camshaft is rotatably shifted by means of a handwheel, pin and spiral groove (Figs. 8 and 9), and clamped in the desired position. A dial indicates to the engineer for what degree of compression the cams are set. It is obvious that this device may be operated automatically by using instead of the handwheel a piston subjected to the difference of exhaust and atmospheric pressure.

On engines operating continuously condensing the auxiliary exhaust valves may be dispensed with and be replaced by valves which connect with the additional clearance space in case the vacuum fails, an arrangement adapted for the standard uniflow engine.

A uniflow engine without auxiliary exhaust valves and without side shaft has been developed by the author for driving the small high-speed ammonia compressors built by the York Mfg. Co., Fig. 10. Identically the same cylinder design is used as for the larger-size machines, but governor and eccentric are placed on the main shaft and the valves operated by means of a reciprocating camshaft.

One of the difficulties in poppet-valve engine construction is to design and manufacture the valve and seat in such a way that they expand equally and maintain steam-tightness under any other temperature than that at which they were ground together.

Good results have been obtained by making valve seats and valve proper of similar shape, likeness and material. However, such an arrangement is not always possible, and valves adjusting themselves to any expansion of the seats are often preferable.

In the design of the Ames Iron Works the upper seat is of thin, flexible steel, and by making the valve somewhat unbalanced this seat is pressed down by the steam pressure until the metallic surfaces meet. The original Stumpf design uses a valve made entirely of steel.

The author's design of a self-adjustable valve is shown in Fig. 11. Due to the peculiar construction of this valve, which is balanced to the same degree as any other standard poppet valve, the upper half will lift under an excess of pressure within the cylinder or in case of a slug of water, and thus constitutes a relief valve of extraordinary large area. As this

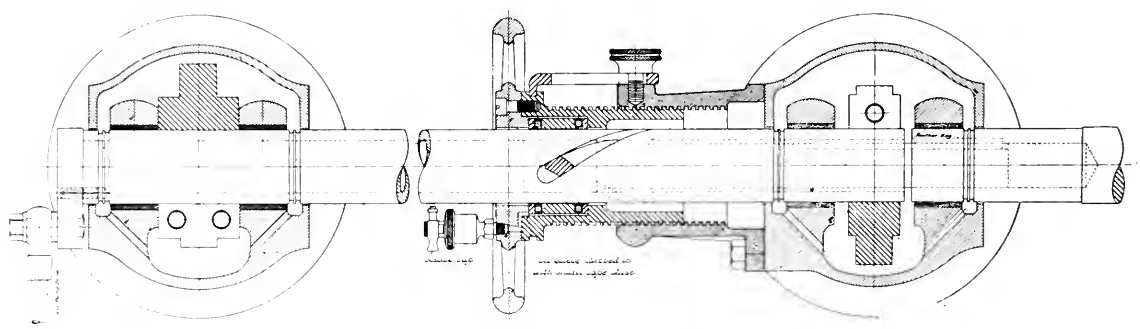

Fig. 8 Valve Gear for Auxiliary Exhaust Valves

release and compression can be obtained, for instance, by opening the auxiliary valves, say 7 per cent before dead center, closing them 30 per cent after dead center—equal to 70 per cent compression and recommendable for condensing work; while for non-condensing operation the cams can be shifted into the other extreme position, when the auxiliary valve opens about 7 per cent after dead center (the main

feature is combined with the admission valve, its safe operation as a relief valve is absolutely insured and the difficulties usually encountered with relief valves avoided. The part of the valve effecting relief lifts only against steam pressure and a spring of light tension and is in no way affected by the tension of the main spring.

Another feature of this valve lies in the fact that it lifts

practically against no steam pressure, as pressures are equalized above and below the seats as soon as the lower valve part is lifted.

As this valve will adjust itself to any expansion of the valve seats, it can be ground in when the cylinder is cold and remains steam-tight under any temperature.

Fig. 12 shows cards taken from a uniflow engine with variable compression as made by the York Mfg. Co.

THE LOCOMOBILE

Considerable favor has been given in the last few years to a very unique and compact power-plant arrangement—the so-called "locomobile," which is a combination of an engine placed on top of a boiler with a superheater, condenser, air pump, feedwater heater and feed pump. In other words, a compact, high-class and self-contained power plant which is extensively used in isolated plants and for farm purposes in Europe and South America.

The success of the locomobile is primarily due to the close combination of boiler and engine whereby heat is transformed into power on the shortest path possible. Designers of plants for stationary engines have nearly always sacrificed these thermal advantages to arrangements which were dictated by an exaggerated sense of safety and conservatism. The success of the locomobile fully demonstrates that a much closer arrangement of boilers and engines has become an economic necessity.

Remarkable economies have been obtained with these engines. Steam consumptions of 8 lb. and coal consumptions of 1 lb. per i.hp. per hour, in units of 100 to 200 hp., are nothing unusual in compound engines, and that with working conditions not exceeding 200 lb. pressure and 300 deg. fahr. superheat. Though these engines are particularly attractive in the smaller sizes, say, up to 300 hp., considerably larger units have been built by several German concerns. A Lentz locomobile of 1000 hp., built by Heinrich Lanz., of Mannheim, Germany, was exhibited at the World's Fair in Brussels in 1910.

In cross-compound engines of this type the two high-pressure admission valves are operated by one cam and one eccentric, the travel of which is regulated by the governor; while the two high-pressure exhaust and four low-pressure valves are operated by a single camshaft on which the three cams are mounted.

A somewhat simplified arrangement is obtainable by using the high-pressure exhaust valves also as admission valves to the low-pressure cylinder.

The cranks are set on 180 deg. and the indicator cards are typical of an engine without a receiver, a so-called "Woolf" engine.

Two very interesting tests carried out on such a type of engine are given herewith. They are noteworthy on account of the steam pressure and superheat carried and on account of the remarkable economies obtained.

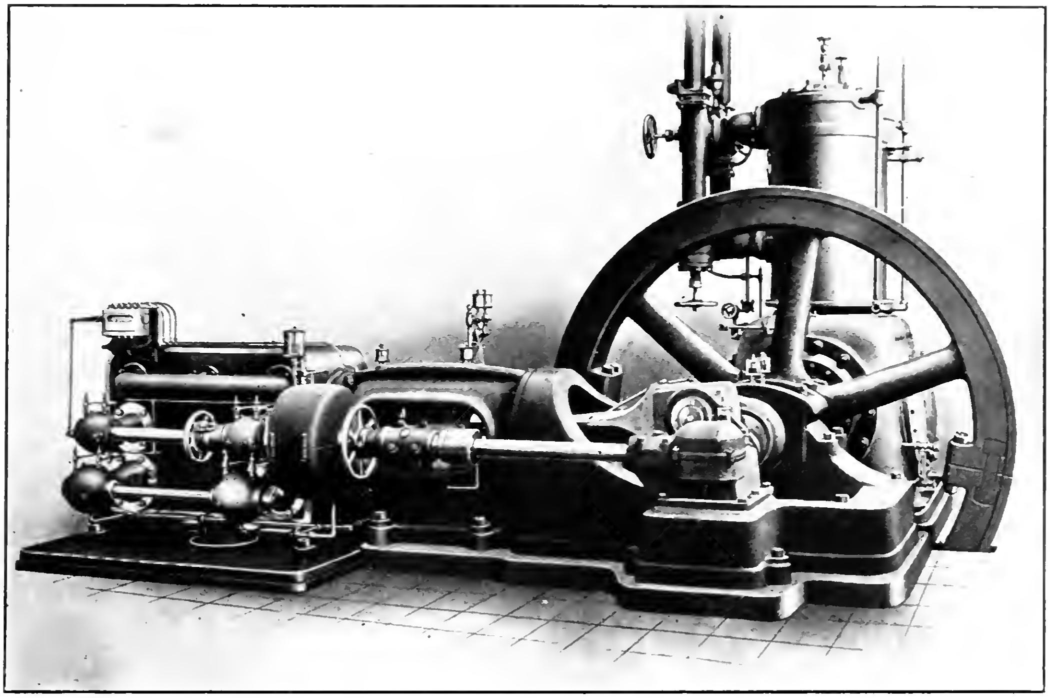

Fig. 9 Poppet-Valve Semi-Uniflow Steam Engine

Steam pressure, lb. per sq. in., gage	213	432
Temp. of high pressure steam, deg. fahr	923	1018
Indicated horsepower	112	99
Revolutions per minute	150	158
Vacuum, inches of mercury	27.7	26.7
Steam consumption per i.hp-hr. lb	6.53	5.68
Heat consumption per i.hp-hr., B.t.u	9720	8640

It is interesting to compare these results with those obtained from a poppet-valve engine of the steam car of the White Motor Co., Cleveland, O., which was so successful before the modern development of the gasoline car set in.

Professor Carpenter, of Cornell, tested one of these engines and obtained with a steam pressure of 427 lb. and a steam temperature of 767 deg. fahr., operating non-condensing, an economy of 12.29 lb. per b.hp. per hr. These results can also be considered quite remarkable, especially in view of the fact that the bores of the high- and low-pressure cylinders were only 3 in. and 6 in., respectively, the stroke $4\frac{1}{2}$ in., and the speed 850 r.p.m.

The uniflow cylinders have also been used considerably in connection with locomobiles. Economically, however, the locomobile has shown no marked superiority over the return-flow

poppet-valve engine, as the heat losses peculiar to stationary engines are considerably reduced on account of the arrangement of the locomobile.

Simplicity of cylinder and valve-gear design, on the other hand, makes the uniflow locomobile a very attractive unit. Usually platforms and stairs are provided to give access to all parts. In some plants, especially where several units are installed, a floor is laid above the boilers, and in this way the boiler and engine rooms are separated.

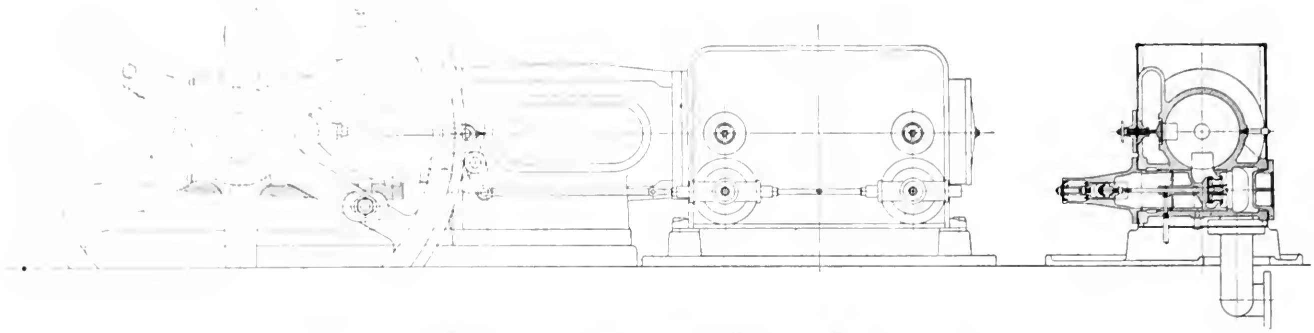

Fig. 10 Poppet-Valve Uniflow Steam Engine Without Auxiliary Exhaust Valves

THE MARINE ENGINE

In order to ascertain the applicability of superheated steam and poppet-valve engines to steamships, the Compagnie Générale Transatlantique, of France, ordered in 1905 from the navy yard of St. Nazaire, two cargo boats, the *Rance*, the two boilers of which were fitted with superheaters and the engines with poppet valves, and the *Garonne*, fitted with the ordinary type of marine engine without superheater.

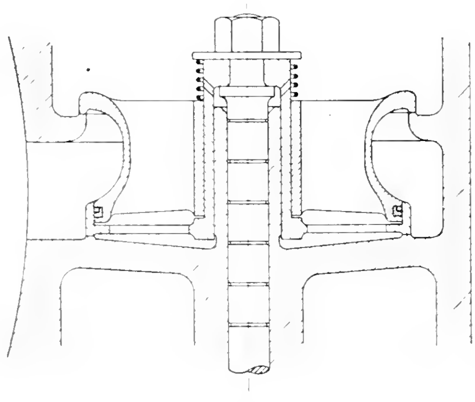

Fig. 11 Self-Adjustable Poppet Valve

Tests made under identical conditions showed that, due to the superheater and poppet-valve engines, an increase of power of 18.1 per cent and a decrease in coal consumption of 20.1 per cent were obtained.

A great simplicity of valve-gear arrangement is possible with these poppet-valve engines, as is apparent from a study of the cross-sections of some typical triple-expansion engines. These show not only a grand housecleaning of moving parts, but also very ingenious arrangements for the disposition of the valve-gear parts.

As a rule, separate steam engines are provided for reversing marine engines, but in this case the usual reversing engine is dispensed with and replaced by a hand-operated reversing gear, very little power being required.

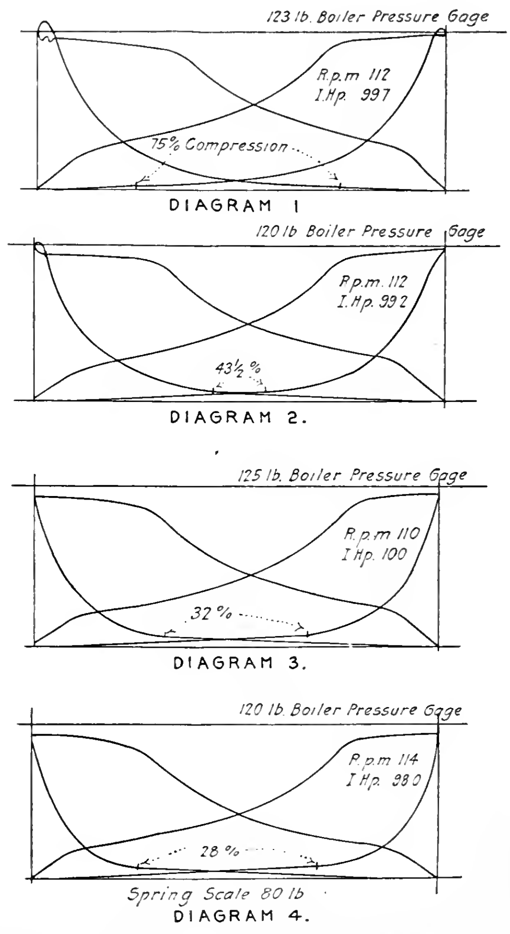

Fig. 12 Cards Taken from Uniflow Engine with Variable Compression

A torpedo-boat engine of striking construction of 6000 hp. was exhibited in Brussels in 1910. This engine is rather unique in its arrangement, being a compound engine having

three low-pressure and one high-pressure cylinders. All four cylinders and sixteen valves are of the same diameters, respectively. The corresponding valve-gear parts are alike for the different cylinders and for that reason are all interchangeable.

Uniflow cylinders have also been applied to marine engineering with considerable success in the last few years, on account of the simplicity of cylinder and valve-gear arrangement, enhanced by the fact that all cylinders belonging to one engine are exact duplicates.

The valves are mostly arranged in a horizontal position and operated by a valve gear of similar design to that used for stationary engines of the uniflow type.

THE LOCOMOTIVE

The first concern to equip locomotives with poppet valves was the Hannoversche Maschinenbau A. G., of Hannover, Germany. Preliminary tests were made in 1905 on an old tank locomotive which happened to be at the shops of this concern undergoing repairs. These tests were made after the old slide-valve cylinders were replaced by cylinders fitted with poppet-valves and Lentz gear.

The results were highly satisfactory to the advocates of poppet valves and superheat on locomotives, as with a steam temperature of 520 to 540 deg. fahr. the poppet-valve locomotive showed a saving in water to the extent of 30.6 per cent and a saving in coal of 19.5 per cent as compared with the slide-valve locomotive working with saturated steam.

On the small pilot locomotives and on the newest express locomotives the poppet valves are arranged horizontally and worked by cams mounted on a horizontal shaft which is oscillated from the eccentric rod by means of a small crank arm.

On the older express locomotives the four valves were placed in a vertical position above the cylinder, in a row one behind the other, the two admission valves toward the middle and the two exhaust valves toward the ends of the cylinder. The cam rod has four symmetrically arranged lifting curves which engage when in contact with the rollers on the valve spindles. The camshaft receives a reciprocating motion from the link gear and raises the valves alternately. The whole valve-gear box is removable from the cylinder, making inspection and replacing of parts a very simple matter.

Uniflow engines on locomotives have shown good results and seem to give better results than the return-flow poppet-valve engines at light and medium loads, while the superiority seems to rest with the latter type at the heavy loads.

It is difficult to say how many poppet-valve locomotives are in service now, but according to the author's information there were several hundred in operation in Germany before the war broke out, and a large number in England, France, Belgium, Austria, Switzerland, Russia, and also in the Scandinavian countries.

It is apparent from what has been said and shown in the foregoing pages that the modern development of the poppet-valve engine has revolutionized steam engineering and has made possible arrangements and working conditions and produced results which were, until recently, considered beyond reach.

Designers and manufacturers would do well to consider the importance and recognize the truth of the principles presented, as the conservation of our natural resources—which have been wasted to a lamentable extent for many years past—has become a matter of great cultural and economic importance.

CORRESPONDENCE

Contributions to the Correspondence Departments of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

Mobile Armament for Defense

To the Editor:

In Mr. Coyle's paper on Mobile Armament for Defense, the importance of having some standards for calibers of guns was not mentioned. This feature is, of course, well understood by military men and provision is made for this to a certain extent, but not enough stress is laid on the matter.

The calibers, bores, breech mechanisms and firing devices for different types of guns should be so standardized that ammunition could be used by either the army or navy and, if possible, by the allies. That is to say, all revolvers and pistols are to have the same caliber and the same cartridges and all rifles are to use the same cartridges. All 1-lb., 3-in., 12-in., etc., projectiles are to be of the same outside dimensions to fit the corresponding-sized gun. This would simplify the problem of munition manufacture and be of vital importance in many cases where shortage of ammunition of a certain size might occur in action.

I have doubt about the practicability of the gun mentioned which has the breech plug sliding against a hardened curved surface. I think that in firing the gun the pressure or blow which would be caused by the discharge would roughen or dent the curved surface so much that the friction would give trouble in elevating and depressing the piece. With reference to the supports on arms shown in the diagrams, with the jackscrews at the ends, I think something on the lines of a tripod, well braced at the sides, designed on the trails for long-recoil field guns and siege howitzers, would give better satisfaction. This would take care of the horizontal fire; the high-angle fire could be taken care of by some substantial supports nearly under the trunnions of the gun.

The question of independent drive for armored trucks and cars of this kind is a very important matter and I am anxious to see something developed and put into commercial use along the line of explosive engines using alcohol instead of gasoline, as it will have to come to this sooner or later.

Arthur F. Cary.

Watertown, Mass.

Problems in Waste Disposal

To the Editor:

The writer considers that a wise choice was made when the reduction process was decided upon for the city of Chicago for the disposal of garbage, although there might be much

room for argument over the use of the drying (Mertz and Simonin) method of reduction. For cities of large and moderate size any one of the three principal reduction methods mentioned may now be used to dispose of garbage in a sanitary manner and with freedom from nuisance. In general, reduction will be found to be much more economical and will show a decidedly higher percentage of successful installations in this country than will incineration. Incineration is the general method employed in Europe, but it has not attained success here because of different conditions encountered.

If service, cost and sanitary results were on a par between reduction and incineration for a given city, I should favor reduction because the question of conservation of our resources is involved. Reduction saves for us valuable products, returning fats and oils to the industries and plant food in the form of tankage to help enrich our soils, whereas incineration destroys and wastes them.

Concerning the author's statement that tankage and grease produced by the drying process are of better quality than by the cooking process as used at Cleveland, Columbus and elsewhere, it is interesting to compare prices received in 1917 for these products as follows:

	Drying Process	Cooking Process	
	Chicago.	Cleveland.	Columbus.
Grease, per cwt........	$7.29	$8.01	$7.52
Tankage, per ton.......	7.00	10.00	11.00

The grease contracts of Chicago and Cleveland were made at about the same period, while the Columbus contract was made when the market was considerably weaker. In the case of tankage the Chicago price is the market price quoted by the author for Chicago and not the actual contract price. For Cleveland and Columbus the prices of tankage fluctuate slightly, being dependent on the analysis of the product, but will average about as given.

The author refers to Dr. Morgan's claim to a process for the production of alcohol from garbage. This process is particularly applicable as an addition to the cooking process of reduction and it has been the writer's privilege to have recently conducted practical tests on the process, during which tests a large amount of the technic of the process was developed. It may be said that the process is entirely practical but that its success financially at its present status is dependent upon market prices of alcohol and certain chemicals and upon the quality of the garbage treated.

Although different ideas may prevail concerning the methods and equipment used in the Chicago plant, much originality in arrangement and selection of apparatus has been shown, which should be beneficial to the industry. The plant should make an excellent record now, due to the fact that high prices for products prevail, and due also to the equipment being new and repairs and maintenance being at a minimum.

T. D. Banks.

Columbus, Ohio.

WORK OF THE BOILER CODE COMMITTEE

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

Below are given the interpretations of the Committee as approved by the Council on July 15, 1917, in Cases Nos. 162-166 inclusive. In this report, as previously, the names of inquirers have been omitted.

Case No. 162

Inquiry: Is it permissible under the A. S. M. E. Boiler Code, that safety valves bearing all the markings called for by the Code, may be sold as conforming to Code requirements, when their lifting devices fail to raise the valves from their seats as required by Par. 282?

Reply: The Boiler Code requires that a safety valve be provided with a substantial lifting device and shall have the spindle so attached that the valve disc can be lifted from its seat not less than one-tenth of the nominal diameter of the valve when there is no pressure on the boiler. The Code does not specify the character of the lifting device.

Case No. 163

Inquiry: Does Par. 317 of the A. S. M. E. Boiler Code and the interpretation in Case No. 110 apply in the case of a boiler plant where duplicate feed lines are used, one of which conforms strictly with Par. 317, while in the other there are no stop valves between the check valves and the boilers?

Reply: It is the opinion of the Boiler Code Committee that Par. 317 of the Code is intended to mean that a valve shall be placed between the boiler and a feed check wherever a feed line is used.

Case No. 164

Inquiry: What is meant by the latter portion of Par. 207 of the Boiler Code which provides for greater spacing between rows of staybolts than indicated in Table 3? Is there not an inconsistency in the language that should be cleared up?

Reply: Par. 207 is designed to cover constructions in water-leg boilers where the portion of the sheet which comes between rows of staybolts is reinforced through the flanging-over of the edge of the handhole openings. It is evident that where the handhole openings are flanged to a depth of, say, twice the depth of the plate, that the transverse strength is increased over what it would be should there be no such flanging. In cases of this sort, the construction may be considered a beam fixed at each end, the beam to have a factor of safety of at least five.

Case No. 165

Inquiry: In view of Par. 274 of the Boiler Code, which states that only water heating surface, and not superheating surface, is to be considered in determining the minimum sizes of safety valves, an opinion is requested as to what portion of the tube surface of vertical tubular boilers shall be considered superheating surface.

Reply: It is the opinion of the Committee that for the purpose of determining the minimum sizes of safety valves to be used in vertical fire tube boilers, the tube surface above the center line of the upper gage cock should be considered as superheating surface. See Par. 274 of the Code.

Case No. 166

Inquiry: Is the maximum allowable working pressure of a locomotive boiler limited by Par. 194 of the Boiler Code, where a special flanged ring construction is used at the base of the dome instead of flanged dome sheet construction?

Reply: It is the opinion of the Boiler Code Committee that the construction referred to, involving special flanged ring construction independent of the dome sheet at the base of the dome, comes under Par. 261 of the Code and must conform thereto.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

WORK at headquarters has been as active during the hot weather and the so-called vacation period as at any time in the Society's history. Visitors from Russia, Australia, South Africa, South America and Japan have been received and special attention given them, as is the Secretary's custom.

We have for quite some time been trying to make the Society a medium for the interchange of technical knowledge and the development of cultural relations with other countries, and it is gratifying to see the extent to which the Society has succeeded.

Also, a large number of members have called. Several of the committees have been meeting regularly, notably the Committee on Engineering Resources, which, through the classification of the members, is furnishing all departments of the Government and the industries generally with names of specialists for any emergency. We have studied the classification systems of the Government, the insurance companies and the universities, and we think we have the most comprehensive of any. This service is free, and is the Society's contribution to the efficiency of the nation.

The progress on the alterations and enlargement of the Engineering Societies Building is satisfactory, and by the middle of October, if not sooner, quarters will be ready for the American Society of Civil Engineers.

Taking advantage of the construction period, this Society is having some much-needed improvements made in its quarters. All of the editorial and clerical rooms are being thrown into two large rooms and sound-deadening ceilings installed similar to those in the new portions of the building now under construction, and in modern offices generally.

The members on the Pacific Coast are looking forward to the visit of President and Mrs. Hollis in October. Another feature will be a Council meeting in November in Chicago, thus developing the contact between the representatives of the Society and the members.

CALVIN W. RICE,
Secretary.

WHAT THE SECTIONS HAVE DONE THIS YEAR

THE first of the Sections yearly reports were published in the August issue of THE JOURNAL, together with an account in general of the Sections activities throughout the past year. The spirit of coöperation developing among the Sections and the local branches of the other engineering societies was commented on at length as a sign favorable both to the Sections themselves and the Society nationally.

The reports published last month included those from Baltimore, Buffalo and New York. Similar reports have since come to hand from other Sections and are published below.

Next month the Committee on Sections will outline the proposed activities of the Sections for the coming season, and the month following the programs of coming Sections meetings will be announced.

ATLANTA

The meetings of the Section have been irregular, but approximately monthly, and a number have been held with the Affiliated Technical Societies of the City of Atlanta. The average attendance at these meetings is 30 per cent, but on special occasions as many as 75 per cent of the members are present.

Among the most important meetings held should be mentioned the following: On January 16 Ira N. Hollis, Pres.Am.Soc.M.E., addressed the Affiliated Technical Societies of Atlanta on the subject of the part being pl yed by the Engineer and the Engineering Societies in Modern Life, appealing to them for concentration of efforts in the war against nature in the preparedness, conservation and promulgation of the country's welfare. Dr. Hollis laid great stress upon the efficient application of power, force and resources, showing very clearly to his audience the real value of the engineering societies and the results of their combined action, and the necessity of concerted action to obtain the highest efficiency in the general results of time, by the war against nature, so necessary to place the country in a state of preparedness which would enable us to use in the most efficient manner the natural, artificial and resourceful products of the country.

In March Lieut.-Col. Lytle Brown, Engr. Corps, U.S.A., gave a very interesting and instructive address on The Engineer in Modern War.

The membership also visited the works of the Atlantic Steel Co., on the invitation of the secretary and treasurer, who is a member of the Society.

OSCAR ELSAS,
Section Chairman.

BIRMINGHAM

Birmingham has had many meetings during the past year, which proved of much interest and help to those present.

The first took the form of an excursion to the Avondale Works of the Continental Gin Company and the plant of the Coyne and Joubert Foundry Company. Among the subjects of special interest at later meetings were The Use of By-Product Coke-Oven Gas as a Fuel and some of the Problems Presented in Its Use at the Ensley Steel Works, by W. P. Caine; The Manufacture of Cast-Iron Water Pipes, by Paul Wright; The Place of the Engineer and the Engineering Societies in Modern Life, by Dr. Ira N. Hollis; The Locomotive Firebox and Combustion Chamber, by J. J. Anthony; Illumination, by Prof. A. A. Wittig; Technical Writing, by Prof. M. Thomas Fullan.

During the year the hearty coöperation and support of the two state universities has been enlisted and two representatives from each have addressed the Section. The Section has also been influential in the organization of the Alabama Technical Association, which includes all the members of the national engineering societies residing in the state of Alabama, of whom there are over two hundred.

PAUL WRIGHT,
Section Chairman.

BOSTON

The season opened with a combination trip to New London for the inspection of submarine design, construction and operation, which was greatly enjoyed by some four hundred members and

[illegible] from Boston, Worcester and Providence. The day included luncheon at the hotels, a trip down the bay on Government steamers, where surface and submerging practice was carefully watched, followed by a return to the works of the Electric Boat Company at Groton.

The next meeting consisted of a trip to the General Electric Works at Lynn, and a further inspection of the United Shoe Machinery Shops at Beverly, followed by a dinner at the clubhouse, with an illustrated lecture on the Turbo Drive for Ships, by W. L. R. Emmett, Mem.Am.Soc.M.E.

On February 7 the meeting consisted of the annual combined banquet, at which very interesting talks were given by Dr. Richard Cabot, who was preparing another hospital unit for France, and by E. W. Ewartz, who delivered an illustrated lecture on submarines. At this meeting a resolution was adopted and forwarded to the President of the United States endorsing his stand and offering the services of this Section. This was probably the most successful dinner ever held in the Boston Section and was attended by about five hundred members and guests.

The meeting held on March 8, under the A.I.E.E., covering electric transmission for vehicles both for the railroad and ordinary road work, was attended by our membership.

The Power Plant Meeting was held April 4 and 5 at the Engineers' Club and the Wentworth Institute, the meetings being held under the direction of Professors Hutton and Williston. Papers were read by several exponents of municipal and independent plants and descriptions given of some modern plant apparatus.

The spring meeting was held at Marblehead, April 17, where the hydroplane plant of the Burgess Company was inspected. In the evening, at Wentworth Institute, the Section was addressed by several engineers connected with this industry.

The season has been exceptionally interesting, not only on account of the increasing influence of engineering work in modern civilization, but also because of the enormous expansion of all the industries connected with the war.

A. L. Williston,
Section Chairman.

CHICAGO

The meetings during the past year have been well attended and a lively interest taken in the various subjects presented.

Four meetings were held during the season, the first and last being devoted to military subjects and the intervening gatherings to semi-technical topics such as oxy-acetylene welding and problems in waste disposal.

The dinner plan of meeting was continued, and for the first time the Section had a "ladies' night." This latter feature was a great success from a social point of view, and it is planned to continue it next year and also introduce innovations tending to enlarge acquaintances and bring the members closer together.

Joseph Harrington,
Section Chairman.

CINCINNATI

The Cincinnati Section is affiliated with the Engineers' Club of Cincinnati, an organization about 30 years' old. At three or four meetings a year the program of the Engineers' Club is carried out by the Cincinnati Section of the A.S.M.E. The chairman of the Section presides, the paper and its discussion being arranged by the officers of the Section. This provides an audience larger than the club could provide of itself.

At the present time the number of local members credited to Cincinnati in the 1917 year book is 94. There are, however, a number of members in St. Bernard, Norwood, Ivorydale, Ohio and Newport, Kentucky, who meet with the local members. In addition to these there have been quite a number of recent applications, which brings the total number of members in the Section to 135.

This Section has been fortunate in having speakers of prominence address the various meetings during the year, on subjects of much interest.

Among these was one on Some Present and Future Carburetion Problems, by C. F. Kettering, Mem.Am.Soc.M.E., and vice-president of the Dayton Engineering Laboratories Company. Mr. Kettering is largely responsible for the Delco lighting systems for motor cars and for the Delco-Light for small isolated electric lighting plants, and handled his subject in such an extremely interesting manner that he succeeded in holding his audience fascinated for two hours. Abner Doble, inventor of the Doble steam car, also gave an interesting paper, which has since appeared in The Journal, entitled The Steam Motor Car.

Much time was spent in making preparations for the Spring Meeting of the Society, one result of which was the Joint Meeting with The National Machine Tool Builders' Association on May 22, at which time papers were read by H. Schneider, Dean of the University of Cincinnati, on The Trend in Engineering Training, and by Dr. Otto P. Geier, on The Human Potential in Industry.

F. A. Geier,
Section Chairman.

DETROIT

A series of meetings of members of the Am.Soc.M.E. residing in Detroit and neighboring Michigan cities, led to the organization in October 1916 of this Section. It is the intention that this Section shall serve a territory around Detroit of approximately ninety miles radius.

It was decided to hold quarterly meetings which will not interfere with the meetings of the local associations. The Section's especial province seems to be to gather together the Society members of the district in order to bring them into contact not only with each other but with the leaders of the national organization; at the same time members of other engineering societies are invited to attend its meetings.

The two meetings held during 1917 were made of a social character. Members and their guests had dinner together before the meetings. Both were held at the Detroit Board of Commerce Building in order that the Section might become better known in the business life of the community. Members had the opportunity of listening to Ira N. Hollis, Pres.Am.Soc.M.E., and John W. Lieb, Mem.Am.Soc.M.E.

M. E. Cooley,
Section Chairman.

ERIE

The Erie Section has recently adopted the rule of holding at least four meetings a year, two to be dinner meetings at which the regular affairs of the Section will be taken up and two meetings will be held in conjunction with the Engineers' Society of Northwestern Pennsylvania, the Section to furnish the speakers.

The Section is one of the newest and regards its first year as one of experience. Adoption of the above program will ensure plenty of work for the coming season.

J. F. Wadsworth,
Section Chairman.

INDIANAPOLIS

The Indianapolis Section was organized in October and the first three meetings were devoted to the completion of this organization.

In February a meeting was held in conjunction with the A.I.E.E., at which Harrington Emerson, Mem.Am.Soc.M.E., spoke on Efficiency and the Engineer.

Several other meetings were planned, but were abandoned in order that the entire energies of the members might be devoted to preparedness work and the formation of a battalion of engineers.

Plans for the fall and winter are now being worked out and it is expected that there will be many discussions of interest.

W. H. Insley,
Section Chairman.

MINNESOTA

The Section has had some very interesting meetings in conjunction with the local branch of the A.I.E.E., and has also been honored with invitations from the Chemical Engineers and the Engineers' Club of Minneapolis. A very cordial feeling exists between the Minnesota Section and the other engineering interests and societies of the State.

This spring it was planned to join with the A.S.C.E. in a trip

to Duluth, Minn., but the war situation postponed the visit of the national society.

Probably the most successful meeting during the year was the Locomotive Session, when there were fifty railroad representatives in attendance and a large number of papers were read.

A banquet was also tendered Ira N. Hollis, Pres., Am.Soc.M.E., which was by far the biggest event of the year, and it may be noted in passing that the Am.Soc.M.E. is the only national society that has thus honored its sections.

The Committee on Sections has been urged to work out a plan whereby the more remote Sections may be able to meet and hear some of our most distinguished engineers.

The Section acts as a "big brother" to the Student Branch at the University of Minnesota and its influence with the students is evidenced by the interest they take in the Society and the possibilities of membership in it. Many of the students enter the Junior grade at the time of their graduation or shortly after.

A very important feature of the Section's activities is the means of bringing the local engineers together on a common basis and fostering by social contact a better understanding among those engaged in different engineering lines which could not well be accomplished in any other way.

The members of the Section were, on July 28, invited by Oliver Crosby, Mem.Am.Soc.M.E., to a picnic at his new home, "Stone-Bridge."

A large number of our members and their wives availed themselves of the opportunity to meet in a social way and all had a most enjoyable time. The fact was impressed upon the minds of those present that the engineers do not get a fair share of enjoyment out of life by a policy of "all work and no play," and it was noted that an affair of this kind offers a splendid opportunity to invite engineering friends, who may become better acquainted with the members, and in this way become interested in joining the Society.

The members are looking forward to the time when all the local engineering interests can be united so as to have a common meeting place and possibly an engineering society building.

J. V. Martenis,
Section Chairman.

MILWAUKEE

We have completed the best year of our existence, our meetings being largely attended. During the early part of the year, before we secured our present permanent quarters at the City Club, we found ourselves slightly handicapped, but are now enjoying an excellent attendance, averaging over 150 members at each meeting.

The first meeting of the year, on September 13, 1916, was held at the plant of the Federal Rubber Company, Cudahy, Wis., under the direction of E. Hutchens, Mem.Am.Soc.M.E., who is supervising engineer of this company. L. J. D. Healey, chief chemist of the company, gave a talk on The Growing and Gathering of Rubber Latex. After the lecture the members were taken on an inspection trip around the plant. The Federal Rubber Company gave the Section a supper and showed moving pictures of the rubber industry. This was considered one of the best meetings we have ever held.

The next meeting held under our auspices was on October 11. Prof. J. G. Callan, of the University of Wisconsin, gave a very interesting talk on Recent Tendencies in Gas-Engine Design, illustrated with pictures of the latest types of automobile, aeroplane and submarine engines.

On January 6, I. N. Hollis, Pres.Am.Soc.M.E., gave a talk on The Place of the Engineer and the Engineering Societies in Modern Life.

William M. White, manager of the hydraulic department of Allis-Chalmers Mfg. Co., gave a talk on April 11 on Modern Hydraulic Turbines. There was a large attendance and Mr. White showed the audience views of the latest types of hydraulic turbines.

We try to arrange to have a supper for the speaker before each meeting, which is generally attended by the board of directors of our affiliated societies, and after the meeting a buffet luncheon is always served. We find that a great many of the members stay after these luncheons, standing about in groups and talking on various subjects, and in this manner become better acquainted than they would in any other way.

Edward Hutchens,
Section Chairman.

NEW HAVEN

While the conditions at New Haven do not offer opportunity for much coöperation, the Section has shown the greatest willingness to take advantage of any chance presenting itself. The meetings of the Section have been of service to the engineers of the whole state of Connecticut, and it is recognized that better results can be obtained through more systematic organization.

A Section for the state has been planned which will provide for the usual fall and spring meetings at New Haven and additional meetings at certain other localities in the state where Branches will be established.

Following the plan of former years, this Section has held two principal meetings. The Mining Department of the Sheffield Scientific School invited the Section to meet in the Hammond Laboratory in November, at which time the equipment of the mining laboratory was explained to those interested and a paper on Applied Metallography, by Prof. C. H. Mathewson, was read.

The evening session was held in the lecture room of the Mason Laboratory with F. B. Gilbreth, Mem.Am.Soc.M.E., and S. J. Berard as speakers.

The recently organized Winchester Engineering Club, composed of over 100 members of the engineering department of the Winchester Arms Company, was invited to join the New Haven Section in its spring meeting on April 19, 1917. This meeting was varied by an excursion to two of the pumping stations of the New Haven Water Company, and was followed by a dinner and social hour and an evening session with two illustrated papers on pumping engines for manufacturing purposes.

Informal local meetings have also been held and it is hoped that the new year will see much added interest.

H. B. Sargent,
Section Chairman.

NEW ORLEANS

The first year's work of the New Orleans Section has been a very successful one.

Due to there being in existence an active local engineering society at the time the Section was formed it was considered best to hold but four meetings of the A.S.M.E. Section. These meetings were in every case held jointly with the local section of the Civil Engineers, and as the meetings were held in the rooms of the Louisiana Engineering Society and the members of that society were invited to attend, the meetings were in fact practically extra meetings of the latter society.

The tentative plan for next year is to have the Louisiana Engineering Society assign each of the local sections of the national societies a meeting at which some member of the section in charge will read a paper of special technical interest to the members of that society. The business meetings of the local sections will be held after the general meeting has adjourned. This plan has yet to be submitted to the societies interested, and approved.

The executive committee for next year will be: Chairman, R. L. Radcliffe; secretary, E. H. Tenney; E. Flad, W. A. Hoffman and H. R. Setz.

W. B. Gregory,
Section Chairman.

ONTARIO

As this Section is so new, having been established in May of this year, there is little to report in the way of sectional work. It might be mentioned that the mechanical engineers, through the local section, obtained representation on the Joint Committee of Technical Organizations.

Plans are being made for the coming year which we trust will prove of interest and value to all the members.

G. V. Ahara,
Section Chairman.

PHILADELPHIA

The activities of the Philadelphia Section during the past year have been marked by the coöperation which it has had with the other engineering societies of that city. In the first place the plan of affiliation of the Section with the Engineers' Club has

with [illegible] very successfully and has many advantages to commend it. The Engineers' Club has become the headquarters for Section [illegible] the dining room of the Club is available for Section members, and when desired special dinners can be held there.

Besides the A.S.M.E. Section the local branches of the following organizations are affiliated with the Club: American Society of Civil Engineers, American Institute of Electrical Engineers, American Society of Heating and Ventilating Engineers, Illuminating Engineering Society, Society of Automobile Engineers, Massachusetts Institute of Technology and the Worcester Technology Club.

An advantage of the affiliation is the cordial intercourse developed between the engineering societies. During 1916-17 the A.S.M.E. Section held three joint meetings with The Franklin Institute and one with the American Society of Heating and Ventilating Engineers, while on May 11 at a dinner given to the speaker of the evening prior to the meeting by the local committee, the Section had as guests the chairman of nearly every engineering society represented in Philadelphia.

The subjects of the meetings we have held and the speakers are as follows: The Development of Our Fleet, by Wm. L. Cathcart, Mem.Am.Soc.M.E.; Aeroplane Engines, by C. E. Lucke, Mem.Am.Soc.M.E.; The Cooling of Water for Power Plant Purposes, by C. C. Thomas, Mem.Am.Soc.M.E.; Coke Ovens and Their By-Products, by C. J. Ramsberg; Design, Construction and Equipment of a Modern Military Aeroplane, by J. C. Hunsaker; District Heating, by Walter J. Kline; The Recent Development of the V-Notch Weir Measurement, by D. R. Yarnall, Mem.Am.Soc.M.E.; and Engineering of Men, by Willard Behan.

During the year the Proceedings of the Engineers' Club of Philadelphia has been developed until it has now become quite a pretentious journal. Each of the national societies is given a large page in each issue of the publication, and in that way members of all societies affiliated with the Club are made acquainted regularly with the proceedings of all engineering meetings held in Philadelphia.

Emmett B. Carter,
Section Chairman.

PROVIDENCE

There exists at Providence a situation different from any other local center of the Society's activities. There is no regularly organized Section of the A.S.M.E. in the city, but the functions of such a section are accomplished for the Providence members of the A.S.M.E. through the affiliation of the Society with the Providence Engineering Society. The local society has made considerable progress during the past year, first by securing adequate and permanent quarters and second, through the sub-division of the organization into sections under the following headings: Fire Prevention and Fire Protection, Machine Shop, Designing and Drafting, Efficiency, Structural Engineering, Chemical, Power, Municipal, Highway and Water Supply, Industrial and Technical Education, Student, and Municipal Engineering.

Each section held meetings monthly at which papers on suitable technical topics were presented and discussed, and it is felt that great benefit was derived by the members attending.

The general meetings of the society were held monthly and included in their programs such speakers as Dr. Miller Reese Hutchison, Prof. William S. Franklin, Dr. Ira N. Hollis, Mr. George H. Pegram, Mr. Harold W. Buck, Prof. Fred H. Newell, Mr. M. Marcel Knecht, University of Nancy, France, and Professor Von Hecke, University of Louvain, Belgium.

Letters were sent out this spring inviting other local engineering organizations and branches of the national societies to coöperate with the society for mutual advantage. The cordial way in which these invitations were received gives promise of closer relations in the future.

J. Ansel Brooks,
President.

ST. LOUIS

Dominating all of the activities of the St. Louis Section was the idea of arousing in the members a greater interest for subjects not related to professional work. Although conditions were not entirely favorable for carrying through such a program, the results obtained encourage further efforts in this direction.

During the season 1916-17 three Section meetings were held, besides four joint meetings with the Engineers' Club of St. Louis. In pursuance of this program the meetings were of a social character with a lecture treating more the human side of engineering or industrial life, while the joint meetings with the Engineers' Club were devoted to more strictly technical subjects.

The average attendance ran between 40 and 45 members, the attendance at the joint meetings being considerably higher. The larger turnout of our members at the Section meetings indicated a strong preference for non-technical affairs. The supper preceding the meeting proved an attraction and will be retained during the coming year. As a result of a canvass among our members it was decided to hold one such Section meeting every month, on a Friday evening.

Of the technical papers presented during the season, one on standardized boiler construction and another on Diesel engines brought out most discussion.

No extensive plans have as yet been decided upon for the activities of the coming year, except that a special effort is to be made to increase our membership. There is a growing feeling that more attention should be paid to the subjects touching upon the human side of the engineer's work. Considerable impetus would be given to such a movement if articles or papers on such subjects were published regularly.

H. R. Setz,
Section Chairman.

WORCESTER

The season for the Section opened with the excursion to New London to visit the United States Naval Submarine Base, and also to inspect the plant of the Electric Boat Company. Many made the trip in automobiles, in addition to a good-sized delegation which went by special train from Worcester to New London.

The first meeting of the Section was held on November 14, 1916. President Jacobus was present, and his remarks concerning the activities and growth of the Society, which he illustrated by means of lantern slides, were thoroughly appreciated. Mr. Charles G. Washburn spoke on the Origin and Development of Leading Worcester Industries. It would be difficult to find one more qualified to speak on this subject than Mr. Washburn, and it was a privilege to hear from an authority the contributions which have emanated from Worcester and the vicinity—contributions to be classified as advancing the art of mechanical engineering.

The second meeting of the season was held on February 8, 1917, when Mr. Charles H. Norton, chief engineer of the Norton Grinding Co., spoke on the Introduction of Cylindrical Grinding and Worcester's Part in the Development of the Art.

The Secretary of the Society, Mr. Calvin W. Rice, was also present at this meeting and spoke on the affairs of the Society in general, and particularly upon the constructive work which was being accomplished under the presidency of Dr. Hollis.

The annual meeting was held on June 5, at which the officers for the ensuing year were elected. The delegates from Worcester who attended the annual Spring Meeting of the Society in Cincinnati were all present and told of the success which attended the efforts of the Cincinnati Section in conjunction with the Cincinnati members of the National Machine Tool Builders' Association. At this meeting announcement was also made that the Council had accepted the invitation of the citizens of Worcester to hold the 1918 Spring Meeting there. This announcement was received with enthusiasm. President Hollis addressed the meeting on Engineering Problems Relating to the War. His remarks were extremely interesting and an enthusiastic general discussion followed.

The last meeting of the season was held on June 28. By courtesy of *Machinery*, their motion-picture film representing the manufacture of 9.2-in. howitzer shells was shown. A portion of the film prepared by the Cincinnati Section, showing incidents connected with Spring Meeting, was also shown.

Interest in the work of the Society was well maintained during the winter months; the membership has increased through the activities of the Worcester Section, and there is every indication of a successful coming season.

George I. Rockwood,
Section Chairman.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER OCTOBER 10, 1917

THE American Society of Mechanical Engineers is an organization for mutual service of over 8,200 engineers and associates coöperating with engineers. The membership of the Society comprises Honorary Members, Members, Associates, Associate-Members and Juniors, all elected by ballot of the Council. Application for membership is made on a regular form furnished by the Secretary which provides for a statement of the standing and professional experience of the applicant and requires references from voting members personally acquainted with the applicant. The requirements for admission to the various grades will be furnished upon request.

Below is the list of candidates who have filed applications for membership since the date of the last issue of THE JOURNAL. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate-Member or Junior, and those in the third under Junior grade only. Applications for change of grading are also posted.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by October 10, 1917, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about November 15, 1917.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be somewhat slower than under normal conditions. The first step in the consideration of an application is taken by the Membership Committee, and this committee is composed of busy men, with fewer opportunities to meet together in these strenuous times.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE MEMBER

Alabama

GARY, HARTWELL H., Superintendent, Ingalls Iron Works Co., Birmingham

Arizona

LEGRAND, CHARLES, Consulting Engineer, Phelps Dodge Corp., Douglas

California

ADAMSON, ARTHUR R., Assistant General Superintendent, Baker Iron Works, Los Angeles
BURNHAM, CHARLES, Superintendent and Manager, Burnham Basket Co., Los Angeles
MALONEY, GEORGE B., Chief Engineer, Associated Pipe Line Co., San Francisco
PIKE, ROBERT D., Chemical Engineer, San Francisco
THOMPSON, NELSON W., Chief Engineer, Simplex Refining Co., San Francisco

Colorado

WOOD, FRANKLIN P., Engineer, Franklin P. Wood & Co., Trinidad

Connecticut

BEDWORTH, ARTHUR H., Plant Engineer, Remington Typewriter Co., Bridgeport
BEGG, THOMAS K., Mechanical Superintendent Manufacturing Departments, Bridgeport Brass Co., Bridgeport
BENTLEY, JOSEPH H., Chief Draftsman, H. E. Harris Engineering Co., Bridgeport
BLOOD, BRYANT H., General Manager, Pratt & Whitney Co., Hartford
CAHILL, ANTHONY M., Equipment and Process Engineer, Winchester Repeating Arms Co., New Haven
CHERRY, JOHN D., Sales Manager, The Roto Co., Hartford
KRUCKLIN, WALTER, Tool Designer, Draftsman, Remington Arms U. M. C. Co., Bridgeport
WHEELER, CHARLES A., Professor and Engineer, Connecticut Agricultural College, Storrs
WHITNEY, ELMAR H., Assistant Wage Rate Supervisor, Remington Arms & Ammunition Co., Bridgeport

District of Columbia

LANDVOIGT, THOMAS E., Acting Heating, Ventilating and Sanitary Engineer, District of Columbia, Washington

Georgia

COVERDALE, E. J., Atlanta
HOLTZCLAW, BENJAMIN W., Chief Engineer, J. S. Schofield's Sons Co., Macon
LINDLEY, HARRY E., Chief Draftsman, L. W. Robert, Jr., Engineer, Atlanta

Illinois

BOSE, KUMUDINI K., Draftsman, Mechanical Department, Armour & Co., Chicago
BURR, ELLIS M., President, The Burr Co., Champaign
DEAN, RAYMOND S., Sales Engineer, Manning, Maxwell & Moore, Chicago
DREXELIUS, H. COREY, Designer of Automobile Machinery, Elgin National Watch Co., Elgin
GERARD, FRANKLIN B., General Superintendent, German-American Portland Cement Works, La Salle
HASKINS, HAROLD L., Engineer, International Harvester Co., Chicago
HOEFER, C. A., President, Hoefer Manufacturing Co., Freeport
JONES, DAVID J., Mechanical Inspector, Illinois Central Railroad Co., Chicago
SORENSEN, CLAUDE S., Special Machine Design, Western Electric Co., Chicago

Indiana

MILLHOLLAND, WILLIAM K., President and General Manager, W. K. Millholland Machine Co., Indianapolis
WOOD, DAVID W., President and Manager, Wood Turret Machine Co., Brazil

Kansas

SULLIVAN, WILLIAM L., Machinery, Power Outfits and Supplies, Pittsburg

Kentucky

MITCHELL, ALGIE R., Chief Draftsman, Andrews Steel Co., Newport

Maine

TODD, WILLIAM N., Electrician and Elevator Engineer The Portland Co., Portland
CHIFFELLE, FRANCIS A., Engineer, Lewiston Bleachery & Dye Works, Lewiston

Maryland

BECK, WILLIAM H., Electrical Engineer, Crown Cork & Seal Co., Baltimore
CRONIN, FRANK H., Superintendent Mechanical Division, Water Department, Baltimore

Massachusetts

[illegible], Manager Steel Engineering Department, [illegible] Employers In[illegible], Boston
[illegible], Third [illegible] Foreman, [illegible] Westinghouse Co., Springfield
[illegible], NATHANIEL S., Chief Draftsman, [illegible] C. F. and M. L., Fall River
[illegible], ABRAHAM L. JR., Assistant Superintendent, [illegible] & Co., West Groton
[illegible], GEORGE W., Consulting Engineer, Holyoke
[illegible]RMAN, [illegible] R., Engineering, Contract Work, Greenfield Tap & Die Corp., Greenfield
[illegible], WILLIAM L., Mechanical Engineer, [illegible] Co., Boston
[illegible]RIS, H. PATTERSON, Sales Manager, Worcester Pressed Steel Co., Worcester
[illegible]RIS, WILLIAM A. JR., Assistant to Foreman, [illegible] Manufacturing Department, New England Westinghouse Co., Springfield
KENDALL, HOBART C., Assistant Manager and Purchasing Agent, [illegible] Sprinkler Co., Worcester
[illegible]NTZNER, KARL S., Experimental Engineer, [illegible] Co., Worcester
[illegible], CHARLES, Inspector and Estimator, Stone & Webster Engineering Corp., Boston
[illegible], CHESTER H., Chief Engineer and Electrician, American Thread Co., Kerr Mills, Fall River
[illegible], ARTHUR E., Expert Mechanical Problems, Saco-Lowell Shops, Lowell
STONE, THOMAS D., Contracting Engineer, Nightingale & Childs Co., Springfield
VAUGHAN, JOHN F., Private Practice, Boston
VEDDER, J. WARREN, General Manager, Rice, Barton & Fales M. & I. Co., Worcester

Minnesota

BROOKE, WILLIAM E., Professor and Head Department Mathematics and Mechanics, University of Minnesota, Minneapolis
FOSTER, CHARLES, Manager St. Paul Office, Charles L. Pillsbury Co., St. Paul
MARSHALL, ERNEST, Electrical Engineer, Great Northern Railway, St. Paul
SMITH, PAUL D., Mechanical Engineer, Minneapolis Steel & Machinery Co., Minneapolis

Mississippi

FREEMAN, HENRY L., Professor of Mechanical Engineering, Mississippi A. & M. College, Agricultural College

Missouri

FERGUSON, JAMES W., Supervisor Mechanical Goods, Sales, St. Louis District, Goodyear Tire & Rubber Co., St. Louis
MORSE, HENRY S., Assistant Superintendent Maintenance and Construction, St. Joseph Lead Co., Herculaneum
SHARP, ABIA J., Proprietor and Manager, Harrisonville Foundry & Machine Works, Harrisonville
WILCOX, FRANK L., Consulting Engineer, Municipal Work, St. Louis

New Hampshire

THOMPSON, HERMAN, Superintendent Mechanical Department, Amoskeag Manufacturing Co., Manchester

New Jersey

CAMPBELL, NORMAN ST. G., Teaching, Registrar, Kingsley School, Essex Fells
DAVIDS, WILLIAM C., Special Engineer, Duesenberg Motors Corp., Edgewater
FEIEREISEL, FRANK A., Manufacturing Manager, De Laval Steam Turbine Co., Trenton
FISHER, EDWARD C., Manager, Cooke Works, American Locomotive Co., Paterson
JOHANNSEN, ODD K., Designer Centrifugal Pumps, A. S. Cameron Steam Pump Works, Phillipsburg
MURPHY, JOHN JR., Assistant Superintendent, United Piece Dye Works, Lodi
ROOT, HAROLD D., Machine Designer, Crocker-Wheeler Co., Ampere
VOLKHARDT, CHARLES E., Industrial Engineer, H. L. Gantt, Trenton

New York

ALPEN, CLARENCE T., Manager, Edison Electric Light & Power Co., Amsterdam
BANASH, JAMES J., Service Engineer, Underwriters' Laboratories, New York
CARMAN, JOSEPH F., Chief Engineer, Abraham & Straus, Brooklyn
COLEMAN, J. EMILE, Efficiency Engineer, The Mergenthaler Linotype Co., Brooklyn
DOVE-SMITH, JOSEPH, Proprietor, Dove-Smith & Son, Niagara Falls
FORSTER, SAMUEL S., Superintendent "See C," General Electric Co., Schenectady
GERDES, HENRY T., President, Gerdes & Co., Inc., New York
HIMMELSBACH, JOSEPH, Consulting Engineer and President, American Packing House Engineering Co., New York
IRWIN, OLIVER C., Refrigerating Engineer, Frick Company, New York
LANG, JOHAN G. V., Consulting Engineer, New York
MACKENZIE, KENNETH G., Consulting Chemist, The Texas Co., New York
MILLER, JESSE F., Chief Engineer, Department of Public Buildings, Albany
MOORE, WILLIAM J., Assistant Professor of Mechanical Engineering, Polytechnic Institute of Brooklyn, Brooklyn
MUIR, ROY C., Commercial Engineer, General Electric Co., Schenectady
PARTINGTON, JAMES, Estimating Engineer, American Locomotive Co., New York
POWELL, WILLIAM B., Partner, Cundall & Powell, Consulting Engineers, Buffalo
RAPP, CONRAD H., Assistant Manager, Designing and Engineering Department, Hoggson Brothers, New York
RICHARDSON, JOSEPH W., President, Nicholas Iron Works, New York
SAMES, CHARLES M., Associate Editor, American Society Mechanical Engineers, New York
SCHACHAT, ABRAHAM B., Charge of Shop, Slocum, Avram & Slocum Laboratories, New York
SPINNLER, CHARLES E., Agent for Franco Tosi, Legnano, Italy, New York
STAEGE, STEPHEN A., Consulting Hydraulic and Electrical Engineering, Staege & Dewey, Watertown
SUPPLEE, WARREN P., Chief Operating Engineer of Power Stations, The Eastern Penn. Lt., Heat & Power Co., the J. G. White Co., New York
TIZLEY, ARTHUR J., General Superintendent, E. F. Caldwell & Co., Inc., New York
VANDERBEEK, HERBERT C., Head Master Boys, Masonic Home, Utica

North Carolina

BAHNSON, FREDERIC F., Engineer and Secretary, Normalair Co., Winston-Salem

Ohio

CHAMPION, DAVID J., President, The Champion Rivet Co., Cleveland
EMERSON, EARL A., Export Manager, The American Rolling Mill Co., Middletown
FERGUSON, JOHN L., Assistant Superintendent, The Quaker Oats Co., Akron Plant, Akron
JOHNSON, FRANK Y., Designing Engineer, The Youngstown Sheet & Tube Co., Youngstown
LAWSON, FENTON, President, The F. H. Lawson Co., Cincinnati
NORDHOLT, JOHN B., Vice-President, The Toledo Steel Casting Co., Toledo
WAREAM, CHARLES E., Chief Engineer, Development Department, The American Laundry Machinery Co., Cincinnati
YORK, RAYMOND D., Vice-President and General Manager, The Plymouth Street R. R. & Lt. Co., Portsmouth

Pennsylvania

ALEXANDER, J. S., General Manager and Mechanical Engineer, Philadelphia
DUFFY, FRANK J., Major 1st Regiment Penn. Engineers, Philadelphia
FRANKLIN, MILTON W., Consulting Engineer, E. F. Houghton & Co., Philadelphia
JULSTEDT, CHAS. J., Engineer-in-Charge, Ordnance Drafting Room, Bethlehem Steel Co., South Bethlehem
McDEVITT, WILLIAM J., Foreman, Fayette R. Plumb, Inc., Bridesburg
McMENAMIN, CHARLES G., Enginehouse Foreman, Pennsylvania Railroad Co., Philadelphia
PAYNE, FRANCIS H., Manager, Metric Metal Works of American Meter Co., Erie
PEEBLES, RODNEY A., Mechanical Engineer, Westinghouse Elec. & Mfg. Co., E. Pittsburgh
SANDERSON, VICTOR L., Sales Manager, Terry Steam Turbine Co., Philadelphia
SMITH, JOSIAH H., Mechanical Engineer, Ballinger & Perrot, Philadelphia
SNYDER, J. E., Superintendent Steam Turbine Erecting and Testing, Westinghouse Elec. & Mfg. Co., E. Pittsburgh
WETHERILL, WILLIAM C., Vice-President, Keystone Screw Co., Philadelphia
McKEE, THOMAS C., Assistant Chicago Manager and Sales Engineer, Carbondale Machine Co., Carbondale

Tennessee

MOSELEY, William S., Mechanical Engineer, C. C. & O. Railway, Erwin
PEEK, Horace H., Treasurer and Manager, Lookout Boiler & Mfg. Co., Chattanooga
TRAPNELL, John M., Engineer in Charge Structural Department, Walsh & Weidner Boiler Co., Chattanooga

Texas

FITZGERALD, Charles, Jr., Assistant Chief Engineer, Gulf Pipe Line Co., Houston
McFARLAND, Archie, Master, U. S. Engineer Department, Port Arthur

Virginia

ASHBY, Chester, Charge Man, Engineering Department, Newport News Shipbuilding and Dry Dock Co., Newport News
PENNING, Nicholas J., Assistant Power Engineer, City Point Power House, Du Pont Co., City Point

West Virginia

BRADY, Hugh S., Superintendent, Hazel Atlas Glass Co., Wheeling

Wisconsin

KIRCALDIE, William L., Engineering Staff, American Appraisal Co., Milwaukee
LEASE, Leonard J., Electrical Engineer, Allen Bradley Co., Milwaukee
VAUGHN, Francis, with Vaughn & Meyer, Milwaukee

Canada

CHRISTENSEN, James C., Superintendent, Canadian Fairbanks-Morse Co., Ltd., Toronto
CLEATON, Reginald E., Manager, The R. E. Cleaton Co., Montreal
ESTLER, Harry S., Manager, Sash Department, Trussed Concrete Steel Co., Walkerville
JOHNSTON, Charles H., Superintendent of Munitions, John Inglis Co., Toronto

Cuba

LOWELL, Walter D., Advisory Engineer, Punta Alegre Sugar Co., Central Florida

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

California

DAVIS, Arthur C., Mechanical Engineer, Los Alamitos Sugar Co., Los Alamitos
GOODWIN, Guy L., Engineer and Superintendent, Refinery & Gasoline Plants, Pinal Dome Oil Co., Santa Maria
JOHNSON, Harold S., Lieutenant, Coast Artillery Corps, United States Army, Mill Valley

District of Columbia

DARNALL, James C., Mechanical Draftsman, Ordnance Office, U. S. Navy Yard, Washington

Illinois

NUTTALL, Frank A., Erecting and Assembly Foreman, Link Belt Co., Chicago
ZIMMERMAN, Fred R., Mechanical and Industrial Engineer, Illinois Engineering Co., Chicago

Indiana

GRISBAUM, Leonard D., District Manager, Dravo-Doyle Co., Indianapolis
KRANNERT, Herman C., Manager Anderson Plant, Sefton Manufacturing Corp., Anderson
RAISIG, Charles L., Plant Engineer, P. H. & F. M. Roots Co., Connersville

Massachusetts

BOYNTON, Winfred S., Mechanical Engineer, The Lamson Co., Boston
CARTER, Clifford R., Industrial Engineer, Scovell, Wellington & Co., Boston
ELIN, Michael B., Engineer, New England Westinghouse Co., Chicopee Falls

Michigan

FRICKER, Jacob E., Mechanical Engineer, Plant Superintendent, Air Reduction Co., Detroit

New Jersey

SAYRE, Leslie A., with Crocker, Wheeler Co., E. Orange

New York

FERGUSON, Louis S., District Engineer and Sales Representative, The Permutit Co., New York
MOLOKIE, Stephen W., Draftsman, Combustion Engineering Corp., New York
SANFORD, Selden B., Engineer in Charge of Testing, Otis Elevator Co., Yonkers
SHUMARD, Fred W., Chief Draftsman, Savage Arms Corp., Utica

Ohio

BOYER, Earl B., Engineer, With Walter G. [illegible], Cincinnati

Pennsylvania

BALSINGER, Harry D., [illegible]
EVANS, Andrew B., [illegible], Westinghouse Electric & Mfg. Co., E. Pittsburgh
JENKINS, David J., Junior [illegible], U. S. Bureau of Mines, Pittsburgh

Virginia

EATON, Alphonse [illegible]

FOR CONSIDERATION [illegible]

California

LEH, Clarence F., Contracting Engineer, L. B. & A. L. Stone Co., [illegible]
GRIFFITH, Earl G., Assistant [illegible] Engineer, Morse & Gottfried Co., Los Angeles

Connecticut

COLVIN, Delancy W., Planning [illegible] Department, Winchester Repeating Arms Co., New Haven
COLLEE, Charles H., Jr., Industrial [illegible] Gun Department, Winchester Repeating Arms Co., New Haven
WHITCOMB, Herbert H., [illegible], Scovill Mfg. Co., Waterbury

District of Columbia

SCHLINK, Frederick J., [illegible], National Bureau of Standards, Washington

Illinois

FEEPY, Bernard T., Chief Draftsman, Webster Engineering Co., Chicago
MALCOLMSON, William J., Superintendent & Manufacturing Engineer, Western Electric Co., Chicago

Indiana

FOYD, Landon B., Production Engineer, Advance Rumely Co., La Porte

Massachusetts

KLEIN, Frederick H., Tool & Machine Designer, Becker Milling Machine Co., Boston
LYON, Raymond F., General Manager, Cowan Truck Co., [illegible]
MARSHALL, Harold F., Aviation Student, U. S. Army School of Military Aeronautics, Mass. Inst. of Tech., Cambridge

Michigan

KARR, Charles L., Assistant Chief Engineer [illegible], The Detroit Edison Co., Detroit
SLOMAN, Cheri M., Designer, Detroit

Missouri

MARTIN, Elmer C., Engineering Accountant, Kansas City

Nebraska

MILES, Dates S., Draftsman, Valuation Department, C. B. & Q. R. R., Lincoln

New Jersey

KENNEDY, Grafton S., with Standard Aero Corp., Plainfield
MUNYAN, Earl A., Assistant Naval Inspector Powder [illegible], Bureau of Ordnance, Navy Department, Jersey City

New York

CONBOY, Raymond G., Assistant to Superintendent, August Mietz Corp., New York
FAIRFIELD, John G., Assistant in Mechanical Engineering, Rensselaer Polytechnic Institute, Troy
GARDNER, Douglas M., Engineer, S. S. Hepworth Co., New York
JACOBS, Henry L., Student, Columbia University, New York
JOHNSON, James W., Head of Industrial [illegible] Department, Carter, Macy & Co., Inc., New York
PARSONS, Henry S., Superintendent, E. R. Ladew Co., Inc., [illegible]
WILLIAMS, Paul, Experimental Engineer, H. H. Franklin Mfg. Co., Syracuse
WITZELL, Paul J., with Charles William Stores, Brooklyn

Ohio

GARDNER, Thomas, Stirling Drum Department, Babcock & Wilcox Co., Barberton
WILLIAMS, Berkelly, Engineer, F. H. Lawson Co., Cincinnati

Oklahoma

AUERSWALD, Howard R., Assistant Manager, Gas, Water and Construction Department, Gypsy Oil Co., Tulsa

Pennsylvania

[illegible] Hazleton

[illegible] Pittsburgh

[illegible] Pottstown

[illegible] Lebanon

[illegible] Brownsville

Rhode Island

[illegible] Woonsocket

Cuba

[illegible] Delicias

Hawaii

[illegible] Honolulu

APPLICATION FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

Louisiana

ANDERSON, James Jr., Superintendent Pipe Line Department, Standard Oil Co. of La. — Shreveport

PROMOTION FROM JUNIOR

Illinois

SINGH, Nand, Sales Engineer, International Harvester Corp. — Chicago

WALTERS, William T., Mechanical Inspector Building Departmt., I. C. R. R.

Louisiana

NELSON, Bernard S., Engineer and Construction Superintendent, A. M. Lockett & Co. — New Orleans

New York

DOYLE, Joseph A., Vice-President, W. S. Rockwell Co. — New York

FINKEL, J. J., Inspection Engineer, New England Westinghouse Co. — Springfield

GITHENS, Thomas F., Mechanical Designer, Chile Exploration Co. — New York

WILLIAMS, Harold J., Instructor Applied Mechanics, Pratt Institute — Brooklyn

Pennsylvania

BENNETT, Ralph M., Superintendent, Frankford Arsenal — Bridesburg

SUMMARY

New Applications	209
Applications for change of grading:	
Promotion from Associate	1
Promotion from Junior	8
Total	218

Member's Pin Found

A member's catch pin has been found in New York City. It is being held in the Society's offices and upon identification will be returned to owner.

ROLL OF HONOR

To the lists already published of those members of the Society who have enlisted in the national service is added the following supplement:

Baird, Lyman S., First Lieutenant, Aviation Section, Signal Corps, U. S. A.

Baldwin, Bert L., Major, Officers' Reserve Corps.

Belcher, P. W., First Lieutenant, Engineer Officers' Reserve Corps.

Boardman, A. Jay, Captain, Ordnance Department, Officers' Reserve Corps.

Brayton, Harold M., First Lieutenant, Ordnance Department, Officers' Reserve Corps.

Briggs, Leroy E., Captain, Ordnance Department, Officers' Reserve Corps.*

Brill, George M., Major, Engineer Officers' Reserve Corps.

Byron, Leroy T., Chief Petty Officer, U. S. Naval Reserve Force, Brooklyn Navy Yard.

Case, Milo M., Captain, Engineer Officers' Reserve Corps.

Conant, William S., Ordnance Department, Officers' Reserve Corps.

Cronemeyer, Henry C., First Lieutenant, Engineer Officers' Reserve Corps.

Dalley, Park R., Captain, Engineer Section, Officers' Reserve Corps.

Diemer, Hugo, Major, Ordnance Section, Officers' Reserve Corps.

Dodd, Willard, Lieutenant, Junior Grade, U. S. Naval Reserve Force, Naval Training Station, Great Lakes, Ill.

Eichelsberg, Mark A., Ordnance Department, Officers' Reserve Corps.*

Farrell, Morgan G., First Lieutenant, Engineer Officers' Reserve Corps.

Field, Crosby, Lieutenant, Ordnance Department, U. S. A. Inspection Division.

Gilbert, Huntly H., Captain, Ordnance Department, Officers' Reserve Corps.

Gillam, William H., First Lieutenant, Officers' Reserve Corps, Ordnance Department.*

Greenwald, Louis, Electrician Sergeant, Fort Totten, N. Y.

Guiteras, Julian G., Lieutenant, Company I, P. O. Battalion, Fort Leavenworth, Kansas.

Hazlehurst, James N., Major, Engineer Section, Officers' Reserve Corps.

Henley, Erl K., Lieutenant, Junior Grade, United States Naval Reserve Force.

Hirsch, Gustav, Major, Signal Officers' Reserve Corps.

Jackson, John R., Captain, Ordnance Department, Officers' Reserve Corps.

Jellum, Kristen, Second Lieutenant, Engineer Officers' Reserve Corps.

Kaelin, Charles G., Captain, Ordnance Department, Officers' Reserve Corps.*

Keep, Henry, Major, Engineer Officers' Reserve Corps.

Keller, Parry, First Lieutenant, Ordnance Department, Officers' Reserve Corps.

Kenrick, Alfred E., First Regiment, Mass. Engineers' National Guard.

Knerr, Lewis E., First Lieutenant, Engineer Officers' Reserve Corps.

Knoebel, Carl B., Company F, 1st Infantry, Texas National Guard.

Kunze, Edward J., Captain, Quartermaster Department, Office Reserve Corps.

Lent, Leon B., Captain, Aviation Section of Signal Corps, active duty Curtiss Aeroplane Co., Buffalo, N. Y.

Lyman, Elihu E., Captain, Ordnance Department, Officers' Reserve Corps, Frankford Arsenal.

Lynch, Frank J., Aviation Section, Signal Officers' Reserve Corps, Texas University.

Lynde, Charles C., First Lieutenant, Engineer Officers' Reserve Corps.

McClintock, Allen P., First Lieutenant, Ordnance Section, Officers' Reserve Corps.

MacGill, Charles F., Ordnance Department, Officers' Reserve Corps.*

Martin, Kingsley G., Captain, Officers' Reserve Corps, Motor Transport Service.

Mosman, Ernest, First Lieutenant, Ordnance Department, Officers' Reserve Corps.

Rettig, George P., Office of Army Inspector, Signal Service at Large as Inspector of Airplanes and Airplane Engines.

Sees, Joseph S., Captain of Ordnance, Officers' Reserve Corps, Assistant Superintendent of Small Arms Ammunition, Frankford Arsenal.

Selfridge, Samuel W., Second Lieutenant, Field Artillery, Officers' Reserve Corps.

Selser, T. W., First Lieutenant, Engineer Officers' Reserve Corps.*

Scott, Rossiter S., Captain, Engineer Officers' Reserve Corps.

Slade, Arthur J., Aeronautical Division of the Signal Corps.

Swift, Harley L., Lieutenant, Officers' Reserve Corps.

Tag, Walter, Ordnance Reserve Corps.

Taylor, William T., Captain, Royal Flying Corps.

Tilson, Howard, Captain, Ordnance Department, Officers' Reserve Corps.

Trego, A. C., Lieutenant, Springfield Armory, Springfield, Mass.

Vogt, Clarence W., First Lieutenant, Ordnance Department, Officers' Reserve Corps.

Walker, Perley F., Major, 314th Regiment, National Army, Fort Riley, Kan.

Webster, Lawrence B., Captain, Ordnance Department, Inspection Division, Officers' Reserve Corps.

Whipple, C. Earl, Captain, Engineer Officers' Reserve Corps.

Whitlock, Elliott H., Eng. Co., 9th P.T. Regiment, Ft. Leavenworth, Kan.

Williams, Fay B., First Lieutenant, Ordnance Department, Officers' Reserve Corps.

Williams, Silas, First Lieutenant, Ordnance Department, Officers' Reserve Corps.

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*Acceptance of commission pending at date of latest list from War Department.

NECROLOGY

FRANK LEWIS BIGELOW

Frank L. Bigelow was born in New Haven on September 21, 1862. He was educated in New Haven, attending Hopkins Grammar School and later Yale University. He was graduated from Sheffield Scientific School with the class of 1881, having specialized in dynamical engineering.

Upon graduation he entered the shops of The Bigelow Co., manufacturers of fire- and water-tube boilers. He worked in the shops for about two years and in 1883 he was made secretary of the company. Later Mr. Bigelow succeeded his father as president. He was also president of the National Pipe Bending Co. for the last ten years of his life. He was a director in the Merchants and National Savings Banks and in the New Haven Water Co.

Mr. Bigelow was a member of the American Society of Naval Engineers, a member of the executive committee of the Yale Engineering Association, and was after graduation continuously the secretary of his class, 1881 (Sheffield). He was also president of the Yale Press Association.

He became a member of the Society in 1887. He died in New Haven on June 20, 1917.

CHARLES EUGENE WILLEY DOW

Charles E. W. Dow was born in Manchester, N. H., on April 25, 1859. He was educated in the public schools of that city, and commenced his professional work there by the acceptance of a position as draftsman with the Amoskeag Mfg. Co.

He held successively the positions of chief draftsman with the Brown & Sharpe Mfg. Co., Providence, R. I.; mechanical engineer with the Hotchkiss Ordnance Co., also of Providence; agent for the Metallic Drawing Roll Co., Indian Orchard, Mass., and manager of the American Bolt Co., Lowell, Mass.

Mr. Dow was widely known in the textile industry of this country, having been closely associated with these manufacturers in humidification work and air conditioning for about fourteen years.

At the time of his death he was consulting engineer and vice-president of the Elbert Clarke Co., engineers, of Rochester, N. Y.

He was a member of the New England Cotton Manufacturers' Association. He became a member of the Society in 1911. He died on June 16, 1917.

CHARLES FITZGERALD

Charles Fitzgerald was born in Monroe, N. Y., on October 1, 1859. He received his early business training and experience with the Ramapo Car Wheel Co., in whose employ he worked from 1879 to 1882, leaving that firm to accept a position with John Roach & Sons, Chester, Pa.

His next position was with the American Ship Building Co., Philadelphia, where he was the foreman in charge of the erection of marine engines. From 1885 to 1889 he worked with Robert Wetherill & Co. as outside erection engineer. He was next associated with the Citizens Traction Railway Co. as chief engineer, and later as general superintendent of that company and the Consolidated Traction Co., Pittsburgh, Pa. In 1902 he accepted the position of mechanical engineer with the firm of Booth & Flinn, Pittsburgh. In 1906 he became general manager of the Brazilian Dredging Co., Brazil, South America. At the time of his death he was assistant to the president of the Pittsburgh Valve Foundry & Construction Co.

Mr. Fitzgerald became a member of the Society in 1912. He was also a member of the Engineers' Society of Western Pennsylvania. He died on June 2, 1917.

ALBERT FREDERICK GANZ

Albert Frederick Ganz was born in Elberfeld, Germany, April 25, 1872, and came to this country with his parents in 1881. After attending private and public schools he entered the College of the City of New York in 1886, and completed the first year's work in the mechanical course. For the next four years he was employed in the electrical works of Bergmann & Company, New York City, and of the Edison General Electric Company, Schenectady. During this time he attended the Cooper Union Night School. He entered Stevens Institute of Technology as a member of the sophomore class in 1892 and was graduated in 1895 with the degree of Mechanical Engineer. Immediately after graduation he was appointed instructor in applied electricity; two years later he was advanced to the position of assistant professor of applied electricity and physics; and in 1902 he was appointed professor of electrical engineering and head of the department. With the appointment of class deans in 1908, he became dean of the senior class. The period of Professor Ganz's connection with Stevens—1895 to the present—coincided with the phenomenal advance in the theory and practice of electrical engineering, and it is mainly due to his study and efforts toward improvement that the electrical course was kept abreast of the times and that so many graduates of Stevens have been fitted for responsible positions in the electrical field.

Professor Ganz was widely known in the engineering world, having made many commercial and scientific tests and investigations. He had made a special study of methods for mitigating corrosion of underground structures by electrolysis and was a national authority on this subject. He contributed many valuable scientific papers to technical societies and journals.

In Professor Ganz's death his associates and former pupils have lost a friend whose helpfulness could always be depended on. The great care which he took in reaching conclusions, coupled with his unquestioned integrity, commanded universal respect for his judgment in engineering matters. His untiring energy and intense love of his work were an inspiration to all.

Professor Ganz was a fellow of the American Institute of Electrical Engineers and of the American Association for the Advancement of Science, and a member of the following societies: The American Society of Mechanical Engineers, American Gas Institute, American Electrochemical Society, The Society for the Promotion of Engineering Education, Illuminating Engineering Society, American Water Works Association, National Electric Light Association, and past president of the New York Electrical Society. He was also a member of the Hoboken Board of Trade, the Engineers' Club and the German Liederkranz of New York, and of the Tau Beta Pi fraternity.

Professor Ganz became a member of the Society in 1910. He died on July 27, 1917.

CASIMIR von PHILP

Casimir von Philp was born in Stockholm, Sweden, in 1853. After having finished his preliminary education, he entered the Stockholm Institute of Technology and in due time was graduated therefrom.

His first position was in the office of W. Wennstrom, in Oerebro, Sweden, but he did not remain there long, and after holding several other positions finally engaged in consulting engineering work. He saw, however, that the United States offered a much broader opportunity, and in 1880 came here with his family.

Shortly after his arrival in America he obtained a position with E. D. Leavitt, of Boston, Mass., and while in his employ had complete charge of several important undertakings, among them being the sewage pumping installation in Boston and the large pumping machinery constructed for the Calumet mines.

After several years in Mr. Leavitt's employ, Mr. von Philp obtained the position of chief engineer with the Burden Iron Company, of Troy, N. Y. In 1890 he became the chief engineer of the Bethlehem Steel Co.

After sixteen years Mr. von Philp severed his connection with the Bethlehem Steel Co. in order to devote all his efforts to his inventions in the field of presses. In 1908, however, he returned to the Bethlehem concern as manager of the machine department, a post which he occupied up to the time of his death.

Mr. von Philp was a member of the American Society of Swedish Engineers, American Society of Engineers, and of The Committee of Fifty, organized to erect a memorial to John Ericsson in Washington, D. C. He was actively interested in the work of this committee and was instrumental in obtaining a donation of \$500 to the funds of the committee from the Bethlehem Steel Company.

He became a member of the Society in 1890. He died on July 4, 1917.

HENRY SOUTHER

Major Henry Souther, senior officer, aircraft engineering division, aviation section, Signal Corps, U. S. A., and vice-president Henry Souther Engineering Corporation, Hartford, Conn., died August 15 in the post hospital at Fortress Monroe, Va., following an operation. He was born at Boston in 1865 and was graduated in 1887 from the Massachusetts Institute of Technology, where he specialized in mining and metallurgical subjects. After studying abroad the manufacturing methods and processes employed in the German iron and steel industry, he entered in 1888 the employ of the Pennsylvania Steel Co., at Steelton, and was made assistant foreman the following year. He was engineer of tests for the company from 1890 to 1893, resigning to become engineer of tests for the Pope Mfg. Co., a position which he held for six years. At the Pope works he organized the first testing plant ever installed, it is believed, by a consumer of steel for the scientific testing of materials and developed the use of cold-drawn tubing for bicycles and automobiles.

When the Pope organization was dissolved in 1899 he engaged in business as an independent consulting engineer and established a metallurgical and testing laboratory and did consulting work for the automobile industry. He was president and treasurer of the Henry Souther Engineering Corporation from 1899 to 1909 and became president in 1911, but of late years was not very active in the management of that organization. He was vice-president and general manager of the Ferro Machine & Foundry Co., Cleveland, from 1915 to the outbreak of the war. Latterly he had charge of the aircraft development of the army and created a corps for the inspection of aircraft.

He became a member of The American Society of Mechanical Engineers in 1894. He was prominent in the Association of Licensed Automobile Manufacturers, was a founder member of what is now the Society of Automotive Engineers, and had much to do with the development of the iron and steel standards of that body. He was president of that society in

Henry Souther

1911 and served as chairman of the standards committee for a number of years. In 1915 he was made a life member in recognition of this work.

DANIEL A. WIGHTMAN

Daniel A. Wightman was born in East Greenwich, R. I., on August 7, 1846. He was éducated in the schools of East Greenwich, attending for a time the academy there. Having learned the carpenter's trade, he worked at that while taking up the study of drawing at an evening school in Providence, R. I.

About 1870 he took a position as draftsman with the Rhode Island Locomotive Works. He soon became chief draftsman there and for a time was virtually superintendent of the shops. In 1876 he accepted the position of superintendent with the Pittsburgh Locomotive Works and was with them until he retired in 1902, then holding the position of general manager. While at Pittsburgh Mr. Wightman rebuilt the plant and made many improvements in locomotive design, the most important of which was the introduction of power flanging in place of the hand method for heavy boiler sheets. After retiring in 1902 he did some consulting work for the Baltimore & Ohio and Lehigh Valley railroads in connection with locomotive repair shops.

He was a member of the American Railway Master Mechanics' Association. He became a member of the Society in 1884. He died in Warren, R. I., on July 6, 1917.

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping anyone desiring engineering services. The Society acts only as a clearing house in these matters.

GOVERNMENT REQUESTS

The Society has been asked to make suggestions of men for the following positions with the Government. Further information will be given on request. Non-members of the Society having the qualifications may avail themselves of these notices by enclosing with their reply a personal introduction to the Society.

AERONAUTICAL MECHANICAL ENGINEER. Age, 25 to 40 preferred. Salary, up to $2750. Qualifications: Technical education with degree of M.E. or C. E. or its equivalent and good practical experience with first-class manufacturing concerns. Must be able to handle and direct men. Duties: In Washington, or as district manager of the various branches of the Inspection service; or at one of the various factories where airplanes and engines are being manufactured. 2059 (Serial No. 31).

AERONAUTICAL ENGINEER. Age, 25 to 40 preferred. Salary, up to $3600. Qualifications: Familiarity with complete design of an aeroplane and the ability to carry through new designs in same. Should be able to direct and handle men. Duties: In Washington, or at one of the various airplane factories where airplanes are being made, to act as Senior Inspector or to act as advisory engineer to such inspection force. 2059 (Serial No. 32).

YOUNG ENGINEERS of high grade, experienced in the manufacture of small arms, small-arms ammunition, or similar repetition work, such as the making of typewriters, adding machines and sewing machines, for duty in the Small Arms Division of the Ordnance Department; and also for inspection duty at the various ammunition factories which will supply small arms and small-arms ammunition for the Government. 1108.

MECHANICAL ENGINEER of experience with electrical auxiliary machinery and with hydraulic-electric machinery, of proved ability, to act in consulting capacity in mechanical matters affecting ship design. Salary commensurate with qualifications desired cannot be paid, but nominal salary will be paid and man of high ability who can volunteer balance of services is desired. 1165.

HEATING AND VENTILATING ENGINEER AND DRAFTSMAN.
ELECTRICAL ENGINEER.
MECHANICAL ENGINEER.
Under Civil Service Commission, September 4. Request Form 2118, Treasury Department, Washington. Pending establishment of eligible list temporary appointments will be made, in office of Supervising Architect. Majority of engineers appointed are versed in heating and ventilating work or in electrical work only, but it is planned to include design of entire mechanical equipment of large buildings. 2074.

EDITORIAL ASSISTANT. Position covers the technical review and editing of manuscripts to be published as bulletins of one of the state departments, shorter papers for the trade and scientific journals, preparation of semi-popular articles on the work of the laboratory, news items for the press and assembling of material for monthly and annual reports. Entrance salary, $1500-$2000. 2128.

INSPECTORS AND ASSISTANT INSPECTORS OF ORDNANCE EQUIPMENT. Subclassification of this examination will be for inspectors and assistant inspectors of aluminum and mess equipment. These items comprise such articles as meat cans, aluminum and steel knives, forks, and spoons, plates and similar articles. Their duties will be to supervise the inspection of these items, both in process of manufacture and when ready for delivery. Also, they will have charge of operation of vouchers and other papers by which the contractor receives payment for the articles supplied. These positions are Civil Service appointments and will pay from $1000 to $2000 per annum. Applicants must have completed a course in a college or university of recognized standing and have at least one year's experience in the lines of merchandise they purpose to inspect, or they must have a high-school education or its equivalent and in addition at least four years' experience in these lines of work or in related lines. Applicants should be at least 25 years of age. No person who is liable to call in the first draft quota can be considered for this position. 2117.

MECHANICAL ENGINEERS, ORDNANCE DEPARTMENT, available as Reserve Ordnance Officers, principally with the grade of 1st Lieutenant. Men should be, probably, between 31 and 35 years of age, and graduate engineers who have had experience in machine design. 2072.

MECHANICAL ENGINEER, QUARTERMASTER'S DEPARTMENT, salary $3,000. Qualifications: Training and experience in the design and construction of central heating plants and central power plants, together with general knowledge of mechanical engineering and office administration. Appointments to this position subject to certification from U. S. Civil Service Commission. 2099.

PRODUCTION SECTION, CARRIAGE DIVISION, ORDNANCE DEPARTMENT. Positions: First Lieutenant, Ordnance Officers' Reserve Corps. Salary, $2,000 per year plus $500 (regular army allowance) and traveling expenses. Age, 27 to 40 years. Duties: Positions under both calls will be in Washington or in field work at various factories in the United States. They will be for the duration of the war. Applicants must be physically sound.

Qualifications: Training and several years' experience in machine-shop practice and production. Must be capable of investigating plants to determine capacity for orders and to investigate causes of failures of contractors to make promised deliveries. 2085 (Call No. 36).

Qualifications: Training and experience in purchasing machine tools and equipment, steel castings, forgings, and other raw material and supplies used in machine construction, and general knowledge of them. 2085 (Call No. 37).

For the following positions, Nos. 2118, 2119 and 2120, letters showing qualifications should be sent to the Secretary. Further information cannot be given at this time.

SUPERINTENDENT OF WOOD-WORKING SHOP. To be familiar with the operation of modern planing-mill machinery such as re saws, rip saws, molders, etc., as required to manufacture wood parts of airplanes and pontoons. Also to be familiar with the construction of life boats or racing shells, or working boats, or airplanes and pontoons. To be of sufficient executive experience to warrant confidence in his ability to build up and control a force of 200 men. 2118.

SUPERINTENDENT OF THE METAL SHOP. To be familiar with general sheet-metal work, including brazing, and welding by the autogenous and spot-welding processes; and with the design of dies for, and operation of, punch presses. To be familiar with general machine-shop and tool-room practice. To have some little experience with manufacturing automatics. To have rudimentary knowledge of the heat treatment of steel. 2119.

ENGINEER OF EXPERIMENTS, OR RESEARCH ENGINEER. To have an engineering education, experience as engineer of tests or research, and an understanding of the value of time. 2120.

POSITIONS AVAILABLE

In forwarding applications, stamps should be enclosed for transmittal to advertisers; applications for non-members should be accompanied by a letter of reference or introduction from a member, such reference letter to be filed with the Society. Copy for notices must be in hand by the 15th of the month.

TOOL DESIGNER who is resourceful and can follow work through to completion. Technical man with practical shop experience. Location Connecticut. 185.

SALES ENGINEERS. It is desirable that applicants be young men between 25 and 30 years of age, preferably M. E. graduates of some approved engineering college, and of good appearance. They will be expected to undergo a period of probation and training in various offices of company for responsible and higher positions in sales work. If a call cannot be made, application may be made by letter in applicant's own handwriting, stating age, education, previous business training, if any, salary desired, etc. Location New York. 205.

STRICTLY HIGH-CLASS MAN who can conduct classes and give lectures covering automobile subjects for a large public institution

[illegible] Middle Northwest. Must be a technical graduate with practical experience [illegible] field of work. 121.

ELECTRICAL ENGINEER possessing extensive experience with electrolytic plants for producing oxygen and hydrogen, wanted by New York concern. 811.

MACHINERY DESIGNER in turbine department of large electric company. Location Massachusetts. 894.

MASTER MECHANIC for lead-smelting plant operating blast furnace and concentrating mill. Must be man of strong personality, capable of handling varied classes of mechanics. Give full details of education and experience. Location Utah. 906.

TECHNICAL ENGINEER with experience in steam engineering to act as assistant operating engineer in large industrial plant located near Chicago. State age, experience and salary expected. 938.

SALESMEN on machine tools to represent large New York exporting corporation in China, Australia and South Africa. 964.

DESIGNERS. Men experienced in steam-engine and turbine work preferred. 967.

DRAFTSMAN familiar with power-house work, installation of equipment, piping, etc., and competent to work out different problems involved from general outline without need of more or less constant supervision. Salary $25 to $28 per week. Location New York. 969.

DRAFTSMEN AND DESIGNERS. Experienced men with some knowledge of valves and fittings; good future with large concern. State experience in full, salary expected and references. Confidential. 1002.

DRAFTSMAN for patent office drawings. Salary $25 to $35. Location New York. 1022.

YOUNG ORGANIZING ENGINEERS for intensive management work, in general manager's office of one of the large units of the rubber industry. Opportunity decidedly promising. State initial salary expected, age, experience, qualifications, etc. Please give full, character-indicating letter. Location Middle West. 1047.

MECHANICAL LABORATORY ASSISTANT for technical school in Greater New York. Recent mechanical engineering graduate with one or more years of practical work since graduation. Single man about twenty-five years of age preferred. Position offers exceptional opportunity for advancement. State age, education, experience, present employment and references. Enclose photograph with application. Salary $1200. 1060.

ELECTRICAL TESTER wanted immediately by Chicago blower manufacturer; to work as draftsman 20 per cent of time. Permanent position, with opportunity for promotion to salesman, designer or foreman. Salary $18 for first 20 weeks. Experience unnecessary. Describe education and physical condition. 1075.

DRAFTSMAN. Young engineer, preferably technical graduate, with about a year's practical experience; who could work into a good position. Salary $25 to start. Location New York. 1080.

DRAFTSMAN AND ESTIMATOR for work of varied character with large concern; good opportunity for advancement. Location New Jersey. 1104.

MECHANICAL-ENGINEERING DEPARTMENT of a Middle West state college desires applications from men suitable for the position of foreman in machine shop. The successful applicant must have had several years' actual machine-shop work and be familiar with methods of mass production and scientific management. College training desirable but not absolutely necessary. Should have had experience as foreman or assistant foreman in some successful shop, and preferably some teaching experience, although this is not absolutely necessary. Prefer a man not over 35 to 40 years of age. 1112.

DRAFTSMEN experienced in ordnance work, particularly small arms and machine guns; or experienced in complicated automatic machinery. Location Ohio. 1131.

COMBUSTION ENGINEER. Duties primarily those of efficiency work in the burning of fuel and generation of power, also in the use of power in the various departments of plant. Power plant is of 1000 hp. capacity, with extensive distributing system for air, steam and electricity. Excellent opening for a man interested in steam power-plant work. State fully qualifications, training and experience. Location New Jersey. 1133.

GRADUATE MECHANICAL ENGINEER with knowledge of theory of centrifugal machinery—preferably fans, pumps and compressors—and also thoroughly familiar with their design and methods of testing. Apply by letter. Location New York. 1140.

COMPETENT MAN, about 35 years old, to take hold of maintenance and machine repairs and general shop economics. Prefer one with a technical education and enough shop experience to understand the operation of all machine tools, and who has a full appreciation of the value of time on an operation without going into any efficiency work. Opportunity for advancement and eventually an executive position. 1166.

MECHANICAL ENGINEER. Technical graduate, several years' experience along general and mechanical lines. One conversant with industrial machine design preferred. Permanent position with large corporation. State age, college, previous experience and salary desired. Location Cleveland. 2023.

MECHANICAL DRAFTSMAN. Young college graduate preferred. General industrial-mechanical engineering work. Permanent position with large corporation. State age, college, experience if any, and salary desired. Location Cleveland. 2024.

INSTRUCTOR IN MECHANICS and strength of materials wanted by an eastern engineering school. Must have had the usual technical training in experimental laboratory work, so that he can also assist in hydraulic and steam laboratories. Good opening for the right man. State additional training and experience if any. Salary will depend on the amount of work that can be carried. 2025.

ASSISTANT PROFESSOR in sanitary engineering. Location near New York City. 2026.

AUTO REPAIR MAN familiar with Hurlbut type of truck. One-year contract. Prefer a single man. Salary $175. Location Chile, near Valparaiso. Expenses down and back. 2092.

ESTIMATOR for New York concern engaged as engineers and contractors for power plants, ventilation, steam and hot-water heating. 2103.

YOUNG MAN between the ages of 25 and 28 who is not drafted and who is interested in manufacturing work. Position will give him full control of the cost work. Salary to start, $100 per month, and depends upon the man. Applicant need not be experienced in the same line, but should have some knowledge of the line. Location New Jersey. 2109.

ASSISTANT YOUNG ENGINEER for office of consulting engineer, to assist in development of patents and inventions. Location New York. 2110.

SUPERINTENDENT for firm engaged in the japanning and enameling of automobiles. Man of executive ability and experience in lines that would fit him for taking charge of shop. Location Long Island City. 2111.

SEVERAL GOOD DRAFTSMEN who have had experience in designing machine work, in particular stoker work. 2114.

EXPERT TOOL- AND FIXTURE-DESIGNING DRAFTSMAN for line of safety valves, steam gages and similar equipment. Applicant must have sufficient education and experience to enable him to take charge of the drafting department, within a reasonable time, as chief draftsman. Location New York. 2115.

WORKS ENGINEER. Must have thorough knowledge of tool design for automatic machines and ability to plan and demonstrate operations. Duties include general supervision of tool design, tool making machine repair and plant maintenance. Salary to start $3000. Apply by letter. Location Ohio. 2116.

ASSISTANT CHEMICAL SUPERINTENDENT for plant involving a wide field, with over 1200 employees, near New York. Man must have ability to handle men. 2028.

DRAFTSMAN familiar with water-wheel equipment. Unusual opportunity in a Central Massachusetts concern. Technical graduate preferred. 2042.

JUNIOR DRAFTSMAN who can do detail work from sketches or personal instructions. Salary $15 per week. 2043.

MECHANICAL ENGINEER to take charge of engineering department. Must be thoroughly familiar with the design and operation of pulp- and paper-mill equipment. Should be competent to design buildings. A sound working knowledge of steam and electrical power-

plant design and operation is required. Good opening for a capable, energetic man. Location Hammermill Paper Co., Erie, Pa. 2044.

JUNIOR DRAFTSMAN with experience in heavy motors. Salary $125-175. Location Michigan. 2047.

DRAFTSMAN on electrical machinery for power plant layout work. Salary $150-160. 2048.

ASSISTANT CONSTRUCTION SUPERINTENDENT. Must be accustomed to handle men, lay out work, to carefully watch all details, etc., and be a good organizer. Main requisites are in connection with mechanical equipment of buildings already erected, i. e., piping, tanks, shafting, timber details, etc. Blueprints will not always show details and considerable knowledge is essential in order to carry on the field work without delay. Salary $175 to start, advancement according to ability. Give full information by mail as to age, nationality, married or single, liability to draft, references, when could report for work, etc. 2049.

INSTRUCTORS for (1) Applied Science Laboratory and in (2) Mechanics and Elementary Electricity wanted by a technical school in Brooklyn. Salary first year $1200 to $1500, according to individual. Preference given to men with mechanical or electrical engineering training and practical and teaching experience. Apply by letter only, giving full personal and experience data and recent photograph if possible. 2050.

INSTRUCTORS. Men of good personality, capable of commanding the respect and attention of the students, most of whom are college-trained men, to train U. S. Army aviators eight weeks' course. Should be capable of directing the assembling, disassembling and operation of aeronautical motors. Prefer to have college graduates who have had one or more years of practical experience and training in either aeronautical works or on engines in a motor-car works. Salary $100 to $125 per month, or more, according to experience and teaching ability. Willing to take a 1917 graduate in mechanical engineering who has specialized somewhat in gas engines, in which case would like to send him for a month of special training to an aeronautical factory and pay him $85 a month to start. 2051.

MECHANICAL AND ELECTRICAL ENGINEERS. One wanted of each. Preferably married men without children. Positions at sulphur refining factories in France. 2052.

MECHANICAL ENGINEER, age about 35, to travel in Dutch East Indies. Must have thorough knowledge of machinery, steel products and kindred lines of territory named. Export knowledge desirable but not essential. State age, experience and salary expected, also when at liberty. 2054.

YOUNG MECHANICAL ENGINEER who is industrious and capable and has had fuel-economy tests and power-plant testing, and practical experience in the construction and testing of modern Westinghouse steam turbines. Possibilities of advancement for right man. Location New Jersey. 2055.

YOUNG TECHNICAL GRADUATE in production department; one who has had some experience in manufacturing operations and understands machine tools. Position will pay from $75 to $100 per month at the beginning and future will depend upon ability. Must be energetic and not afraid of work and capable of developing executive ability. 2057.

DRAFTSMAN on a.c. or d.c. motor design. Salary about $40 per week. 2058.

RAPID DETAIL DRAFTSMAN AND DESIGNERS on hydraulic turbines, electric furnaces, gas producers, heavy machinery for steel-plant and coke-oven equipment, coal and ore-handling equipment, and complicated structural details. Location Cleveland. 2061.

SALES ENGINEER for Cleveland territory to handle power-plant equipment. Technical graduate preferred with power-plant and sales experience. 2062.

DESIGNER for tools and rapid-production devices wanted by engineering department of a munition factory. 2066.

DRAFTSMEN on mechanical-stoker work. Men familiar with boiler-room layouts, building construction or heavy-machine design acceptable. Salaries up to $30 per week to start, depending upon ability and experience. Permanent positions. Also draftsmen experienced in auxiliary marine machinery, hoisting engines, hoisting-engine design in connection with this class of machines, engine designers. Salaries up to $30 per week. Location Philadelphia. 2069.

MECHANICAL ENGINEER who has had several years' experience in the design, construction and erection of machinery, structural work, piping, etc., and preferably as many months' selling experience, for permanent position among congenial associates. Location New York City, but must be willing to go out of town whenever required. Salary $225 per month to start. 2070.

TWO TECHNICAL GRADUATES approximately 30 to 38 years of age with experience of sufficient breadth so that they would be posted on problems of manufacture in more than one line. Men who have been steadied by experience, yet ambitious to push ahead and interested in the various problems of manufacture and construction. Location Massachusetts. 2071.

CHIEF DRAFTSMAN. Location Connecticut. 2076.

INSPECTOR competent to handle structural material for firm of consulting, construction and management engineer. Location Connecticut. 2078.

ASSISTANT SUPERINTENDENT for Chicago tool manufacturer. Start at $150 per month with increase to $200. Describe education and physical condition. State number of months in previous positions, exact nature of duties and number of hours per month on each duty. 2079.

DRAFTSMAN on machine tools. Young man wanted who has had considerable experience in designing machine tools, more especially grinders. Salary $25 at least, depending upon ability. Location Boston. 2083.

EXPERIENCED TIME-STUDY MAN familiar with the production of small interchangeable parts, for manufacturing plant in Philadelphia. Position will lead to one of responsibility. 2084.

MECHANICAL ENGINEERS experienced in jigs, dies, gages and fixture work; also in mass production of small articles where drawing and other press work has been the principal occupation. Location New York. 2086.

PRODUCTION PLANNING MAN. One with considerable experience in such work and who is ambitious and capable of getting results. Work will consist of planning the production of ball bearings through the entire shop, routing of the material, etc. Prefer a man not subject to military draft and upon whom considerable authority can be placed. Location Connecticut. 2088.

EFFICIENCY TIME-STUDY MAN who has had some experience along these lines, and, if possible, is acquainted with the manufacture of small parts in automatic machinery and grinding machinery. Location Connecticut. 2089.

EMPLOYMENT DEPARTMENT HEAD. Man wanted to take charge who has had some experience and who understands all the different phases of hiring and keeping help. Location Connecticut. 2090.

PRODUCTION MANAGER for factories located at various places, but with headquarters at New York office. Man between 35 and 40. Salary depends entirely upon man. Write asking for appointment, giving brief record of education and experience. 2091.

INSTRUCTORS in steam-engineering laboratory in training government recruits. $30 a week, hours 9-11 a. m., 1-3:30 p. m. 2093.

INSTRUCTORS in machine design, with some laboratory work. Location Brooklyn, N. Y. 2094.

ASSISTANT IN STEAM LABORATORY. Salary about $1,200. Previous teaching experience not necessary. Location Brooklyn N. Y. 2095.

TECHNICAL GRADUATE wanted as instructor in mechanical engineering, tracing, machine design, gas engines and machine shops for southern university. In application state age, education, experience, references and salary desired. 2098.

AUTOMOBILE ENGINEER capable of designing pleasure cars and motor trucks. Experience with Russian requirements desired. Must be good correspondent. Middle-aged man preferred. In first letter state age, education, experience in detail, salary expected, also when at liberty. 2104.

A LARGE GROWING PAPER MANUFACTURING CORPORATION can offer excellent opportunities for interesting and effective work to two young college graduates with tact, initiative, ability and common sense. Non-graduates with two or more years of manufacturing experience will be considered; men wanted who can develop and who have the vision to see and grasp an opportunity. Fair living salary at start. Give complete information. Men will not be engaged until the right ones are found.

EMPLOYMENT MANAGER in plant employing 600 men in the [illegible]. Exceptional opportunity for experienced men. 212[illegible]

PRODUCTION MANAGER in organization operating under a pro[illegible] management, under the production manager come all questions of planning, scheduling and routing. Man at least 30 [illegible] who has had a technical training and some years' experi[illegible] modern methods of management, and whose personality will [illegible] to readily control quite a large force of people. Po[illegible] [illegible] opportunity and pay such salary as will attract [illegible]. Location Middle West. 2123.

DRAFTSMAN. Weekly salary of \$20. Apply by letter to Employ[ment] Department, Maxim Munitions Corporation. Location W[atertown], N. Y. 2124.

MAN to take charge of a stationary engineering department, and who has had actual operating experience in addition to a technical training. Opening should be desirable for type of man interested in educational work. Prompt action necessary, because decision will be made in [short] time. 2126.

YOUNG SALESMAN in the Boston or Philadelphia districts. Guarantee income and extended commission on sales. Applicant should have an education, good appearance, some advertising or artistic ability preferred. 2127.

STRUCTURAL STEEL DRAFTSMAN experienced in powdered coal plants, industrial plants, power houses, layouts, etc. 1011.

ASSISTANT SUPERINTENDENT for maintenance and construction work in chemical factory. Technical graduate desired. Location St. Louis. Salary \$1,500. 1149.

MEN AVAILABLE

Only members of the Society are listed in the published notices in this section. Copy for notices should be in hand by the 15th of the month, and the form of the notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

PRODUCTION SUPERINTENDENT. American, age 36, married. Twenty years' practical experience in interchangeable parts manufacture, such as locomotives, road rollers, traction engines, conveyor machinery, rock crushers, marine engines, and munitions. Has had wide experience as sales engineer and has successfully held positions as machine shop foreman, general foreman, superintendent. Desires position with Eastern firm, preferably Philadelphia or vicinity. Best of references. I-297.

CONSTRUCTION SUPERINTENDENT. Japanese, aged 42. Fourteen years' practical experience in mechanical and electrical installation work as foreman, inspector of railroad cars and electrical building constructor. At present employed in one of the largest traction companies as power-plant and sub-station designer. I-298.

SUPERINTENDENT. General foreman, who has had seventeen years' experience in mechanical and executive positions in interchangeable manufacturing, desires position. I-299.

MECHANICAL ENGINEER broadly experienced in design and management of power plants, factory maintenance and development of methods and processes, desires position where such experience along with executive ability and chemical training will be of value. At present employed. I-300.

CHIEF DRAFTSMAN OR ASSISTANT ENGINEER, now chief draftsman of a staff of twelve, totaling a monthly payroll of over \$2000, desires change of location. Specialty, large industrial plants, as mining and smelting, covering all branches of engineering. Salary \$250 a month. Age 36. American born, single. Associate-member A S M E. I-301.

WORKS MANAGER OR CHIEF ENGINEER. Technical graduate, M.E., experienced in superintendence, management, and in shop planning and intensive production of duplicate parts. Salary \$3500-\$4000, depending upon nature of work. Prefers location near New York or Philadelphia, but will consider any good proposition located in the United States. I-302.

CHIEF ENGINEER AND RESEARCH EXPERT with 16 years' practical training in oil and gas-engine development work. Broad experience in the fine points of both the technical and business side of engineering, with special aptitude for research work and the perfection of new ideas. Thoroughly competent to handle men and to take charge of the development, design and supervision of construction of either marine or stationary internal combustion engines. At present employed. Best of references. I-303.

MECHANICAL ENGINEER. M. I. T. graduate, age 23, married. Desires a position with a future, where work and responsibility will count. Mechanical and electrical drafting room experience. At present employed. Location in the East preferred. I-304.

ENGINEERING EXECUTIVE. Technical graduate, age 29, married. Seven years' experience in designing, manufacturing and industrial plant construction. Wants responsible position. At present employed as mechanical engineer for eastern steel foundry. I-305.

STEAM AND COMBUSTION ENGINEER. Technical graduate, age 31, married. Nine years' practical experience with large concerns, including executive experience and the handling of men. Desires change of location. I-306.

ASSISTANT TO EXECUTIVE OR EXPERIMENTAL ENGINEER. Stevens M.E. graduate, age 28, married, finishing present engagement, returns East early in September. Three years' successful experience in executive and experimental work in natural gas, and two years' in power-plant operation. Possesses energy, initiative, self-confidence. Desires position with large industrial or engineering concern. Initial salary not a primary consideration, but position must be permanent and offer a future. I-307.

ASSISTANT SUPERINTENDENT OR CHIEF DRAFTSMAN, age 28, experienced on tools, jigs and fixtures for motors or munitions, wishes to engage permanently with an established firm in this business. Ability has been proved. Salary \$2500. Location in the East preferred but not essential. I-308.

MANUFACTURING EXECUTIVE. M. E. Lehigh, age 30, wants to connect with a live organization producing mechanical material. Eight years' executive and practical experience in engineering and efficiency methods, tools, machinery, equipment and labor-saving methods. Specialty, quantity production of interchangeable parts. I-309.

MECHANICAL AND ELECTRICAL ENGINEER. Technical graduate, age 28, two years with engineering department of manufacturer of gas producers, internal-combustion engines and steam pumps; two years with manufacturer of electrical machinery. At present assistant gas and electric inspector in a large city. Also familiar with storage batteries and power-plant practice. I-310.

RECENT M. I. T. GRADUATE desires position involving efficiency, planning or time-study work. I-311.

SUPERINTENDENT OR WORKS MANAGER at present employed in that capacity wishes to make a change. Fifteen years' experience in the manufacture of medium-weight interchangeable cars in large quantities. Under favorable conditions would consider making an investment as a guarantee of good faith. I-312.

MECHANICAL ENGINEER AND PRODUCTION EXECUTIVE. Age 39. Practical experience as toolmaker, designer, foreman, supervisor of engineering, tool and experimental departments. Experienced in the manufacture of small and medium interchangeable parts, and knows how to handle men to get coöperation. At present employed but seeks larger field. Location preferred, New York City or vicinity. I-313

EXECUTIVE ENGINEER. M. E. Lehigh, age 43, with good experience along lines involving design, operation, construction, purchasing, management, etc. Several years in responsible charge of the construction of power and industrial plants. Wishes a position of responsibility connected with the commercial rather than the strictly technical side of engineering, as manager, assistant manager, superintendent, sales engineer, manufacturer's agent, etc. At present employed. Salary \$3000-3600. I-314

WORKS MANAGER or General Superintendent, age 36, desires connection with large plant making any product from automobiles to clocks. Broad-gage, fully trained executive, experienced in plant layouts, best shop practices, management-control methods, systems and man training. Successful in all jobs successively through production, design and control divisions. A man with vision equal to the possibilities of a business and accustomed to make plans become facts. Full details on request. I-315

MECHANICAL AND EFFICIENCY ENGINEER desires responsible position, any location. Technical education, M. E. and C. E., and 12 years' general engineering experience, including power-plant construction and operation, appraisal work, railroad and highway construction, general machine-shop work, installation, design and construction of heaters and general power-plant efficiency work. Good executive and well known as writer of technical subjects. I-316

CHIEF DRAFTSMAN with broad experience and a successful record desires position with a growing concern where his initiative and industry will lead to advancement. I-317.

ENGINEERING SURVEY

A Review of Engineering Progress and Attainment in Mechanical Engineering and Related Fields, Including a Digest of Current Technical Periodicals and a Selected List of Engineering Articles

Industrial Research in the United States

THE Secretary of the Department of Scientific and Industrial Research (England), issued the first of a series of papers projected by the Advisory Council, and bearing on industrial research. It contains a fully illustrated report of Mr. A. P. M. Fleming on Industrial Research in the United States of America, based on a visit to America last year. The report is divided into sixteen sections, is preceded by a short introduction, and has a good index. The author deals with every kind of industrial research as undertaken by (1) manufacturing corporations; (2) associations of manufacturers; (3) universities and colleges; (4) national institutions; (5) commercial laboratories; and (6) scientific societies. He next discusses the questions as regards (1) endowments for scientific research; (2) the coördination of research in the United States; (3) the selection and training of research men; (4) the fundamental consideration in industrial research; and (5) the organization of British industrial research. All these are fundamental questions which the author's experiences have raised in his own mind or which his readers will be likely to ask. To some of them he suggests answers which cannot fail to stimulate thought and discussion. Industry is the basis of national prosperity, and no stone should be left unturned to facilitate its progress. The instances adduced by the author show that in this respect research is of the utmost importance. The nation is entering upon a new phase in industrial and economic life, and its development will be governed largely by the extent to which new scientific knowledge is obtained and is turned to the benefit of all concerned. (*The Foundry Trade Journal* vol. 19, no. 187, July 1917, p. 358)

Research as a Profession

Address delivered by Dr. P. G. Nutting before the joint meeting of the Worcester Polytechnic Institute and Engineering Societies on May 18, 1917. The author is engineer in charge of the Research Department of the Westinghouse Electrical and Manufacturing Company at Pittsburgh, Pa.

The most interesting part of the address is that referring to industrial-research organization.

It is the opinion of the speaker that industrial research is preëminently fitted to be carried on by teamwork. He believes that this system is much more efficient than the elimination cell system, where each leading man has a room, or suite of rooms, to himself and keeps his work to himself. In the ideal organization two or three men work together on the same large problem, or group of problems, the aim being to have a good theoretical man and a good experimentalist working together as much as possible, or even a physicist and a chemist in some cases.

The characteristic of the teamwork plan is the conference system. The five or six men most interested in the problem meet for an hour each week to discuss it in its various aspects, to plan new work and to consider various applications of the results obtained. The ideal conference is composed of not less than four, or not more than eight men, and includes an efficient stenographer. To one experienced in such teamwork the results of getting together are simply amazing. A good suggestion is no sooner made than capped by a better one, and the saving in time and effort is almost incalculable.

The conference system aids in putting useful results before the other wing of the Research Division, and before the Patent Department. In the Westinghouse Company, at each of the conferences, were present representatives of the other wing of the Research Division charged with taking up any results immediately applicable; there is also present a member of the Legal Department, who takes care of any ideas worth obtaining. This plan of conference relieves the scientific men from responsibility for calling the attention of the works, or of the Patent Department, to useful obtainable results. (*Journal of the Worcester Polytechnic Institute*, vol. 20, no. 5, July 1917, pp. 312-322.)

French National Laboratories for Scientific Research

The French Academy of Sciences appointed in 1916 a special commission to study the question of the need of national laboratories in France. After reviewing what private initiative has done in France and what the government and private enterprise have accomplished in other countries, notably in Great Britain, the United States and Germany, the commission concludes that there is an urgent need in France for the establishment of a national laboratory for scientific research. Such an institution could be placed under the control of the French Academy of Sciences in the same way as the National Physical Laboratory in London is placed under that of the Royal Society.

After hearing the report, the Academy of Sciences has passed a resolution to the effect that the establishment of a National Laboratory for Physical Science and Mechanics is highly desirable, and that it should be specially entrusted with the work of scientific research for the purpose of promoting industry. The resolution contains some hints as to the status, organization and administration of such a laboratory, further details of which are elaborated in the commissioner's report. As regards financial support for the new institution, the report states that in France it would be useless to wait for the large industrial firms to combine and take the initiative, as they did in Great Britain, and to try to start the laboratory without a Government grant. To insure a successful start for the institution, about \$100,000 would be required, apportioned among the central institution and its branches. (*The Iron Age*, vol. 100, no. 6, August 9, 1917, p. 311)

The New Jersey Zinc Company's Franklin Laboratory

The Franklin Laboratory was designed mainly for the analysis of products from the two concentrate mills in its

[illegible] as determinations of zinc, iron, manganese, etc., in the ores. Within the last five years, however, it has been found advisable to examine most of the supplies of the mills, and therefore additional space and equipment was allotted for the examination of such substances as oils, greases, soaps, alloys, fuels, paints, explosives, and water.

As the greater part of the determinations carried on are volumetric, good light is a very important factor, and, with this in view the interior walls of the building were constructed of white enameled tiles laid in Keene cement. This also gives a clean and attractive appearance to the room. As the zinc titration requires a constant light, which is not available, especially in winter, two artificial-daylight lamps were installed and proved to be fully satisfactory.

In the old laboratory great difficulty was experienced in keeping the wooden floor in good condition. Therefore in the new building the wood was treated with aniline black; it is now in excellent condition despite the fact that in many places it has been occasionally subjected to the action of concentrated acids. (D. Jenkins, in *Bulletin of the American Institute of Mining Engineers*, August 1917, pp. 1181-1185, 5 figs.)

A New Tool Steel

British papers contain an announcement, on behalf of Darwin & Milner, of Sheffield, of the discovery of a tool steel stated to be equal in durability and hardness to high-speed steel, yet of which tungsten is not a component.

The new steel is called cobalt-crom, and is based on a discovery that by adding cobalt to chromium carbon steel the latter is converted into a steel which has red-cutting hardness.

Tungsten high-speed steel has not been used to any large extent for milling cutters, taps, reamers, etc., and Darwin & Milner estimate that at least 90 per cent of this latter type of tools are still being manufactured from carbon steel, which is probably mainly due to the difficulty which the toolmaker experiences in hardening such tools. Tungsten high-speed steel requires hardening at from 1250 to 1350 deg. cent., if the best results are desired. To try to obtain this heat for milling purposes is very risky, and to harden at a lower heat gives less satisfactory results.

It has been found, on the other hand, that the maximum heat necessary for the hardening of the new steel is only 1000 deg. cent. It is stated that hardening is satisfactory nearly always when the tool is allowed to cool naturally in air free from drafts and currents, and it is claimed to be possible with the new steel to get absolutely the same standard of hardness throughout.

It is also stated that the cutting efficiency of the new steel is quite equal, even in the form of castings, to that of tools made from forged or rolled bar, in which high-speed steel is supplied commercially, and, as the material in the molten state is much more liquid than high-speed steel, it lends itself to all forms of tool-casting.

As stated in *The Iron Age* (August 16, 1917, page 365), a convention of representatives of the iron and steel industry of Germany has been recently held at Düsseldorf at the instance of the Association of German Steel Makers. It was urged that it was necessary to extend the system of metallurgical research in order to be equipped in every respect for the inevitable economic contest after the war. It was decided to form an institute for undertaking iron and steel research in association with the Kaiser Wilhelm Company, and to raise the necessary funds almost entirely in the iron and steel trades.

Notes from the Engineering Colleges

Equipment of Laboratories—Investigations in Progress—Changes in Curricula

BELOW is a continuation of the review of professional work being undertaken at the engineering colleges. The articles contain information regarding (1) characteristics of laboratory equipment, (2) tests or researches under way or in prospect, (3) important changes in curricula.

The articles are concluded this month.

NORTHWESTERN UNIVERSITY, COLLEGE OF ENGINEERING

Equipment: Electrical Laboratory. The apparatus is provided with special features to make it effective for a general laboratory study in connection with a five-year curriculum leading to the degree of Bachelor of Science at the end of four years and to the degree of Electrical Engineer at the end of five years. Class and laboratory instruction are closely correlated in setting forth and making concrete the fundamental scientific principles underlying the theory, the operation and the design of the electrical apparatus which form the basis of electrical engineering.

Laboratory of Applied Mechanics. This laboratory work is taught directly in connection with the theoretical study of strength of materials. The present equipment includes a 20,000-lb. universal testing machine; a 50,000-in-lb. torsional machine; a 5000-lb. end-load bending machine; a 200,000-lb. compressive-testing machine; an Upton-Lewis toughness-testing machine; a Smith endurance-testing machine; a Fairbanks cement-testing machine, and other apparatus.

Shop Laboratory. The equipment is adapted to instruction in an understanding of shop processes as distinguished from the acquirement of manual skill. The machines are individually motor-driven.

Hydraulic Laboratory. The equipment includes tanks, a centrifugal pump, a Pelton wheel, a hydraulic ram, and other apparatus for the study of small quantities of water flowing through weirs, orifices, nozzles and pipes.

Engine Laboratory. The equipment includes a Corliss engine, a Ball engine equipped with both a throttling governor and an automatic cut-off governor, a Kerr turbo-generator set, a Foster superheater, a steam-flow meter, a Wheeler condenser, and a Foos gas engine equipped for use with various fuels and equipped with hit-and-miss governor and throttling governor, and all necessary instruments for power-plant testing.

Research: Primary and storage batteries; work upon residual stresses, with particular respect to the persistence of these stresses over a period of two or three years; work on web stresses in an I-beam (preliminary work on a 7-in. I-beam has given encouraging results; a 15-in. 42-lb. I-beam is practically ready for testing); efficiencies of gas engines, particularly with kerosene as fuel.

Curriculum: No change is contemplated. The purpose is to furnish a thorough training for the profession combined with the general training of the man. The fundamental aim of education is steadfastly kept in mind in both the class room and in the laboratory, namely, to communicate knowledge of principles which are of broad application and to discipline the intellect. It is believed that the objects of the class and laboratory work are identical, and to this end emphasis was laid on the selection of apparatus which would illustrate the *why*, the rationale of the phenomena under investigation and the *why* of practice.

The Ohio State University

Equipment: Usual apparatus for work in strength of materials, hydraulics, friction, lubrication, gas, power and steam engineering. This is one of the six universities chosen to establish a cadet aviation school, which started on May 21, to which 25 men will be sent by the War Department each week, given three weeks of intensive military drill and five weeks of instruction in aviation work, and then sent to the Wright flying field at Dayton for their training in flying.

Research Work: Tests on gas engines, on friction and lubrication, and the flow of fluids through pipes and diaphragms; feed-water regulators, and gas tractors.

University of Wisconsin

Research Work: Thesis research on the cycle of temperature in a gas engine. The method originally contemplated was as follows: A number of extremely delicate thermocouples connected in parallel were to constitute a source of current which was to be recorded by an oscillograph. The couples were to be calibrated by rapid introduction to and withdrawal from an electrically heated tube furnace the known temperature of which approximated that to be measured. After some preliminaries a string galvanometer was substituted for the oscillograph on account of greater sensitiveness. (Unfinished.)

Thesis study of the vibration of automobile motors, a mechanical amplifier being used to obtain record which was on a smoked drum alongside a chronographic time line. So far the mathematical deduction that the principal vibration of a four-cylinder motor was of double periodicity with respect to the rotative speed, has been confirmed.

Experimental Work: A 100-hp. uniflow engine has been under test during the past year, and some additional work has been accomplished in testing the laws of flow of oil of a viscous nature through small orifices, and on the behavior of concrete slabs under varying temperatures and moisture conditions.

Syracuse University

Equipment: The laboratories, mechanical, electrical and hydraulic, are fairly well equipped for research; there is a foundry, woodworking department, forge and machine shop. The chemistry department of the University is exceptionally well equipped for research work.

Research Work: The college has done a limited amount of research work; the mechanical department contemplate making a test on shafting friction next fall.

Tufts College Engineering School

Curriculum: A new curriculum was adopted this year for all departments. Its first object is to avoid the differentiation of courses during the first two years, and, in the case of such closely allied courses as mechanical and electrical engineering, or civil and structural engineering, to require a common course for three years. The fourth year will then be used for intensive and specialized work more closely allied to professional work. To enable a more discriminating selection of a specialty during the senior year, we have introduced the fundamental principles of each department in courses to be given during the freshman and sophomore year, and required of all students. The elements of surveying, hydraulics, mechanics, mechanism, heat engineering, electrical engineering and chemical engineering are given during this period. These are taught with a proper consideration for the coordination of theory and practice, and in some cases requiring the practice to precede the theory. Many of these subjects are taught by the heads of the respective departments.

A recent addition to the laboratories is in the Department of Electrical Engineering, which has completed the installation of apparatus for laboratory work in connection with its instruction in telephony. There are two complete central offices consisting of standard types of switchboards, terminal and power apparatus, etc., having a sufficient number of circuits equipped for any demonstration desired. One is a simple magneto office with a single-position switchboard. The other is a common-battery office with a three-position switchboard. The circuits are arranged to provide a toll, local and trunk position. Standard apparatus has been used throughout and recent practice followed in its arrangements so that the students may become familiar with the practical side of telephony as they study its principles.

Agricultural and Mechanical College of Texas

Equipment: Texas is essentially an agricultural state and is undeveloped in engineering. For this reason the chief lines of investigation, research and preparedness are along agricultural lines. The present equipment is ample for materials, dynamic, hydraulic, pneumatic, metallurgical, automotive, electrical, chemical, and other engineering instruction, research and study. A mechanical-engineering building is in course of construction and will enable the college to handle almost any kind of research in mechanical lines.

Curriculum: A few years ago changes were made which put the courses up to the standard courses of the country. Recently, modifications in the curricula were inaugurated to meet the needs of the country in military preparedness. A strong feature of the college is its military work. A Reserve Officers' Training Corps has been established and at the time of writing more than a hundred seniors and undergraduates have gone to the Reserve Officers' Training Camp. A number of seniors have also been sent to the different branches of the Naval service.

Purdue University

Faculty: An executive committee of fifteen members has been constituted which takes care of routine business and reports to the general faculty. The latter body retains the legislative power and controls all questions involving new rules. The executive committee meets twice a month and the general faculty once a month on stated days.

Engineering Experiment Station: This has been created for the conduct of research work in engineering. The dean of the engineering schools will be director of the station and will have associated with him the heads of the engineering schools in a board of management. The station will be in a position to extend the same assistance to the manufacturing industries and public utilities of the State as has been afforded the farmers by the agricultural station.

Short special courses will be started to prepare men for special Government service.

Research Work: Effect of flat spots on railroad car wheels; testing of side frames and low temperature effects on steel rails; testing once a month for the past twelve months, of a locomotive to determine the loss of efficiency due to boiler scale; study of the fire-carrying possibilities of locomotive

sparks at known temperature, testing of brake beams; work on carburetors, work on a bituminous gas producer; research on different kinds of pulleys and belt of different tannings; tests of two types of refrigerating cars; establishing a correct method of measuring heat and a proper rate of charge to the consumer using hot water or steam from a central heating station, comparative tests of all the bituminous furnace coals of Indiana with coals from Pennsylvania and Illinois; the possibilities of powdered fuel in stationary boilers.

The University specializes in Railroad Engineering and Gas Engineering.

RENSSELAER POLYTECHNIC INSTITUTE

Equipment: The laboratory is primarily fitted for instruction work. There has been no specialization.

Research: During the past year work on the determination of the coefficient of heat transfer through blocks of commercial insulation has been carried out.

Curriculum: A course in military engineering and instruction will be established next year.

MICHIGAN AGRICULTURAL COLLEGE

Equipment: The laboratories are provided with typical steam engines, gas engines, pumps, electric motors, air compressors and heating apparatus, the ordinary apparatus required for determining the strength of materials, etc.

Research Work: Carburetor behavior, tests on various kinds and makes of gasoline engines, problems involving repetition of stress in materials, and combined stresses in materials, such as combined torsion and bending, experiments on the power required to operate drills at various speeds and feeds.

Curriculum: A course in chemical engineering has been added.

WASHINGTON UNIVERSITY (ST. LOUIS)

Equipment: Laboratories are equipped to do research work on fuels, gas and steam appliances, automobiles, etc., and especially equipped for testing cutting tools.

Research Work: Tests have been made on steam-turbine nozzles, automobiles, and high-speed steel cutting tools, but the work may not be completed owing to the seniors carrying on the work being excused for military duty.

High-Speed Steel Alloys

A patent issued to Radclyffe Furness, of Jenkintown, Pa. (assignor to the Midvale Steel Company), states that if a certain amount of both cobalt and tungsten be added to an ordinary high-speed tool steel, containing tungsten, chromium and vanadium, a substantial increase in cutting efficiency is attained. The amount of uranium is so small that it cannot be said to replace the known high-speed tool-steel additions, its presence even in apparently negligible proportions improving the efficiency of the tools.

	Preferred analysis, per cent	Limiting proportions, per cent
Cobalt	4.5	3.0 to 7.0
Uranium	0.7	0.1 to 2.0
Tungsten	13.5	12.0 to 20.0
Chromium	3.5	2.0 to 6.0
Vanadium	1.5	0.5 to 2.0
Carbon	0.7	0.5 to 0.9

(1,233,862. July 17, 1917.) (*Metallurgical and Chemical Engineering*, vol. 17, no. 4, August 15, 1917, p. 191)

This Month's Abstracts

The latent heat of steam is a subject still attracting the attention of engineers.

In the present issue will be found an abstract of an investigation by Frank B. Aspinall, of interest because it establishes certain novel facts. Among other things the claim is presented that water can be present in steam in some form which is not a mechanical mixture, and further, that steam has a dewpoint like air.

The basic laws for heat of steam are enumerated, and values are offered for the latent heat of steam and heat latent, when absolutely no water is present, as well as for the constant representing pressure multiplied by the volume.

In the section Aeronautics is abstracted an article on measuring stresses in aeroplane wires by means of an instrument called a frequentiometer, which utilizes the phenomena of resonance for this purpose.

In the same section is presented a description of a German aeroplane possessing several features of interest, in particular the location of the radiators on the sides of the fuselage instead of in front.

In a paper before the American Society of Heating and Ventilating Engineers, Arthur K. Ohmes shows by a parallel series of determinations that the value of air flow cannot yet, except in the simplest cases, be determined by the application of the known formulæ and coefficients of resistance.

The influence of high temperature upon the elastic and tensile properties of wrought iron is discussed in detail by Frank A. Epp and E. Olney Jones. They come to the conclusion that for iron intended to be used at high temperatures a different factor of safety should be used than for iron used at low temperatures.

In a report abstracted from *Stahl und Eisen* through a British periodical, are given the results of experiments carried out in Germany with the view of ascertaining the influence of carbon, silicon and phosphorus on the mechanical strength of cast iron.

The practice of a central station of the Toledo Railways and Light Company in the use of combination coal and gas firing, reported in the section Firing and Fuel, indicates that the amount of coal burned per hour with the combination firing is practically the same as the amount burned when coal alone is fired. The efficiency of the boiler, furnace and grate was not materially improved by the use of combined firing, and the cost of evaporating water with the combined firing is 8 per cent higher than with coal alone; but on the other hand, an added evaporative capacity of 31 per cent was obtained with 50 per cent less investment than would be required with coal alone.

The quenching process, and in particular the influence of the surface factor, is discussed by Lawford H. Fry, member of the Am.Soc.M.E., in the abstract in the section Machine Shop. The writer, among other things, makes a careful distinction between the rate of loss of heat by the body subjected to quenching and its rate of loss of temperature, and shows that under certain conditions water-cooled pieces of steel may have the same properties as air-cooled pieces.

The brick-arch tests of the Pennsylvania Railroad, reported in the section Railway Engineering, present a good example of carefully conducted experiments on an interesting and difficult subject. These experiments appear to have established the fact that both the equivalent evaporation and the efficiency of the boiler are noticeably improved by the presence of the arch.

REVIEW OF ENGINEERING PERIODICALS

Aeronautics

NEW METHOD FOR REGULATING THE TENSION OF AEROPLANE WIRES BY MEANS OF A FREQUENTIOMETER.

Carlo Maurilio Lerici

In regulating the tension of aeroplane wires it is necessary that the distances between the ends of each wire should be constant, that symmetry of construction should be maintained and that the tension itself should not exceed a certain limit determined either practically or by calculation.

Since, however, in the vast majority of cases, this regulation is carried out in a purely empirical manner, it is not unusual that a difference of 30 to 40 per cent between the tensions of symmetrical wires in the same machine occurs, and quite often such differences do not produce any noticeable alteration in the symmetry of the aeroplane while it is at rest.

The process described in the present article is said to have been successfully tested out. It appears to be simple and susceptible of great precision. This method of measuring the tension of wires utilizes the phenomena of vibratory resonance and is analogous to that employed by Captain Largier in his musical tension meter.

The present apparatus is based on the application of the formula

$$T = \frac{4\,l^2 p n^2}{g} = K n_1^2$$

where T is the tension of the wire: l the length of the wire: p the weight of the wire per unit of length, n_1 the frequency of vibration and g the acceleration due to gravity, all in metric units. For a given wire, in order to determine the value of T, all that is necessary is to know that of n.

The present apparatus is so designed that n_1 can be measured directly. It is nothing else but a frequentiometer similar to that used for measuring the frequency of alternating currents, but more simple in construction and more convenient to handle.

As shown in Fig. 1, the apparatus consists of a series of steel plates of different lengths rigidly held at one of their extremities. In accordance with the usual formula the dimensions of each plate are in a relation with the natural period of oscillation of the plate expressed by the formula

$$t = \frac{1}{n} = \frac{8L^2}{\pi b (1.198)^2}\sqrt{\frac{5d}{6gE}}$$

where L is the length of the plate: b the radius of inertia of its section: g acceleration due to gravity: d density and E modulus of elasticity of the plate.

In accordance with the laws of resonance, when a plate rigidly held at one end is placed into light contact with a vibrating string, it obtains a very noticeable maximum oscillatory movement, provided its natural period of oscillation is

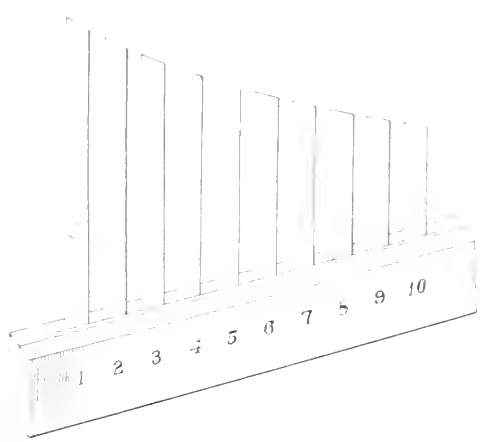

FIG. 1 FREQUENTIOMETER FOR DETERMINING THE TENSION IN AEROPLANE WIRES

equal to that prevailing at the instant in the wire. It is not even necessary that the plate be in direct contact with the vibrating wire, and it is enough that the support of a series of plates of a frequentiometer be placed in contact with one end of the vibrating wire. In this way there is no difficulty in determining the particular plate of which the natural period of oscillation is nearest to that of the vibrating wire. The proper selection of a set of plates makes it possible to secure indications of a far higher precision than can be obtained by the empirical methods employed in the majority of shops.

With the type of frequentiometer described there is a possibility that both the fundamental vibration and the secondary vibration may appear, if in the set of plates used there are two plates such that the period of one is twice as great as the period of the other. In practice, however, the series of plates employed reproduces only a limited number of vibrations. Furthermore, even should a case of multiple resonance be observed, all that would be necessary would be to consider only the indications of the plate having the least period.

In fact, for regulating the tensions of wires in the fuselage

[illegible] of modern medium powered machines (100 to 400 hp.), it is enough to have a set of plates of from 20 to 40 oscillations, and actually a dozen plates will give indications sufficiently precise for all practical purposes. With [illegible] the average error due to the presence of turnbuckles does not exceed five per cent.

The frequentiometer may be so designed as to have a scale in kilograms for each type of wire. If each plate has a mark showing its frequency, a corresponding tension in the wire may be found from a chart giving the interrelations of the frequency, the length of the wire, diameter (or weight per meter) and the tension. Two such charts are given in the original article. (Nouvelle méthode pour le réglage de la tension des haubans des aéroplanes au moyen d'un fréquencomètre, Carlo Maurilio Lerici, *Le Génie Civil*, vol. 71, no. 3, July 21, 1917, pp. 39-41, 5 figs., *d*)

The Albatros D.I "Chaser" Biplane

Description of the German Albatros "Bu" chaser scout machine.

Although being comparatively heavy and lacking the high speed and other performance qualities possessed by some of the machines of the Allies, it has proved a formidable fighter. The present description is based on a thorough examination of a machine brought down some six months ago on the British front.

The fuselage is of the monocoque type, built up entirely of wood without any wire bracing.

The arrangement of the planes, contrary to the usual German practice, has neither sweep-back nor dihedral, the top plane, in fact, being one complete unit. A somewhat novel feature consists of the method of adjusting the stagger of the top plane from 0 to 12 cm. by moving it along the top of the cabane. This is done in the following manner. In each end of the top horizontal tube of the cabane is formed a slot which receives an eyebolt passing through the main spar of the plane. Each slot has five holes passing horizontally through the tube, one of which, according to the adjustment required, receives the bolt that locks the eyebolt in the cabane. Only one pair of struts on each side of the fuselage separate top and bottom planes, these struts being of streamline steel tubing. The top fittings are slightly different from the lower ones, which are adjustable. The main spars are located well forward, the front ones being some four inches from the leading edge and spaced to fit $7\frac{1}{2}$ in. from the rear one. They are of rectangular section, fabric-bound, and are beveled off from the top at the extremities. The lower plane is attached to an abutment built out from and flushed with the side of the fuselage. The stabilizing plane, semi-elliptical in plan form, is divided into two parts and is exceptionally thick ($5\frac{3}{4}$ in.). It is non-lifting and is mounted in the line of flight without any external bracing. Hinged to the trailing edge of the stabilizing plane is a single elevator balanced by small triangular extensions forward of the outer extremities. The system of supporting the rudder and tailskid is described in detail.

The fuselage is a compromise between the formal standard Albatros system and the true monocoque type. In section it varies from circular at the nose to a horizontal knife edge at the rear and is flat-sided with rounded top and bottom in the center. The method of construction of the fuselage is described in some detail.

The radiators differ from those usually employed. They are of the honeycombed type and are mounted one on each side of the fuselage. Above and at the left of the camshaft is a flat water tank, one end connected to the engine jacket and the other end to the tops of the radiators. The lower orifices of the radiators are connected to the water pump at the rear of the engine. On each side of the engine is mounted a machine gun synchronized for firing through the propeller. (*Flight*, vol. 9, no. 26/444, June 28, 1917, pp. 628-641, illustrated, *d*)

Air Engineering

A Study in Air Measurements and Air Flow, Arthur K. Ohmes, Mem.Am.Soc.M.E.

Data of an interesting investigation bearing on the comparison of test results on one hand, and theoretical results of air movement on the other hand, with special reference to flow of air through small channels under very slight pressure differences.

Among other things, these tests have established that there are now fairly complete means available for engineers in conducting tests on air-flow measurements.

The writer checked the results of tests with such tests as would be theoretically derived by the application of proper formulæ, and found the following situation to exist: As regards the pressure differences necessary to drive a certain amount of air through a channel at an assumed velocity of 10 ft. per sec., he found for the square channel that, whereas the pressure was 0.092 in. of water, the test showed only 0.032 in., or a proportion of 1 to 2.88.

Likewise, in the case of the round channel, the proportion between the test magnitude and the theoretical value was as 1 to 2.5. In other words, the theoretical resistances are greater than the accurate testing results indicate them to be. On the other hand, nearly all coefficients are usually increased by the authors some 15 to 20 per cent for safety reasons.

As regards coefficients of resistance, the data do not appear to be entirely conclusive, but as regards the velocity of air secured under certain pressure differences, it was found that, whereas, according to theory, for a given pressure difference a velocity of 5.95 ft. per sec. would have been obtained with the square channel, and 6.2 ft. per sec. with the round channel, the actual velocities were in each case 10 ft. per sec., or 1.68 and 1.61 times as much as the theoretical values. (These latter neglect the very small frictional losses.)

Altogether, it would seem that tests of this kind cannot as yet be dispensed with, because we have scarcely sufficient coefficients of resistance at our disposal to determine flow of air in any but the most ordinary duct systems, and even this with no scientific accuracy. (*Journal of the American Society of Heating and Ventilating Engineers*, vol. 23, no. 4, July 1917, pp. 577-586, 9 figs., *et*)

Engineering Materials

The Briquetting of Metal Swarf

Third article of a series. The preceding two articles (*Engineering*, June 8 and 15) describe the advantages derived from the application of briquetting to scrap which has to be remelted in ordinary furnaces.

Taking British costs as a basis, it appears that the cost of briquetting in a plant which is kept constantly at work may not amount to more than, say, 25 shillings (say, \$6.00) per ton, including allowances for standing charges, such as overhead, depreciation, etc.

As regards machinery, the writer states that there is already

under construction by a British manufacturer a machine which is to have an output of some $6\frac{1}{2}$ tons per hour when dealing with non-ferrous scrap. The question of the size of the machine has an effect on the cost of briquetting per ton, the larger the machine, other things being equal, the less the cost per ton, provided enough material for the machine is available.

The briquets made by the larger non-ferrous machines are ordinarily in the form of a cylinder 6 in. long by 6 in. in diameter. According to a statement made to the writer by a representative of the Southwark Engineering Company, of Philadelphia, Pa., the approximate weight of briquets 6 in. long by 6 in. in diameter is as follows:

From steel turnings, 38-43 lb.
From iron turnings, 35-40 lb.
From copper turnings, 43-49 lb.
From brass turnings, 41-46 lb.
From aluminum turnings, 13-15 lb.

As regards the method of briquetting, a British engineer, who designed the plant mentioned in the earlier part of this abstract, has found, in the first place, that it is much better to use oil as the hydraulic fluid than water. He found that with oil, in addition to avoiding corrosion, the leathers last much longer and the cost of repairs and renewals is considerably decreased. Further, he has found that there is a distinct tendency for the molds to become barrel-shaped, so that if they form an integral part of the mold table, the expense of putting them right is very high. He has, accordingly, made the molds entirely separate from the table, and when they become worn he simply removes them and replaces them by others, this being done at much less cost and much more quickly than repairing molds on the table.

As regards binders, he has found that the employment of a suitable binding material is a most important factor in the production of successful briquets. He himself uses a mixture of linseed oil and resin melted together and mixed with the scrap. The proportions here recommended are about $22\frac{1}{2}$ lb. of oil and $1\frac{1}{2}$ lb. of resin to the ton of scrap. The briquets were made with this binding material and dried for 12 hours in an oven. He also lays great emphasis on the necessity for employing heavy pressures. For the non-ferrous briquets which he is making he puts on a maximum pressure of 180 tons dead load, which means an actual pressure on the scrap of about $21\frac{1}{2}$ tons per sq. in. (*The Engineer*, vol. 123, no. 3208, June 22, 1917, pp. 557-558, 2 figs., *d*)

The Influence of High Temperature Upon the Elastic and Tensile Properties of Wrought Iron.

Frank A. Epp and E. Olney Jones

The modern use of iron and steel under stress at temperatures considerably above the usual range makes an investigation in this field of possible commercial and engineering value.

For metals at ordinary temperatures, the use of a proper factor of safety brings the stress for which the piece is designed well within the elastic limit. But, as the results of this test would indicate, at higher temperatures this design factor of safety will have to be modified greatly or the work will have to be designed wholly on the basis of the elastic limit.

As examples of the employment of iron in stressed condition at high temperatures, the writer quotes the following: Temperatures of superheated steam vary now from 450 to 550 deg. fahr., and the strength of tubes, valve stems, etc., as affected by these temperatures, is, indeed, worthy of serious consideration. Other examples of the same condition are encountered in boiler construction, metal rigging above large crucibles or ladles carrying molten metal, etc.

In the present series of tests wrought iron was brought to the desired temperature in an electric furnace (and was, therefore, not affected by the gases of combustion), and then submitted to various physical tests.

The article describes in detail the apparatus used, methods of calibration and conduct of tests. As regards the apparatus, the most interesting piece used was the extensometer rigged up for this purpose. While very simple in construction, it has a least count equal to 0.0002.

A complete summary of all tests is given in the accompanying curves.

From these results it appears that the ultimate tensile strength of wrought-iron bars increases as the temperature increases from 70 deg. fahr., until a maximum is reached between 350 deg. and 550 deg. fahr.

From the temperature of maximum strength the tenacity diminishes rapidly until the highest temperatures covered by these tests are reached.

The greatest gain over the strength of the metal at 70 deg. fahr. was 37.6 per cent. This occurred at 430 deg. fahr., as judged from Fig. 2. The loss at 1000 deg. fahr. over the strength of the metal at 70 deg. fahr. was 53.5 per cent. A continuation of the curve at 1200 deg. fahr. indicates a loss in strength of 75 per cent.

The elastic limit appears to decrease from 70 deg. fahr. to about 270 deg. fahr., showing a maximum decrease of about 13 per cent. From that temperature the elastic limit appears to increase suddenly to about 350 deg. fahr., where it reaches its maximum value of about 10 per cent above the stress at 70 deg. fahr. From here on it gradually drops, and at 1000 deg. fahr. shows a loss of 70 per cent over the elastic limit at 70 deg. fahr.

Owing to a period of rapid yielding without increase of stress, the yield point is well defined at moderate temperatures. This yield point, however, vanishes at about 500 deg. fahr., and the stress-deformation curve assumes a gradual slope from the start to finish.

With reference to elongation under stress, this peculiarity is noticed: that greater rigidity exists under certain stresses

The physical properties of wrought iron are materially affected by high temperature.

The ultimate tensile strength increases as the temperature increases from 70 deg. fahr. until a maximum is reached between 350 deg. and 550 deg. fahr.

Tenacity diminishes rapidly with increase of temperature.

The elastic limit appears to decrease from 70 deg. fahr. to about 270 deg. fahr., showing a maximum decrease of about 13 per cent. From that temperature the elastic limit appears to suddenly increase to about 350 deg. and then gradually drops.

The curve of elongation versus temperature is irregular.

For iron intended to be used at high temperatures a different factor of safety should be adopted than the one for iron used at low temperatures.

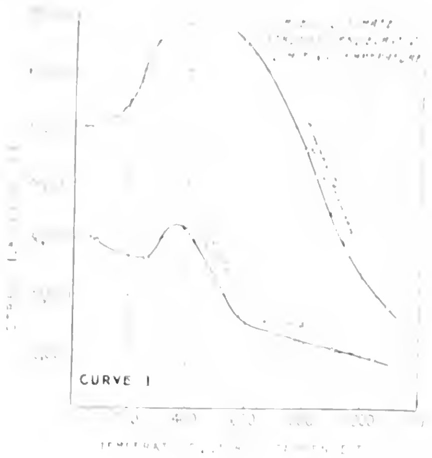

FIG. 2 CURVES OF ULTIMATE STRENGTH AND ELASTIC LIMIT VERSUS TEMPERATURE FOR WROUGHT IRON

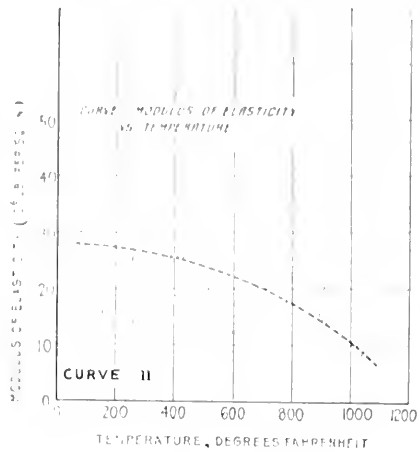

FIG. 3 CURVE OF MODULUS OF ELASTICITY VERSUS TEMPERATURE FOR WROUGHT IRON

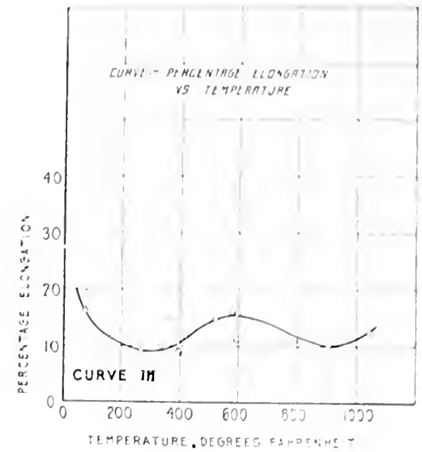

FIG. 4 CURVE OF PERCENTAGE ELONGATION VERSUS TEMPERATURE FOR WROUGHT IRON

at intermediate temperatures than at either higher or lower temperatures. Thus it will be noticed in Curve III that at 300 deg. fahr. and 900 deg. fahr. the metal shows only about half the elongation that it shows at 70 deg. fahr. It is surmised that beyond 1000 deg. fahr. the curve gradually rises and the metal exhibits powers of greater ductility as it approaches a workable heat.

Other remarkable features in the elongations are found in bars tested at temperatures varying from 200 deg. to 400 deg. fahr., in which there are displayed alternate periods of rigidity and relaxation under increasing stresses.

It will be readily observed how irregular Curve II is beyond the yield point. Some of the tests taken at this temperature showed even greater irregularity. The repetition of these intervals of rigidity and relaxation is suggestive of some remarkable change taking place within the metal in this zone of temperature, conspicuous in a series of tests possessing many remarkable features.

The contraction of area at the place of rupture varies with the temperature of the bar. It appears that the contraction of area of wrought-iron bars is a great deal less between 200 deg. and 600 deg. fahr. than at 70 deg. fahr., and within this range of temperature there is a tendency to fracture obliquely across the bar.

The results obtained for the modulus of elasticity have very little value, except that they indicate a gradual decrease.

It is shown conclusively that should similar iron be used in work where the design factor of safety was five, and where the temperatures were 900 deg. fahr. or above, the part under consideration would be stressed beyond its elastic limit if the allowable stress was applied. Furthermore, at that temperature the factor of safety on the ultimate strength would be reduced to three. Curve I shows the relation of ultimate strength and elastic limit throughout the complete temperature range.

For tubes, valves, pipe lines, etc., carrying superheated steam, Curve I shows that at 600 deg. fahr. the elastic limit has fallen 50 per cent of its value at ordinary temperature. Hence a design factor of safety in superheater construction should be so modified as to give an ample factor on the elastic limit at this temperature. Assuming that the factor of safety is five on the ultimate strength at 70 deg. fahr., this would be equivalent to a factor of three on the elastic limit at the same temperature. Therefore, considering that the metal should never be stressed to more than one-third of its elastic power, at 600 deg. fahr. the factor of safety would have to be ten on the ultimate strength of the metal at 70 deg. fahr.

Reference to Curve III indicates that the metal is very brittle between 150 deg. fahr. and about 1100 deg. fahr. Where this state exists, it is, of course, impractical to work the metal. In other words, it would be better to work the metal cold than at 200 deg. fahr., at which temperature it might fracture without warning. Nine hundred degrees fahrenheit is even a more critical point, for here the ultimate strength and the elastic limit have dropped to less than half their original values.

The conclusions attained are rather startling. The wide fluctuations in the physical properties are not generally realized.

A brief bibliography of the subject is appended. (*Metallurgical and Chemical Engineering*, vol. 17, no. 2, July 15, 1917, pp. 67-71, 6 figs., *eA*)

THE METALLURGY OF FERROCHROMIUM. Robert J. Anderson

An article of a general nature describing the manufacture of ferrochromium and chromium steel and outlining the use of the latter.

Chromium in steel does not act as a scavenger, nor does it confer soundness on the steel as do silicon and aluminum. But added in small amounts it increases the tensile strength of the steel to some extent without markedly decreasing its ductility. When added in excessive amounts it causes brittleness.

The effect of chromium when added to steel is to raise the normal critical range, thus causing changes to take place at high temperatures and also more slowly. Hence, chromium steels are harder than ordinary steels, because quenching more effectively prevents the transformation of the austenite. When added to iron, chromium does not materially harden the metal. Chromium steels contain from 1 to 4 per cent or more of chromium, and the carbon may range from 0.50 to 2 per cent. (*The Iron Trade Review*, vol. 61, no. 2, July 12, 1917, pp. 75-78, 3 figs., *g*)

PROPERTIES AND STRUCTURE OF NICKEL STEEL. S. W. Parker

Data of experiments made at the testing department of the Bethlehem Steel Company at Steelton, Pa., in order to

determine the best annealing temperatures for two grades of 3.50 per cent nickel steel, commonly used for forgings.

The test bars used were forged down to 1 in. sq. by 6 in. long from two 4 x 4-in. billets of different grades. The writer describes in detail the methods of testing and states that the minimum hardness and tensile strength were obtained by annealing at between 1250 and 1350 deg. fahr., at which temperatures the structure had only started to break up and refine. The property most affected by annealing is the elastic limit. This was increased from 41,000 lb. per sq. in. in the unannealed bar to 50,000 per sq. in. in the bar annealed to 1400 deg. fahr., in which the grain was the finest in the series. This increase in elastic limit by refinement of grain plays an important part in annealing forgings, especially when the specifications require high elastic limits together with good ductility.

The best combination of physical properties in the case of 3.50 per cent nickel steel of 0.22 per cent carbon is obtained by annealing at a temperature ranging between 1400 and 1450 deg. fahr.

A similar series of tests on nickel steel of 0.41 per cent carbon indicated a general similarity in the properties. For this steel the best combination of physical properties is obtained by annealing at between 1350 and 1450 deg. fahr., the minimum temperature being lower than in the case of 0.22 per cent carbon steel. (*The Iron Age*, vol. 100, no. 2, July 12, 1917, pp. 67-69, 18 figs., *e*)

Metallurgy of Cast Iron

Mr. A. Stadeler, in recent issues of *Stahl und Eisen*, reports the results of experiments carried out by F. Wust and his pupils with a view of ascertaining the influence of carbon, silicon and phosphorus on the mechanical strength of cast iron. Various mixtures were prepared of Swedish charcoal pig with Swedish horseshoe iron, the silicon, manganese and phosphorus contents being varied by the addition of ferroalloys. As square or rectangular test bars are liable to develop a white iron at the edges, test bars cast round and turned down were used in the experiments. The quantity and character of the graphite appear principally to determine the mechanical properties, but these are materially influenced also by the pouring and method of cooling. With gray iron containing 1.5 per cent of silicon, small quantities of manganese, up to 0.3 per cent, increase the formation of graphite, but a further increase to 2.5 per cent has no influence. Cast irons high in phosphorus, contrary to existing ideas, may be improved by the presence of 1 per cent of manganese, or more, provided the rest of the ingredients has been fixed properly. With a rise in the proportion of graphite the strength of the iron in tension and bending falls off, as a rule. This is also the case with an increase in the percentage of carbon and silicon, both of which favor the formation of coarse graphite. With increase of phosphorus up to 0.3 per cent, and of manganese up to about 1 per cent, the strength in tension and bending increases. Phosphorus up to 0.3 per cent and also high graphite content enhance the bending strength, while manganese and silicon have the opposite effect. The resistance to specific impact shows the greatest sensitiveness to silicon, manganese and phosphorus. It diminishes rapidly as the phosphorus content rises until this reaches 0.6 per cent, above which the decrease is considerable. This property brings out the superiority of irons low in phosphorus, in respect of resistance to impact, which the tensile and bending tests fail to reveal. Hardness decreases with a rise in graphite content and is increased by a rise in manganese and phosphorus. It does not seem to be affected by the silicon content, but the physical properties of cast iron depend not only on the percentage but also on the character of its graphite content, and an explanation of the difference in the physical properties of test pieces containing the same percentages of carbon can be readily found by an examination of their microstructure. (*Page's Engineering Weekly*, vol. 31, no. 670, July 13, 1917, p. 19, *g*)

Firing and Fuel

Combination Coal and Gas Firing, Alex W. Morgan

Description of the Water Street Station of the Toledo Railways and Light Company, where conditions were such as to make it advisable to use this system of operation.

A large number of boilers of the company are now equipped for combined firing. At first gas alone was burned under six type S 475-hp. Stirling boilers equipped with McKinzie grates. These grates were partly covered with asbestos and a space of 12 in. wide was left uncovered for a secondary air port. The front of this air port was 40 in. from the burner tips and flush with the nose block of the ignition arch. Over this entire grate surface was spread firebrick crushed to the size of an egg, a layer varying in thickness from about $2\frac{1}{2}$ in., at the burner tips to 7 in. at the bridge wall. This cover deflected the flame and prevented it from striking the tubes directly. With this arrangement it was found that the rating was limited and the installation lacked flexibility.

To burn the gas directly above the coal in combination with it, a special tile with a 2.5-in. hole was developed and set so that the gas, when introduced into the firebox, was directed down against the coal. This tile was placed in the ignition arch next to the grate. All primary air was shut off and the gas in the firebox made to depend upon the secondary air coming through the fuel bed for its combustion.

Tests were then made to determine accurately the performances of the boilers thus equipped. The boiler used for these tests is of the Stirling type with a heating surface of 6680 sq. ft. and a superheating surface of 256 sq. ft., designed to deliver steam at 200 lb. per sq. in. pressure and 100 deg. fahr. superheat at rating.

The results obtained indicate that the amount of coal burned per hour with the combination firing was practically the same as the amount burned when coal was fired, and hence the additional rating developed was the result of the introduction of gas in the furnace. This additional rating was 31 per cent over that obtained with coal alone.

The temperature of the flue gases leaving the boiler was 43.4 deg. fahr. higher with the combination than with coal alone. The stack temperature during the tests was considered to be too high, and it was found that better results came from getting a lower stack temperature with the combination than from coal alone.

The efficiency of the boiler, furnace and grate was not materially improved by the use of the combination.

One of the conclusions arrived at is that the cost of evaporating 1000 lb. of water from and at 200 deg. fahr. is 8 per cent higher for the combination fuel than for coal alone, and 21 per cent higher for gas alone than for coal alone (taking the cost of fuel as it was at the time of the tests, November 1916). Nevertheless it was calculated that the added capacity with the combination fuel was obtained at 50 per cent less investment than would have been required with the coal.

Considering the situation from an operating standpoint the company obtained 31 per cent added capacity with an 8 per cent increase in the cost of producing a pound of steam. With the increased cost of coal becoming operative, this increase in cost over the cost of coal to produce a pound of steam would be offset.

The original article gives also a set of curves showing points at which combination coal and gas firing is economical. Another illustration in the original article shows two boiler-meter records of tests, one where coal alone was burned and another where gas and coal were fired in combination. (*Electrical World*, vol. 70, no. 2, July 14, 1917, pp. 52-54, 4 figs., *e*)

The Value of Peat Fuel for the Generation of Steam, John Blizard

Report forming the third and last of a series comprising the investigation undertaken some years ago by the Department of Mines of the Dominion of Canada to determine the value of peat fuel for the production of power. The former reports, entitled Utilization of Peat Fuel for the Production of Power, and Peat, Lignite and Coal, dealt mainly with the production of power through the media of gas producers and internal-combustion engines, while this report sets forth the results obtained with peat when burned on the grate bars of two distinct types of steam generators.

Results show that under favorable conditions and circumstances peat fuel can be economically employed for the production of power by steam, but the controlling factor which determines the feasibility of using peat fuel for steam generation is the cost of producing this form of fuel and delivering it to the steam plant in a sufficiently dry state. Not only this cost of peat fuel delivered to the plant must be less than that of a quantity of good steam coal equivalent in heating value, but it is important to bear in mind that peat fuel, as commercially produced today, is much bulkier than coal equivalent in heating value. Hence, the problem of storage of peat fuel assumes important proportions.

Speaking generally, it is safe to say that peat fuel for steam-raising purposes cannot compete with good steam coal costing \$5 and less per ton. It appears, therefore, that in the majority of cases the more economical method of procedure with respect to peat utilization is the conversion of the peat fuel into a combustible gas which can be burned in a gas engine in this form, or used for the different heating furnaces in metallurgical work.

The above is taken from a preface to the investigation written by B. F. Haanel, Chief Engineer, Division of Fuels and Fuel Testing of the Department of Mines, Canada.

The trials themselves, described in the present report, were made partly on a Babcock & Wilcox water-tube boiler and partly on an internally fired boiler of portable locomotive type. The fuel used was manufactured by the Anrep process and had a moisture content of 16 to 20 per cent, which is rather low for this class of fuel. Hence, care should be taken when estimating the steaming properties of peat to allow for this fact. Further, the peat was of excellent quality, contained only a small percentage of dust, and throughout the series was hand-fired by an experienced fireman.

From tests on the water-tube boiler, conclusion is drawn that the most efficient grate bar would be one having an air space sufficiently large to permit the ash to fall through without taking an undue proportion of combustible with it.

It was also found that the ratio of free oxygen to combined oxygen in the flue gases increased with increased combustion per square foot of air opening. Probably, because as the draft increased, the supplementary air supply over the bars also increased, or it was the smaller air spaces that decreased the facility for the removal of ash by gravity, thus leaving the combustible portion of the fuel less accessible to the air.

As regards the flue-gas losses, the contents of carbon monoxide appear to be unusually high, and in addition to that, other gases were present. In fact, it may be taken as a rough approximation that the unused energy in these gases amounts to one-half of that remaining latent as carbon monoxide.

On the whole, the peat used proved to be a good fuel, easily handled and giving no trouble due to clinker or ash. It burned with a long flame and considerable light-colored smoke. The best results were obtained with the fuel consumption of 15 lb. per sq. ft. of grate, and the highest efficiency was obtained with the fuel highest in moisture content. Efficiency, however, was, on the whole, low, which may be attributed in part to the superheated steam in the flue gas, as well as losses due to unburned hydrocarbons and hydrogen. In fact, the total loss due to unburned gases was so high as to warrant the design of a large specially constructed combustion chamber in order to insure more complete combustion when burning this fuel.

Table 1 gives a synopsis of the results of trials with the water-tube and fire-tube boilers, respectively. (*Canada Department of Mines, Mines Branch Bulletin No. 17*, Ottawa, 1917. 42 pages, illustrated. *eA*)

TABLE 1 RESULTS OF TRIALS OF BOILERS FIRED WITH PEAT FUEL

	Water-tube Boiler			Fire-tube Boiler		
No. of Trial	71	72	73	83	84	85
Net calorific value of fuel as fired, B.t.u. per lb.	7490	7490	6990	7130	6970	7110
Peat fired per hour, lb.	476	586	569	160	214	341
Peat fired per sq. ft. of grate surface per hour, lb.	20.5	15.5	15.0	17.7	23.8	37.9
Equivalent evaporation per hour from and at 212 deg. fahr., lb.	1950	2322	2250	621	802	1054
Equivalent evaporation per hour per sq. ft. of heating surface, lb.	2.88	3.43	3.32	2.89	3.73	4.9
Pounds of dry flue gas per lb. of peat	12.4	9.8	11.1	9.8	9.1	6.5
Temperature in flue leaving boiler, deg. fahr.	720	760	715	690	690	750
Equivalent evaporation from and at 212 deg. fahr. per lb. of peat as fired, lb.	4.10	3.96	3.95	3.89	3.74	3.09
Thermal efficiency of boiler, furnace and grate, based on the net calorific value, per cent	53.1	51.3	54.8	52.9	52.1	42.2

Hydraulics

The Friction of Water in Iron Pipes and Elbows, F. E. Giesecke

Data and description of a series of experiments carried out by the Division of Engineering, Bureau of Economic Geology and Technology of the University of Texas, in November 1916, to determine the friction of water in standard American pipes and fittings.

The data are presented in the form of curves, expressing the friction of flow of water in various pipes at different velocities.

Equation showing the relation between the friction (h) and the velocity (v) for clean iron pipes ranging in size from ½ to 3 in. when the water has a temperature of about 68 deg. fahr. and flows at velocities up to 3 ft. per sec.:

$$h = 0.00685 \frac{v^{1.77}}{d^{1.275}}$$

Friction of water at temperature of about 68 deg. fahr. in one standard short-radius steam elbow:

$$h = 0.0141 \frac{v^{1.96}}{d^{0.26}}$$

From Fig. 5 the equations showing the relation between the friction and the velocity for 1¼-in. black pipe are for the line *GH* (below critical velocity)

$$h = 0.00925\ v^{0.87}$$

and for the line *HI* (above the critical velocity)

$$h = 0.004675\ v^{1.756}$$

Other pipes ranging in size from ½ to 3 in. were tested, the results plotted and the friction for 1 ft. of pipe was determined.

In order to derive an equation applicable to pipes of different sizes the coefficients and exponents of v in the equation

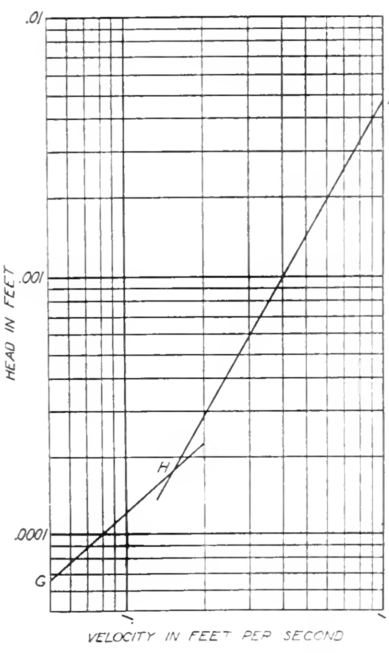

Fig. 5 Diagram Showing the Friction of Water in 1 Ft. of Pipe at Different Velocities

$h = kv^n$ were plotted, and from this diagram was derived the following approximate equation:

$$h = 0.00685 \frac{v^{1.77}}{d^{1.275}}$$

(A more accurate equation is given in the original article.) This equation applies to water having a temperature of about 68 deg. fahr. flowing through clean iron pipes ranging in size from ½ in. to 3 in., and with velocities up to 3 ft. per sec.

A series of tests was also made to determine the effect of galvanizing and incrustation on the friction in pipes and equations were derived. From these tests it appears that the exponent of v in the expression for h increases with the roughness of the interior surface of the pipe. On the other hand, tests with water at temperatures varying from 70 to 140 deg. fahr. showed that the friction decreases as the temperature increases, and that the decrease is due to a change in the coefficient of v rather than to a change in the exponents.

An interesting series of tests was made to determine the friction in an elbow (Fig. 6). This friction may also be represented by the expression $h = kv^n$. The two heavy lines show, as nearly as possible, the average values of k and n, and from them the expression

$$0.0141 \frac{v^{1.96}}{d^{0.26}}$$

was determined as representing the friction of water at the

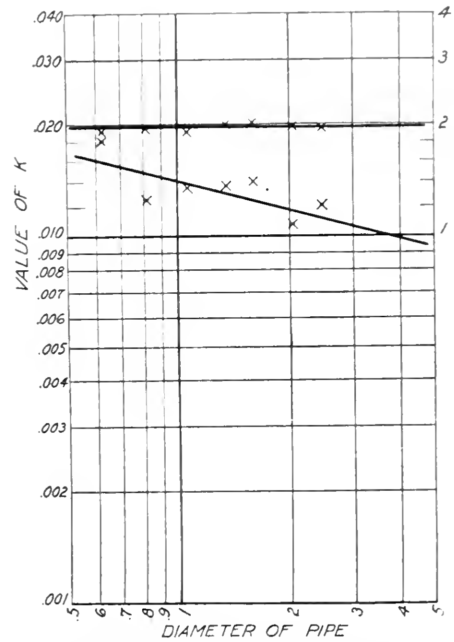

Fig. 6 Diagram Showing the Relations of Coefficients and Exponents of v for Elbows of Different Sizes

temperature of about 68 deg. fahr. in one standard short-radius steam elbow.

In the original article a diagram is given showing the number of feet of straight pipe equivalent in friction to one elbow for any velocity of flow.

A bulletin giving a full report of the tests will be issued by the University of Texas as early as possible and will be sent free to all persons requesting a copy so long as the supply lasts. (*Journal of the American Society of Heating and Ventilating Engineers*, vol. 23, no. 4, July 1917, pp. 587-594, 6 figs. *et*)

Hydraulic Billet Breaker

Description of a 200-ton hydraulic billet breaker recently erected at a works in Yorkshire.

As shown in Fig. 7, the present machine, which is designed for breaking steel bars of 55 tons tensile strength into 16-in. lengths, has top and bottom notching blades provided in the form of an equilateral triangle, so that when worn they may be reversed in the dies and thus give three cutting edges. In this way the necessity for nicking the top side and then turning the billet over to break it is eliminated.

The bar to be cut is fed over a spring-supported roller, which carries it clear of the bottom knife and allows it to be fed up to the adjustable stop at the dead end. The ram which carries the top notcher is 20 in. in diameter and has a stroke of 12 in., with a working pressure of 1500 lb. per sq. in.

After the bar has been notched on both sides by a stroke of the ram, the lower knife, which has an easy fit in its die, is withdrawn by means of the handle and the bar is broken by a second stroke of the ram. The machine has an output capacity of 38 billets per hour. When dealing with particularly soft material it might be found necessary to turn the bar, so as to notch it on all four sides.

Attention is called to the fact that the operating lever is placed at the side and not at the front of the machine as in earlier designs. The ram is actuated direct from the pump, which is of the vertical three-throw type with plungers $2\frac{1}{2}$ in. in diameter by 6-in. stroke. It is driven by a 25-hp. motor through a double-helical gear enclosed in an oiltight casing.

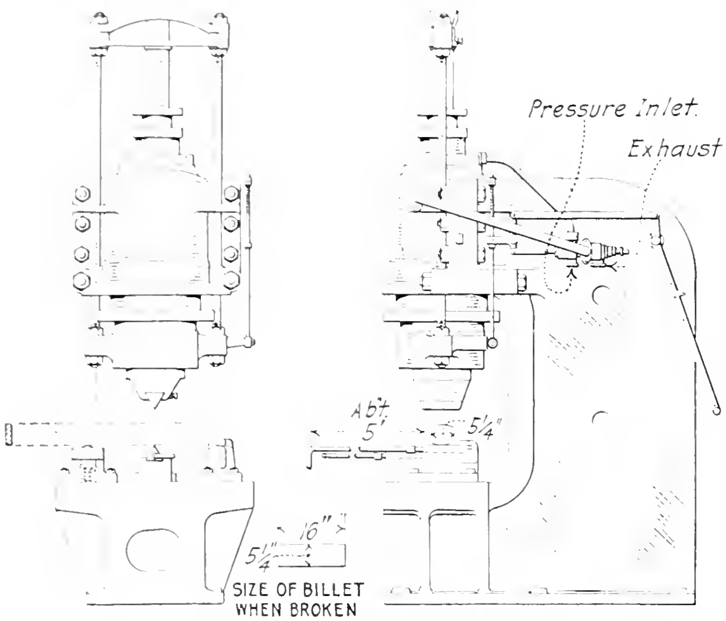

FIG. 7 BRITISH 200-TON VERTICAL HYDRAULIC BILLET BREAKER

The pump plungers are fitted with a weight-controlled relief valve, and this weight is so arranged that it may be thrown over and thus relieve the pressure of the pump plungers when the breaker is not in actual duty. In this latter connection the writer mentions, however, that a serious defect in the use of this reliever device lies in the fact that experience has shown that such devices are seldom made proper use of so long as their neglect does not interfere with the proper operation of the plant. (*Page's Engineering Weekly*, vol. 31, no. 670, July 13, 1917, pp. 17-18, 2 figs., *d*)

Machine Shop

SURFACE FACTOR IN QUENCHING EXPERIMENTS. Lawford H. Fry, Mem.Am.Soc.M.E.

Data of experiments carried out with the purpose of studying the rate of cooling in various quenching media and of connecting the rate of cooling with the physical properties obtainable in quenched and tempered forgings.

The main series of experiments was carried out with two

> ***In quenching, the rate at which heat is lost per unit of surface is determined by a quenching medium, but the physical properties of steel are determined by the rate at which temperature is lost, that is, the rate at which heat is lost per unit of weight.***
>
> ***The rapidity of cooling depends on:***
>
> ***a—Intimate contact between fluid and object to permit transfer of heat from object to fluid;***
>
> ***b—Free flow of fluid to remove heated or vaporized fluid from the surface of the object.***

locomotive driving axles, which were drilled so that a pyrometer could be inserted and the temperature of the axle measured continuously during the process of quenching. One axle was 11 in. in diameter and forged solid. The other was 12 in. in diameter and bored longitudinally with a 3-in. hole. The quenching media experimented with were air, water, and heavy oil of 26 deg. B. gravity, a light oil of 29 deg. B. gravity, and three strengths of a cutting compound dissolved in water. This cutting compound, which was composed of mineralized lard, oil and soft soap, was used in solutions of 50 per cent, 33 per cent and 25 per cent. The cooling curves for twelve experiments are given in Fig. 8. Of these twelve experiments eight were made with a solid and four with a bored axle.

These curves indicate that the bored axle cooled more rapidly than did the solid axle in the same medium.

Further tests with a small test piece indicated that in a given medium the heat is given up by the big axle and the small test piece had practically the same rate in B.t.u. per sq. in. of surface, which makes it probable that fairly accurate information as to the quenching properties of a medium can be obtained from small-scale experiments..

It must be remembered, however, that the physical properties of steel are determined not by the rate at which heat is lost per unit of surface, but by the rate at which heat is lost per unit of weight, that is, by the rate at which temperature is

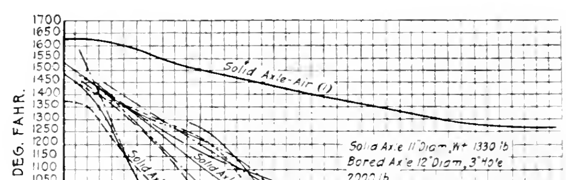

FIG. 8 COOLING CURVES IN QUENCHING EXPERIMENTS

lost. From data presented in the paper it appears that the rate at which heat is lost per unit of surface is determined by the quenching medium, while the physical properties of the steel are determined at the rate at which temperature is lost. Furthermore, the rate of temperature loss depends both on the quenching medium and on the form of object quenched, the latter being the more important factor.

The writer, together with some other investigators, claims

that the only scientific method of defining heat treatment in connection with physical properties is not to speak of "water quenching" or "air cooling," but to give the rate of temperature loss over a given range. To show how indefinite is the expression "air-cooled," the writer cites from the present test the fact that the test piece lost heat at the rate of 120 deg. per min. Hence, although the rate of cooling would be somewhat slower if it were averaged over a longer temperature range so as to include the recalescent period, still the rate at which the test piece cools in the air is of the same order as the rate at which the axle cools when quenched in water. Consequently the physical properties of the "air-cooled" test piece and the "air-cooled" axle will differ as widely as the properties of the "air-cooled" axle and of the "water-quenched" axle.

As regards the quenching speeds and composition of media, the experiments have not been complete enough to establish a theory of quenching action, but justify the conclusion that to have rapidity of cooling it is necessary to have first an intimate contact between fluid and object to permit transfer of heat from object to fluid, and second, free flow of fluid to remove heated or vaporized fluid from the surface of object.

A noteworthy feature is the great acceleration in cooling produced by a forced agitation of solution. Likewise the more rapidly cooling system produced with a light oil in comparison with heavy oil is evidently due to the greater fluidity of the former which enables more rapid convection currents to be set up and carry off the heat. (Paper before the Annual Meeting of the British Iron and Steel Institute, London, May 3-4, 1917, reprinted in the *American Drop Forger*, vol. 3, no. 7, July 1917, pp. 239-241. 1 fig., *e*)

Measurements

An Aneroid Calorimeter for Specific and Latent Heats, Nathan S. Osborne

The unstirred type of calorimeter has been embodied with important refinements in an instrument especially designed for determinations of specific heat and latent heat of refrigerating media. Heat developed and measured electrically is distributed automatically to the calorimeter and contents whose temperatures are measured by a platinum thermometer. Heat from other sources is excluded by a null method.

The calorimeter is adapted for use between minus 50 deg. and plus 50 deg. cent. In experiments where the measured heat added is used either to change the temperature of the contents or to evaporate a portion of the contents withdrawn as superheated vapor; in the first case, the specific heat of the liquid, and in the second, the latent heat of vaporization being obtained when proper corrections are made. (*U. S. Bureau of Standards*, Scientific Paper No. 301, advance abstract)

The Relative Sensibility of the Average Eye to Light of Different Colors and Some Practical Applications to Radiation Problems, W. W. Coblentz and W. B. Emerson

This paper gives data on the relative visibility of radiation of the average eye, based upon a group of 130 observers. The data were obtained by means of a flicker and an equality-of-brightness photometer. The energy evaluation of the light stimulus was made with great care.

The point of maximum visibility of the average eye is at $\lambda = 0.5576\mu$. A mathematical equation is given of the average visibility curve, which is applied in calculating the luminous energy emitted by a black body at various temperatures and the mechanical equivalent of light. The eye responds to light having an intensity less than 1×10^{-16} watt per cm². The paper describes tests on diffused light and on a physical photometer. A screen is described which transmits radiations proportional to the average eye. (*U. S. Bureau of Standards*, Scientific Paper No. 303, advance abstract)

Mechanics

Effect of Countershaft Speed Ratio on Power and Torque, Prof. A. Lewis Jenkins, Mem.Am.Soc.M.E.

A study of the two different combinations of countershaft speeds, back-gear ratios, and cone-pulley ratios for a pump-driven machine. An example is worked out for each combination, showing the belt speeds, horsepowers and spindle torques.

In the operation of cone-driven machines the consecutive spindle speeds may be obtained in a number of different ways by effecting various combinations of countershaft speeds, back-gear ratios and cone-pulley ratios. But there are two ways in use which require different cone-pulley ratios and ratios of countershaft speeds, and these are as follows:

First, the consecutive spindle speeds are obtained by starting with the slow countershaft speed, the largest back gear and the belt on the largest step of the head cone, which gives the first cone-pulley ratio. The change from the first, or slowest, to the second spindle speed is accomplished by merely changing the countershaft speed from slow to fast. For the next change of speed it is necessary to change the belt from the first to the second step on the head cone and change the countershaft speed from fast to slow. The fourth speed is then obtained by merely changing the countershaft speed from slow to fast.

The next case is where the back-gear ratios are used in the same way as in the preceding case, but the countershaft speeds and steps on the cones are not.

The slowest spindle speed is here obtained by using the slowest countershaft speed and the largest step on the head cone. In changing from the first to the second and from the second to the third spindle speeds it is only necessary to shift the belt from one step to the next. The fourth speed is obtained by using the fast countershaft speed with the belt on the largest step of the head cone, while the next two spindle speeds are obtained by using the second and third cone-pulley ratios with the fast countershaft speed.

The article gives formulæ for the back-gear ratios, cone-pulley ratios for duplicate cones and for the countershaft speeds.

An example is worked out numerically and covers the determination of the back-gear, cone-pulley and countershaft speed ratios for a machine of given dimensions having three steps on the cone-pulley and two back-gear reductions. In this connection the comparative merits of the two systems outlined above are discussed. (*American Machinist*, vol. 47, no. 2, July 12, 1917, pp. 49-51. 3 figs., *(p)*)

Railway Engineering

Brick-Arch Tests, Pennsylvania Railroad

Data of tests made by the Pennsylvania Railroad to show the value of the brick arch as a means of conserving fuel. These tests were made in Altoona on a Mikado-type locomotive.

The boiler equipment was of the Security sectional type. All tests were hand fired, the fuel used being Jamison coal, bituminous, high volatile, sized by being passed over a screen having 1½-in. openings. The screening and the use of coal from a single mine were resorted to, because preliminary tests had demonstrated the need of uniformity in the size of coal for the test.

On the whole, the tests have demonstrated marked advantages which can be ascribed to the use of the arch, summarized in the report as follows:

a The maximum evaporation when using high volatile coal was increased [illegible] per cent by the use of the arch.

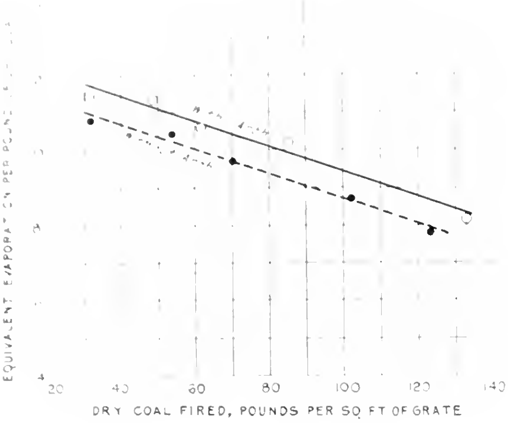

Fig. 9 Rate of Evaporation Per Pound of Coal, Brick-Arch Test

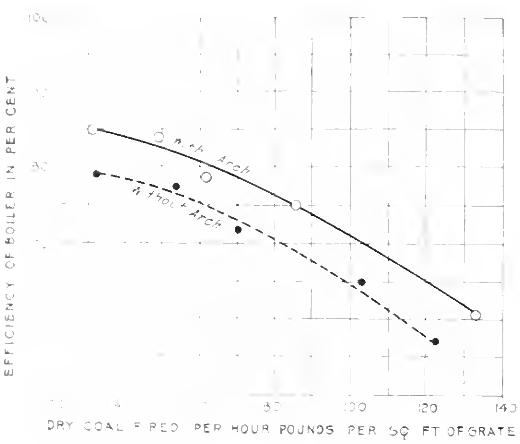

Fig. 10 Rate of Firing and Efficiency of Boiler, Brick-Arch Test

b With the arch a lower smoke density is measured by the Ringelmann scale.

c The arch increased the evaporation per pound of coal, and for ordinary rates of working this increase of evaporation represents an economy in coal of from 6 to 8 per cent.

This effect of the arch on evaporation was evident at all rates of combustion, as shown by Fig. 9. At maximum capacity the boiler when equipped with the arch was capable of evaporating 15.5 per cent more water than when without it.

A higher boiler efficiency was made possible by the arch at all rates of evaporation. This is shown in Fig. 10. When plotted against the combustion rate, the factor of boiler efficiency shows an increase ranging between 6.9 and 11.6 per cent, with a rate of firing varying from 35 to 120 lb. of dry coal per sq. ft. of grate per hour. An examination of the values obtained between the limits common to road service indicate improvement under these conditions of from 7 to 8½ per cent. The report draws attention to the fact that other experimenters have found that the arch tubes alone, because of the added surface and improved circulation, afford improvement to the extent of about one per cent for each tube involved.

Because of the conditions under which the tests were made, that is, at fixed speed and cut-off, no noticeable economy was observed in the operation of the engine, but there was an increase in the power developed consequent upon the larger volume of steam flowing. On the basis of drawbar pull, it was found that at speeds above 8 m.p.h. the locomotive when equipped with the arch had an appreciable advantage. This advantage, measured at the maximum power developed, which was at the speed of 29 m.p.h., amounted to an increased drawbar pull of 2066 lb., or 6.4 per cent. (Pennsylvania Railroad Test Department Bulletin No. 30, abstracted through the *Railway Review*, vol. 61, no. 5, August 4, 1916, pp. 137-139, 3 figs., *e*)

Steam Engineering

Condenser-Tube Corrosion, William Ramsay

A general discussion of the subject, together with data of observations and experiments made by the writer.

The writer does not ascribe much value to analyses of the defective tubes of a condenser after a breakdown. The analysis itself is a simple matter, but since the corroded matter has disappeared and the tube adjacent to the corroded part is, as a rule, normal, it does not give much material for the explanation. Further, the examination of the residue seldom points to anything useful, because the corrosion product contains the metals as basic chlorides, carbonates, oxides, or even sulphates, and much of this product is washed away in both soluble and insoluble form.

The writer made a number of experiments, many of which were abortive. The chief difficulty of experiments of this nature lies in the impossibility of reproducing actual working conditions. Even model condenser arrangements in which the same water is circulated many thousands of times failed to give the desired information. Such water may lose its corrosive properties, or, perhaps, become more corrosive with continued use, and the results are not likely to be conclusive.

The nature of brass corrosion is mainly, if not entirely, electrolytic in character, assisted by the fact that the commercial brasses are not homogeneous bodies, but are a kind of conglomerate.

Corrosion of a condenser tube may be said to commence from the moment it is put into use, and the extent to which it proceeds depends upon such factors as composition, time, temperature, water, etc.

The effect of corrosion in condenser tubes is varied. Copper and zinc may be removed uniformly from the surface, or, what is more commonly the case, zinc is dissolved out, leaving the copper or a copper-rich material as a coherent film, the original dimensions of the tube being nearly preserved. This is known as dezincification. In the case of the 60:40 tubes, the action takes place between the α and β constituents, and may proceed to completion, the tube retaining its original dimensions and to the naked eye preserving the appearance of a solid copper tube. On microscopic examination, however, it is seen to consist of coppery material, preserving the form of the α constituent, the space previously occupied by the β

being more or less filled by corrosion products, or possibly quite empty. In the case of 70:30 tubes, or Admiralty alloy, the action is probably somewhat different. Owing to some slight inequality in the composition, the equilibrium of the brass becomes upset and a more or less continuous film of copper results; electrolysis then takes place between the copper and the adjacent brass, resulting in a gradual concentration of copper. With these tubes dezincification is, as a rule, superficial.

Dezincification in itself is not a simple process. If some of the copper was in the solution, it may be redeposited as metallic copper on the brass, with an accumulative amount of zinc going into solution. The writer has proved that cuprous and cupric chlorides, oxide of copper and, in fact, most copper compounds are capable of depositing metallic copper on brass. The action of basic chloride of zinc is less clear, but on painting tubes with this material and immersing them in warm sea water, a distinct coppery stain results after some time. Dezincification may, therefore, at times even become protective.

It is an interesting fact that, if a portion of the coppery film be removed so as to expose the brass, it does not immediately become recoated with copper. A tube which had been dezinced to a depth of less than 1/500 in. was taken, and a small patch about ¼ in. sq. removed with fine emery paper, without appreciably altering the thickness of the tube. On immersing it in sea water kept warm, the brass rapidly corroded at this point until, in about a month, it was about 1/32 in. deep; copper then gradually encroached on the brass and stopped the action.

From this the writer proceeds to discuss the case of the so-called laminations in condenser tubes, due to defects in the manufacture of tubing, such as spills or blowholes in the original casting. On opening them up they are seen to be coated with oxide of copper, which, on immersing in sea water, is gradually reduced to the metallic state. This is probably the initial stage of electrolytic corrosion. Sooner or later the corroded lamination breaks away, exposing fresh lines of yellow brass. The following experiment was carried out to test the truth of the above. An Admiralty tube which showed indications of lamination was immersed in estuary water, which was changed almost every day over a period of more than two years, the containing flask being kept at a temperature of about 110 deg. to 150 deg. fahr. by means of an electric heater. After a few weeks the tube was completely coppered and the suspected lamination showed unmistakable signs of opening out. In about six months it had corroded away to a measurable extent, and several other lines of laminations, which had not been suspected, showed themselves. Throughout the test it was noticed that bubbles of gas adhered tenaciously to the laminations and the sharp edges of the tube. During the corrosion the lamination presented a varying appearance, at one time showing black lines, which cleared up to yellow brass or filmed over with copper through which minute specks of brass were visible, but at all times the action was greatest at the lamination and edges.

Likewise, due to defects in manufacturing, there are isolated holes in what may otherwise be perfect tubes. It is the opinion of the writer that these holes act in the capacity of corrosion centers.

The writer describes several sets of experiments, indicating that the strongest corrosion took place at, or near, the point of contact between two metals. Even metals, such as iron, zinc and lead, which are electropositive to brass, behave in this manner, which may be due to copper being redeposited on the foreign matter. It is noteworthy, in this connection, that magnetic oxide of iron, or metallic iron, coated with this oxide is sometimes electropositive, and at other times electronegative with reference to brass.

A form of corrosion of which the writer has definitely traced the cause is that which attacks the inlet ends for a few inches immediately beyond the tube plate. Here the cold circulating water, on becoming warm, deposits its dissolved gases; the part in the tube plate being kept cool, escapes this particular action, but just beyond this bubbles of CO_2 and air adhere to the tube, causing round each a ring of corrosion which eventually takes the form of a horseshoe, the open ends of which point in the direction of the water flow. This type of defect is most certainly due to the main condenser being used in harbor for the auxiliary machinery, when the smaller volume of steam does not necessitate the full-power circulation, and the friction of the water is insufficient to sweep away the deposited gases. Where an auxiliary condenser is used for port service this defect is obviated. Several rivers and harbors, and canals especially, have an evil reputation in this respect, all being more or less foul with sewage, while those with a good tidal scour are less objectionable. The accelerating effect of sewage, CO_2 and ammonia is well known.

In the original article is given a photograph of an opened-out tube which has suffered from this type of corrosion. It shows that, although the part in the tube plate is corroded, it has escaped the typical horseshoe action. The vessel from which this tube was taken was known to berth in a very dirty harbor. Dezincification is general all over the tube, and in the middle of each horseshoe, but where the corrosion is severe the brass remains yellow. This seems to point to the electrolysis between the separated copper and the brass.

There is another type of corrosion which affects the ends of the tubes and which may be found in any part of the condensers, and may occur singly or in groups. The extreme ends of the tubes are eaten away in the ferrules, which also may be involved; and in this case a curious accommodation between tube and ferrule often takes place, the more corroded part of the one fitting into the less affected part of the other, almost as if the action ceased when the pressure between the two had been relieved. This is most probably the case, since in cases of this type the writer has almost always observed that the tubes had been crushed or distorted by the ferrule. Physical condition as a factor in brass corrosion is fairly well established, and this seems a case which meets this theory. A condenser is generally tubed by several men, each taking a certain section or group of tubes, and it is not unlikely that one worker may have exerted such force as to bruise his tubes. This probably explains why such corroded ends generally occur in groups. (*Engineering*, vol. 104, no. 2689, July 13, 1917, pp. 40, 44-46, 7 figs., *eA*)

Thermodynamics

The Latent Heat of Steam, Frank B. Aspinall

The writer starts by giving the following definitions of terms:

Steam is that which exists when absolutely no water and absolutely no superheat is present.

The *total heat of steam* is the exact quantity of heat present when absolutely no water and absolutely no superheat are present.

The *latent heat of steam* is the exact quantity of heat required to convert water from the form of water completely into the form of steam at the same temperature and pressure

as the temperature and the pressure of the water converted into the steam.

Heat latent is the varying heat latent when varying mixtures of steam and water are present.

The *steam volume* is the maximum volume which can be present without superheat being present.

The writer states that when he analyzed hundreds of indicator cards he noticed facts which were unexplainable, unless it be admitted that steam at high pressures containing absolutely no water and absolutely no superheat carried more heat and had a smaller volume than the steam tables stated.

A series of measurements was therefore made to ascertain the maximum heat and maximum volume which could be present without superheat being present, and this was the result:

The maximum heat which could be latent, or the latent heat of steam, was found to be constant, at a value nearly, if not actually, 970.13 B.t.u.

A steam volume multiplied by a steam pressure is constant, if steam is accepted as that which exists when absolutely no water and absolutely no superheat are present, the value stated in cubic feet and pounds absolute being nearly, if not actually, 399.84.

From these two constants the following conclusions were arrived at in regard to the steam tables:

The values stated for the total heat at atmospheric pressure apply to wet steam, the wetness increasing as the pressure increases. The values stated for the total heat at below atmospheric pressure apply to the superheated steam, the superheating increasing as the pressure decreases.

The values stated for the latent heat at above atmospheric pressure apply to the heat latent in mixtures of steam and water, the water increasing as the pressure increases.

The values stated for the latent heat at below atmospheric pressure apply to neither latent heat nor heat latent.

The values stated for the volumes at above 25 lb. absolute apply to superheated steam, the superheat increasing as the pressure increases.

The values stated for volumes at below 25 lb. absolute apply to wet steam, the wetness increasing as the pressure decreases.

The values are therefore not only not comparable in themselves, but are also not comparable to each other.

The late Dr. Silvanus Thompson was instrumental in having the Finsbury Technical College in London carry out, under the present writer's supervision, the determinations described in the article here abstracted.

The article describes in detail the conditions which were to be fulfilled during these tests, the method and apparatus used, observations and numerical results and the deductions arrived at. The following definitions were adopted for the terms employed:

The latent heat of steam is the amount of heat required to convert water, at a definite temperature and pressure, completely into steam at the same temperature and pressure as the water.

The sensible heat in steam is the heat in the water at the definite temperature and pressure at which it is converted into steam.

The total heat of steam is the latent heat plus the sensible heat or the maximum heat which can possibly be present without superheat being present.

Wet steam is a mixture of steam and water in some form. The total heat present is therefore less than that which would be present if the water had been completely converted into steam.

Steam is all steam, the total heat present being the exact amount required for all the water to be converted completely into steam.

Superheated steam is all steam, the total heat present being more than the amount required at the given pressure and temperature for all water to be converted into steam.

The following formula was used to work out the latent heat of steam:

The latent heat of steam at the pressure P at the point $B =$

$$\frac{W(t_1 - t_2) - w(T - t_1) \pm j}{w}$$

P. As the supertemperature was so low, the observed pressure was accepted as the pressure of pure steam, but if the steam had been very highly superheated, a correction would have to have been made for the supertemperature.

W. In the first trials. The water present at commencement of the second blow + the water value of the metal.

In the second, third and fourth trials. The water present when the pipe was dropped into the water + the water value of the metal + the water value of the wood.

w. The actual weight present at the finish of the trial, minus the actual weight present at the commencement of the trial.

T. The mean corrected observed temperature of the thermometer in the long temperature well — the mean supertemperature.

t_1. The mean corrected observed temperature of the condensing water at the finish of the trial, as shown by thermometers, T.I., T.II., T.III. + the temperature the condensing water would have gained if it had not lost or received heat due to the surrounding air.

t_2. The mean observed corrected temperature of the condensing water at the commencement of the trial, as shown by thermometers T.I., T.II., T.III.

j. The difference between the superheat in the steam due to the supertemperature and the heat radiated from the lagged and bare pipe beyond the controlling valve admitting steam to the condensing water to within 1½ in. above the maximum height of the water in the wooden vessel.

It will be noticed that the writer, like Southern and Regnault, makes no correction for possible changes in the specific heat of the boiler water. It appears, however, from the results of James Watt, Southern, and the writer, that the specific heat of water is constant *when water is subjected to the conditions present when a boiler is making steam.*

The method employed to determine the water value of the wooden vessel by the method of mixtures is described in detail.

Among other things, it has been found that even although extreme care was taken to prevent the steam from containing water just before it was wiredrawn, the small supertemperature obtained for such a large drop in pressure shows that water must have been present. There seems no other explanation than to conclude that *water can be present in steam in some form which is not a mechanical mixture.* This view also seems to be confirmed by the fact that for equal differences of pressure higher supertemperatures were usually obtained at 50 lb. than at 100 lb., which apparently shows that steam at a higher temperature can contain more water than at a lower temperature. The experiments seems to support the conclusion that *steam has a dewpoint like air.*

The Finsbury value for the latent heat of steam, or the

exact quantity of heat required to convert water from the form of water completely into the form of steam at the same temperature and pressure as the temperature and pressure of the water converted into the steam, is 969.67 B.t.u., a constant, per 1 lb. of steam. The writer takes, however, 969.90 as the constant latent heat of steam. This figure is the mean of the Blackheath value 970.13 and the above Finsbury value.

The writer proclaims the following basic laws:

It is the quantity of water present and not the temperature present which determines the quantity of heat which is latent.

The quantity of heat latent is a variable if water is present, because the maximum quantity of water which can be present increases as the pressure increases.

The evidence collected by the present writer leads him to believe that the heat latent when absolutely no water is present, or the latent heat of steam, is nearly, if not actually, 970 B.t.u. at all pressures.

Further, provided absolutely no water and absolutely no superheat are present, the pressure multiplied by the volume is always nearly, if not actually, 400.

The writer concludes by calling attention to the fact that James Watt distinguished between latent heat and heat latent, and believes that all the trouble has arisen owing to Regnault not making this distinction. (*The Engineer*, vol. 124, nos. 3210, 3211, 3212, July 6, 13 and 20, 1917, *tA*)

Ventilation Standards and the Synthetic Air Chart, Dr. E. V. Hill

The writer claims that one of the problems of modern ventilation is not so much *how* to accomplish the desired need, but *how to know* when that end has been attained. In other words, the need is for improvement not in mechanical equipment, but in methods of testing to determine with greater accuracy what the equipment accomplishes, and more than all else, satisfactory standards by which conditions may be compared. The development of a satisfactory air-condition test record, however, is made difficult through the fact that combinations might occur that when plotted would be misleading. Such a test record must cover at least temperature, air movement and humidity, and there is a definite relation between the *variations* of these elements that it is difficult to show accurately on the chart.

In fact, after giving this matter considerable study, the writer came to the conclusion that more definite information regarding the relations of temperature, humidity and air motion to each other in their bearing on comfort must be secured before a workable chart could be designed. To do this a room in a factory building was equipped so that any combination of temperature, humidity and air motion could be maintained and their relations approximately determined.

On the whole, it has been found that, first, comfort depends upon air conditions that allow the normal heat losses from the body without the undue exercise of heat-regulating mechanism. Second, other things being equal, the heat loss is approximately constant if the wet-bulb temperature is constant. And third, the comfortable wet-bulb temperature increases with the air motion.

On this basis two synthetic air charts were developed, of which the second, introducing air-motion curves, is reproduced in Fig. 11. The theory on which the chart is based is that the factors which determine ventilation of a given space may be conveniently combined into three principal groups, as follows: (1) Temperature, humidity and air motion; (2) Dust, bacteria and odors; (3) Air supply and carbon dioxide.

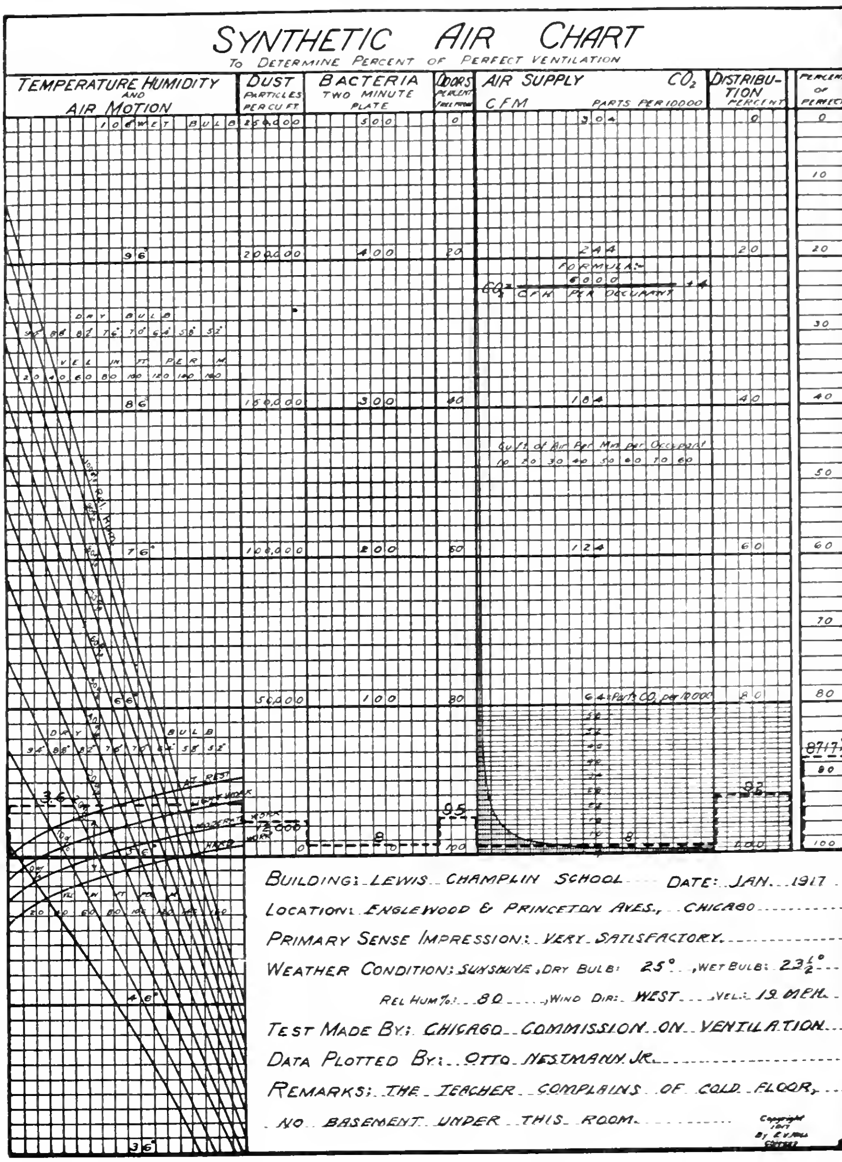

Fig. 11 Synthetic Air Chart

The use of the chart in Group 1 is as follows: From test data is noted the wet-bulb temperature. This is indicated by the horizontal line connecting this wet-bulb temperature and the appropriate air-motion curve. Next is noted from test data the air motion prevailing, and the appropriate air-motion curve is connected by a horizontal line with the wet-bulb that is desired for this velocity. The number of squares between these two horizontal lines across this portion of the chart is the amount of penalization. (*Journal of the American Society of Heating and Ventilating Engineers*, July 1917, p. 477, *ep*)

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Gray's Plumbing Design and Installation. By William Beall Gray. David Williams Co., *New York, 1916.* Cloth, 6 x 9 in., 559 pp., 500 figs. $4. Gift of U. P. C. Book Co.

Heaton's Annual; The Commercial Handbook of Canada and Boards of Trade Register (13th Year). Heaton's Agency, *Toronto, 1917.* Cloth, 5 x 7 in., 518 pp. $1.25. Gift of the publisher.

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How to Study. By George Fillmore Swain. McGraw-Hill Book Co., inc., *New York, 1917.* Paper, 5 x 7 in., 65 pp. $0.25. Gift of the publisher.

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Modern Milling: A Practical Manual on Milling Machines, Milling Accessories and Milling Operations. By Ernest Pull. The Macmillan Co., *New York, 1917.* Cloth, 6 x 9 in., 207 pp., 188 figs. $3. Gift of the publisher.

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Moody's Manual Complete List of Securities Maturing, July 1, 1917–June 30, 1919. Vol. IV. *New York, 1917.* Purchase.

Montclair (N. J.) Town Council. Annual Report, 1911. Gift of City Clerk.

Motor Boats, Hydroplanes, Hydroaeroplanes: Construction and Operation with Practical Notes on Propeller Calculation and Design. By Thomas H. Russell. Charles C. Thompson Co., *Chicago, 1917.* Cloth, 5 x 8 in., 254 pp., 106 figs. $1. Gift of the publisher.

National Association of Railway Commissioners. Proceedings of the 28th Annual Convention, Washington, D. C., Nov. 14-17, 1916. *New York, n. d.* Purchase.

National Industrial Conference Board. Summary of report on workmen's compensation acts in the United States. April, 1917. Gift of Board.

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Naval Architecture. By Cecil H. Peabody. 4th ed. John Wiley & Sons, Inc., *New York, 1917.* Cloth, 6 x 9 in., 641 pp., 218 figs. $7.50. Gifts of the publisher.

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New Jersey Department of Conservation and Development. Annual Report for the year ending Oct. 31, 1916. *Trenton, N. J., 1917.* Gift of Department of Conservation and Development.

North Adams, Mass. City Clerk. Annual Reports. 1912-1916. *North Adams, 1912-16.* Gift of City Clerk.

Ohio Engineering Society. Report of the 38th annual meeting, 1917. *Norwalk, 1917.* *Gift of Society.*

Omaha, Nebraska, Department of Accounts and Finances. Report 1910-11, 1912-14. Gift of Superintendent of Accounts and Finances.

Organizing and Conducting Safety Work in Mines. U. S. Bureau of Mines. Technical Paper 103. *Washington, 1917.* Purchase.

Ottawa, Canada. Annual Departmental Reports for the Corporation, 1912. *Ottawa, 1912.* Gift of City Clerk.

Outlines of Industrial Chemistry; A Text-Book for Students. By Frank Hall Thorp, with assistance in revision from Warren K. Lewis. 3d ed. The Macmillan Co., *New York, 1916.* Cloth, 6 x 9 in., 665 pp., 137 illus. $3.75. Gift of the publisher.

The Panama Canal and Commerce. By Emory R. Johnson. D. Appleton & Co., *New York, 1916.* Cloth, 5 x 7 in., 295 pp., 8 illus., 7 maps. $2. Gift of the publisher.

Passaic, N. J. Financial Report, 1910, 1912-1916. Gift of City Clerk.

Pennsylvania. Commissioner of Health. Annual Report. 1914, Part I-II. *Harrisburg, 1916.* Purchase.

Pennsylvania. Commissioner of Labor and Industry. Annual Report (2d), 1915, Part II. *Harrisburg, 1916.* Purchase.

Pennsylvania Company. Annual Report (45th), 1917. *Pittsburgh, 1917.* Gift of Pennsylvania Co.

Pennsylvania State College. Annual Report, 1914-15. *Harrisburg, 1916.* Purchase.

A. S. M. E. Accessions

American Wool Preservers' Association. Report of Proceedings 13th Annual Meeting, 1917. Gift of Association.

Co-Partnership After the War. A Memorandum Submitted Feb., 1917, to the reconstruction committee appointed by H. M. Government.

Industrial Fatigue in Its Relation to Maximum Output. By Henry J. Spooner.

Investigation of the Municipal Light Plant. Report of. By C. W. Whiting, *Boston, 1917.*

Metropolitan Water and Sewerage Board. Annual Report (16th). *Boston, 1917.* Gift of Board.

National Board of Fire Underwriters. Address of R. M. Bissell, May 24, 1917.

National Machine Tool Builders' Association. Proceedings of Annual Convention, 1915-1916. Gift of Association.

New Orleans, La. Sewerage and Water Board. Report (34th semi-annual), 1916. Gift of New Orleans Sewerage and Water Board.

New York (City) Board of Water Supply. Information for bidders for vitrified brick pavement in the Kensico Aerator in the town of Mt. Pleasant, Westchester Co., N. Y. (Contract 184.) 1917.

——— ——— for surfacing with vitrified brick block the East Hill Drive at the Kensico Dam in the town of North Castle, Westchester Co., N. Y. (Contract 179.)

——— ——— for the completion of the superstructure over the drainage chamber at shaft 21 of the City Tunnel of the Catskill Aqueduct, in the Borough of Manhattan, 1917. (Contract 129.)

——— ——— for erecting, remodelling and removing buildings along the Catskill Aqueduct. (Contract 180.) Gift of the New York City Board of Water Supply.

Second Pan-American Scientific Congress. The Report of the Secretary General. *Washington, 1917.*

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by September 16 in order to appear in the October issue.

CHANGES OF POSITION

E. E. Arnold has left the employ of The New Departure Manufacturing Company, Bristol, Conn., and is now affiliated with the Iron City Products Company, Pittsburgh, Pa.

A. R. Dickinson, formerly connected with the Mill Management Department of Lockwood, Greene and Company, Atlanta, Ga., has become identified with the Winnsboro Mills, Winnsboro, S. C.

Dr. Barton Cruikshank has severed his connection with The Engineers' Company of New York, and is now designing engineer of the Maxim Munitions Corporation, Watertown, N. Y.

Edwin S. Boyer, until recently with Walter Kidde and Company, of New York City, has identified himself with the American Hard Rubber Company, of the same city.

Charles C. Hoke, formerly engineer with the Cia Minerales y Metales, Laredo, Tex., has accepted a position with the Compania Minera de Penoles, Mapimi, Tex.

W. C. Kerr is now affiliated with the Republic Railway and Light Company of New York City. He was formerly in the employ of the Philadelphia Rapid Transit Company, Philadelphia, Pa.

S. Howard Sweet has resigned from the Remington Arms-Union Metallic Cartridge Company, and has joined the Oil Engine Company, Bridgeport, Conn., in the capacity of chief engineer.

Raymond W. Muller, recently assistant maintenance engineer with the Bosch Magneto Company, New York City, has joined Walter Kidde and Company in the capacity of mechanical engineer.

George B. Malone has resigned from the Winchester Repeating Arms Company, New Haven, Conn., to take charge of the welding department of the Remington Arms Company, Bridgeport, Conn.

George W. Hawkins has identified himself with Anderson, Meyer and Company, Ltd., Shanghai, China. He was formerly Tucson manager of Chas. C. Moore and Company, San Francisco, Cal.

William E. Anderson, formerly designer with the Alberger Pump and Condenser Company, of New York City, is now associated with the A. S. Cameron Steam Pump Works, Phillipsburg, N. J.

W. A. J. London has severed his connection with the General Electric Company, West Lynn, Mass., to become engineer with the Steam Motors Company, Inc., Springfield, Mass.

W. H. Ripley, for several years associated with the Griscom-Russell Company as sales engineer and evaporator expert, has been appointed sales agent for the Nashua Machine Company, Nashua, N. H., to succeed the late W. E. Van Keuren.

C. C. Hinkley has severed his connection as chief engineer with the Chalmers Motor Car Company, Detroit, Mich., and is now president and general manager of the Hinkley Motors Corporation of the same city.

Henry M. Wood, formerly with The Lodge and Shipley Machine Tool Company, Cincinnati, Ohio, has assumed the duties of vice-president and general manager of The Malm and Wood Machine Company, Dayton, Ohio.

Charles L. Bruff has severed his connection with the United Gas Improvement Company, Philadelphia, Pa., and has taken up consulting engineering work, making a specialty of power-plant economy work.

George H. Sharpe has accepted the position of chief engineer with the Westcott and Mapes Company, New Haven, Conn. He was, until recently, mechanical engineer with the New York Central Railroad, Heat and Power Department.

A. H. Gill, formerly superintendent of the Perth Amboy plant of the American Smelting and Refining Company, Metuchen, N. J., has taken a position with the American Zinc and Chemical Company, Langeloth, Pa.

Charles J. Mancel has resigned from his position with F. W. Bird and Sons, East Walpole, Mass., and has assumed the duties of draftsman of the tool department of the Aeromarine Plane and Motor Company, Keyport, N. J.

G. C. Vennum, formerly assistant chief engineer of power plants, Union Electric Light and Power Company, St. Louis, Mo., is now associated with the Electric Bond and Share Company, New York City, in the capacity of mechanical engineer.

John F. Glenn, contracting engineer for the past seven years with the Wickes Boiler Company, Buffalo, N. Y., is now New England sales manager for the Edge Moor Iron Company, manufacturers of the Edge Moor water-tube boiler, Boston, Mass.

Edmund Barany, machine designer of the Singer Manufacturing Company, Elizabeth, N. J., has assumed the duties of assistant mechanical engineer of the Cleveland Twist Drill Company, Cleveland, Ohio.

John H. McNally until recently district manager of the Kokomo Foundry and Machinery Company, Philadelphia, Pa., has accepted a position as fuel engineer with Weston Dodson and Company, Inc., Bethlehem, Pa.

Frank Gentles, until recently in the engineering department of the Chester Shipbuilding Company, Ltd., Chester, Pa., has become affiliated with the engineering department of the Emergency Fleet Corporation, Washington, D. C.

Harold B. Bernard has resigned his position with the Oklahoma Petroleum and Gasoline Company, Tulsa, Okla., to accept the position of superintendent of the gasoline department of the Sinclair Oil and Gas Company, of the same city.

Charles W. Stephen, in charge of experimental work and testing of materials with the Bridgeport, Conn., division of the Crane Company, has severed his connections with the company and has accepted a position with the Pratt and Cady Company, Hartford, Conn.

Harry T. Anderson, formerly assistant in the tool-design department of the Simplex Auto Company, New Brunswick, N. J., has become identified with the Colt's Patent Firearms Manufacturing Company, Hartford, Conn.

Homer W. Goodier, formerly mechanical engineer with the Cayuga Cement Corporation, Portland Point, N. Y., has become connected with the Pierce-Arrow Motor Car Company, Buffalo, N. Y., in a similar capacity.

B. M. W. Hanson, vice-president and works manager of the Pratt and Whitney Company, Hartford, Conn., has resigned after nineteen years' service with the company and has accepted a similar position with the Colt's Patent Firearms Manufacturing Company, of the same city. Mr. Hanson has also resigned from the machine-gun board appointed by the U. S. Government, but he will continue to give the latter the benefit of his services, as far as his new duties will permit.

Frank H. Crockard, vice-president of the Tennessee Coal, Iron and Railroad Company since 1906, recently tendered his resignation, effective July 1, to accept the presidency of the Nova Scotia Steel and Coal Company, and will have charge of plans for a considerable extension of the company's operations. H. C. Ryding, who has served as Mr. Crockard's assistant for the past ten years, has succeeded to the position of vice-president of the Tennessee Coal, Iron and Railroad Company.

ANNOUNCEMENTS

A. P. Brush, of the Brush Engineering Association, has been selected by the Studebaker Corporation to serve as consulting engineer.

H. WADE HIBBARD, professor of mechanical engineering, University of Missouri, is now in Washington with the National Council of Defense.

L. L. WALKER, formerly district manager of the Good Roads Machinery Company, Philadelphia, Pa., is now sales engineer of the same company.

CRANSON D. GATES, who was associated with the Celluloid Company, Newark, N. J., in the capacity of chief draftsman, is now assistant works superintendent of the same concern.

EDWARD F. ENTWISLE, mechanical engineer at the Bethlehem Steel Company, Steelton, Pa., has been promoted to the general superintendency of the Donaghmore plant at Lebanon.

J. LEO MAYER, formerly connected with the Zanesville, O., works of the Mark Manufacturing Company, has become affiliated with the Indiana Harbor, Ind., office of the same company.

T. S. BAILEY, until recently with the Electric Boat Company at Groton, Conn., is now connected with the San Francisco, Cal., works of the same company.

ALVAH H. SABIN, consulting chemist of the National Lead Company, New York, and lecturer at New York University, was given the degree of Doctor of Science by Bowdoin College, June 21.

EARL N. MATTSON has been transferred to the Birmingham office of the American Cast Iron Pipe Company. He was until recently connected with the Chicago, Ill., office of the company.

GEORGE RAMSEY, senior member of the patent law firm of Ramsey and Parmelee, of Washington, D. C., is now in charge of the new office of the firm in New York.

WILLARD DOUD has accepted a commission as Lieutenant (Junior Grade) in the United States Naval Reserve Force, and has been assigned to active duty at the Naval Training Station, Great Lakes, Ill.

FRANK G. COX, until recently New England sales manager of the Edge Moor Iron Company, is now located in New York City as New York sales manager for the same company.

R. M. DYER, president of the Pacific Northwest Society of Engineers, addressed the June 28 meeting of The Engineers Club of Seattle, on Wooden-Ship Construction.

CLARENCE E. BIRKENBEUL, recently with The Holt Manufacturing Company, Stockton, Cal., as draftsman, has accepted a position with Meese and Gottfried of San Francisco, Cal.

JAMES OGG, with the American Cuban Estates Corporation, Santa Clara, Cuba, has become associated with the Honolulu Iron Works Company, Honolulu, Hawaii.

LOUIS E. KENFIELD, until recently mechanical engineer with R. Hoe and Company, New York, has entered the employ of The Locomobile Company of America, Bridgeport, Conn., in the capacity of chief tool designer.

HUGH P. FELL has assumed the duties of general superintendent of the Kings County Lighting Company, Brooklyn, N. Y. He was until recently associated with the Electric Bond and Share Company, New York.

WALTER H. VOLKMAR has severed his connections with the New England Westinghouse Company of Springfield, Mass., and is now with Baker, Sutton and Harrison, New York, industrial engineers and public accountants.

JAMES D. REIFSNYDER, formerly affiliated with the Stokes and Smith Company, Philadelphia, Pa., in the capacity of chief engineer, has assumed the duties of vice-president and manager of the Gefes Machine Company, Hoboken, N. J.

NEWMAN COMFORT has been transferred from the position of Ohio branch manager of the National Workmen's Compensation Service Bureau to that of Louisiana branch manager of the same bureau, with offices in New Orleans, La.

THOMAS CHESTER is now special representative, handling U. S. Navy business for the American Blower Company, with headquarters in New York. He was formerly associated with the Detroit, Mich., office of the same company.

B. B. MILNER, engineer of motive power of the New York Central at New York, will hereafter also perform the duties heretofore performed by the chief mechanical engineer, R. B. Kendig, deceased. The office of chief mechanical engineer has been abolished.

EDWARD J. KUNZE has resigned his position as professor of mechanical engineering at Oklahoma Agricultural and Mechanical College, to accept the commission of captain in the Quartermaster Officers' Reserve Corps, and has been ordered to Fort Sam Houston, Tex., for duty.

JOHN A. BRITTON, in addition to his present duties on the California State Council for Defense, will also serve on the national committee on gas and electric service, of which JOHN W. LIEB, of the New York Edison Company, is chairman.

AMOS WHITNEY, founder of the Pratt and Whitney Company, Hartford, Conn., was tendered a complimentary dinner by 40 members of the "Old Guards" at the Farmington, Conn., Country Club, June 20, in celebration of his eighty-fifth birthday.

B. F. RABER, associate professor of mechanical engineering and B. M. Woods, assistant professor of theoretical mechanics at the University of California, have returned from a governmental commission to Toronto, and are assisting in instituting a curriculum on military aeronautics at the State University.

THOMAS MORRIN, consulting mechanical engineer of San Francisco, Cal., announces that he has now associated with him, as partner, Albert A. Coddington, and that the business will hereafter be conducted under the firm name of Morrin and Coddington, consulting mechanical engineers.

THOMAS E. DURBAN has severed his connection with the Erie City Iron Works, Erie, Pa., as general manager, and has opened an office in the same city for the conduct of the affairs of the American Uniform Boiler Law Society, of whose Executive Council Mr. Durban is Chairman. This society was organized for the purpose of promulgating the A.S.M.E. Boiler Code.

HENRY M. LELAND, president of the Cadillac Motor Car Company, Detroit, Mich., and his son, Wilfred C. Leland, whose names have been connected so prominently with the perfection of gasoline engines, have announced their retirement from the automobile industry to devote their time and interests to the call of the nation. They are dedicating their services to the task of building up a powerful aeroplane fleet that will give the United States mastery of the air in the present war.

DAVID L. GALLUP, professor of gas engineering at Worcester Polytechnic Institute, Worcester, Mass., left for Indianapolis, July 1, to establish a research and consulting department for the Nordyke and Marmon Company, builders of the Marmon motor car. Professor Gallup will temporarily take the place of Howard Marmon who is going to France as an aircraft engineer of the aeroplane division of the United States Army.

APPOINTMENTS

A. R. MCARTHUR, resident engineer of the American Sheet and Tin Plate Company, at Gary, Ind., has been appointed a member of the School Board of that city.

D. MCCALL WHITE, formerly chief engineer of the Cadillac Motor Car Company, Detroit, Mich., has been appointed consulting engineer to the General Motors Company and will work closely with all of the General Motors divisions.

AUTHORS

FREDERIC G. COBURN has contributed an article on The Work of Management to the July number of *Industrial Management*.

H. F. STRATTON is the author of New Starters for Induction Motors, which appeared in the July 12 issue of *The Iron Trade Review*.

CHARLES M. HORTON has contributed an article on The Reason for Efficiency "Experting" to the July number of *Industrial Management*.

WALTER D. FULLER has contributed an article entitled Standardization in Office Work to the July issue of *Industrial Management*.

C. E. KNOEPPEL is the author of The Industrial Engineer and Preparation for War, which appeared in the July number of *Industrial Management*.

HALBERT P. GILLETTE has contributed an article entitled Logic for Engineers—Induction and Deduction, to the July 4 issue of *Engineering and Contracting*.

A. LEWIS JENKINS is the author of Effect of Countershaft Speed Ratio on Power and Torque, which appeared in the July 12 issue of the *American Machinist*.

THE NEW BOOKS

ALL books received by The Journal will be listed under this heading, generally accompanied by brief descriptive notes. Works of special importance to mechanical engineers will be commented on at length by members and others peculiarly qualified by reason of their experience and training.

Manufacture of Artillery Ammunition

Manufacture of Artillery Ammunition. By Members of the Editorial Staff of the *American Machinist:* L. P. Alford, Editor-in-Chief; F. H. Colvin, Ethan Viall, Robert Mawson, E. A. Suverkrop and John H. Van Deventer. McGraw-Hill Book Co., Inc., New York, 1916. Cloth, 6 x 9 in., xli+759 pp., 648 illustrations. $6 net.

This book is an excellent volume from a practical viewpoint of how the average shop equipment can be readily converted into a shop for the manufacture of munitions.

As a reference book for dimensions of the different types of munitions made for the different Governments, it is comprehensive and convenient.

As a general guide to one who is contemplating the manufacture of munitions with standard shop equipment, it would be of considerable value.

As a handbook for the student, it would prove not only convenient but valuable in giving him an idea of the general and detail requirements of munitions manufacture.

The authors deserve great credit for the thoroughness with which the subject has been covered. We all realize, however, that the progress which has been made in the manufacture of munitions since the book was published and the tendency to specialize in munitions manufacture, owing to the large quantities which the United States Government is now having made, would necessitate the use of the information in this book with care and caution.

Frederick A. Waldron.

Shop Expense Analysis and Control

Shop Expense Analysis and Control. By Nicholas Thiel Ficker, Consulting Industrial Engineer and Lecturer at N. Y. U. School of Commerce. The Engineering Magazine Company, New York, 1917. Cloth, 6 x 9 in., 236 pp., 20 illustrations. $3.

This book is not a general treatise on cost finding, but treats almost entirely of the problems that center around manufacturing expense and its allocation. The book consists of twelve chapters, the first eight of which were published originally in *The Engineering Magazine*. The titles and content of these chapters are as follows:

1 Establishment of the Unit of Time as a Basis of Distribution
2 Machine Expense and Material Expense
3 Classification and Interpretation of General Ledger Accounts Pertaining to Production
4 Distributing Manufacturing Expense to Production Centers and Segregating Power Expense
5 The Standardization of Rent Expense Distribution
6 Depreciation, Insurance, Taxes and Interest
7 The Machine Unit System
8 Current Variation Ratio for Adjusting Current Costs
9 Organization
10 Waste in Manufacturing
11 Graphic Determination of Costs
12 Standard Reports.

The object of the author, apparently, is to call special attention to the difficult problems involved in distributing expense burden in manufacturing plants. The treatment of the problem, however, is not very general, but describes the methods which the author believes are best for this purpose. These methods might or might not be applicable to every plant, depending on the industry and the size of the plant. The author's discussion of the problems of distributing expense burden, however, is clear and illuminating, and is based obviously on actual experience.

No theories are advocated that are especially new, but many of the author's methods and forms are both interesting and instructive, though all will not agree with some of his conclusions. The book is not as well balanced as one would wish. Too much space is devoted to Chapter 10, for instance, to detailed descriptions of wasteful methods, and the review of the principles of organization given in Chapter 9 covers ground that all who will read the book are thoroughly familiar with. On the other hand, little or nothing is said of methods other than those advocated by the author, which, as has been stated, may or may not be applicable to a given factory.

The book, however, will be interesting and helpful to managers, cost accountants and students of such matters, and should be in every library that is devoted to this line of work.

Dexter S. Kimball.

Laws of Physical Science. By Edwin F. Northrup. J. B. Lippincott Co., Philadelphia, 1917. Leather, 5 x 8 in., 210 pp. $2.

This book contains a collection of general propositions or laws of science grouped under the six headings Mechanics, Hydrostatics, Hydrodynamics and Capillarity, Sound, Heat and Physical Chemistry, Electricity and Magnetism, and Light, together with a combined author and subject index, arranged alphabetically.

The leading idea of the book is a most praiseworthy one, and the volume undoubtedly fills a gap in the reference literature of science. There are many publications giving more or less complete collections of tables of constants, formulæ, etc., and hitherto these have to some extent made up for the absence of a dictionary of physical laws, but the advantages of a book dealing entirely and systematically with these laws, which thus provides the authorities a historical and logical foundations for these tables, are obvious.

The typographical arrangement of the book is somewhat poor, and the use of italics in formulæ and for reference letters would be a decided improvement. For example, on page 37, to point out only one place, the roman letter "*l*" and the numeral "1" are indistinguishable.

Much remains to be done, however, before the book can really be considered "a very epitome of the world's heritage of the fundamentals of its knowledge and wisdom," as stated in the preface. Thus, looking over the index, we find no mention of the names of Arrhenius, Bunsen, Becquerel, Lavoisier, Quincke, Lehmann, Roentgen, Sir Oliver Lodge, and others; nor are there any references to Hertzian waves, X-rays, N-rays, cathode rays and dissociation. The development and present

status of the periodic law deserves more comprehensive treatment than the perfunctory reference to Mendeléeff on page 97. However, a good beginning has been made in a most useful undertaking and it is to be hoped that in the second edition the author will have due regard to possible improvements, some of which have been referred to here.

Paint Researches and Their Practical Application. By Henry A. Gardner. Washington, D. C. (privately printed), 1917. Cloth, 6 x 9 in., [illegible] pp., 156 figs. $5.

In this volume the author summarizes the investigations which he conducted at the Institute of Industrial Research for the Educational Bureau of the Paint Manufacturers' Association of the United States. Chapters are included on the following subjects: The Growth of the Prepared Paint Industry and Its Relation to the Work of the Painter; The White Pigment Industry; Physical Characteristics of Pigments and Paints; Tests of Lithopone; Washington Paint Oil Tests; Paint Protection for Portland-Cement Surfaces; Paints to Prevent Electrolysis in Concrete Structures; Paints for Metal; Marine Paints; Arlington Paint Tests; Observations on Painted Lumber; Impregnated Panel Tests; Fire Retardent Paints for Shingles and Other Wooden Structures; The Composition of Paint Vapors; The Toxic and Antiseptic Properties of Paints; The Light-Reflecting Values of White and Colored Paints; Formation and Inhibition of Mildew in Paints; Fungi on Painted Surfaces; Changes Occurring in Oils and Paste Paints, Due to Autohydrolysis of the Glycerides; The Effect of Pigments Upon the Constants of Linseed Oil; Storage Changes in Vegetable and Animal Oils; Paint Driers and Their Application; Miscellaneous Oil Investigations; The Application of Paints and Finishes to Wood.

American Hydroelectric Practice: A Compilation of Useful Data and Information on the Design, Construction and Operation of Hydroelectric Systems from the Penstocks to Distribution Lines. By William T. Taylor and Daniel H. Braymer. McGraw-Hill Book Co., Inc., New York, 1917. Cloth, 6 x 9 in., 439 pp., 258 figs. $5.

This is not a textbook on the fundamentals underlying the design and construction of the parts of a hydroelectric system, but a compilation of the practical and essential features of design, construction and operation as used in many plants, interpreted and arranged for use by designers and engineers. Contents: General Survey of Water-Power Engineering; Low, Medium and High Head Developments; Layout and Selection of Plant Equipment; Transmission Line Construction and Operation; Plant Line and Substation Costs; System Operation and Economics; Special Plant and Line Problems; Data, Reference Tables and System Diagrams.

War-ships. By Edward L. Attwood, M. Inst. N. A., Member of the Royal Corps of Naval Constructors, etc. Longmans, Green & Co., London and New York, 1917. Sixth edition. Cloth, 6 x 9 in., 338 pp., 209 illustrations. $4 net.

This textbook on the construction, protection, stability, turning, etc., of war vessels, while prepared primarily for the use of naval officers taking the course in naval architecture at the Royal Naval College, Greenwich, and amplified in certain particulars to meet their special requirements, is, nevertheless, believed by the author to be well adapted to serve as an introduction to the subject for students generally. The present edition, it is stated, has been modified in many places to take account of the rapid change of practice in recent years.

Handbook of Chemistry and Physics: A Ready-Reference Pocket Book of Chemical and Physical Data. Fifth Edition. The Chemical Rubber Co., Cleveland, O., 1917. Cloth, 4 x $6\frac{3}{4}$ in., 414 pp. $2.

In the present edition of this compact, easily portable and fairly comprehensive reference work, the text, it is stated, has been carefully revised and brought down to date and a large number of new tables have been added.

Export Trade Directory 1917-1918. Compiled by B. Olney Hough. Johnston Export Publishing Co., New York, 1917. Cloth, 6 x 9 in., 537 pp., 1 map. $5.

Contents: Export Merchants in the United States; Manufacturers' Export Agents, Managers of Export Departments and Export Brokers; Leading Bankers Engaged in Foreign Exchange Business; Foreign Exchange Brokers; Marine Insurance Companies in New York City; Foreign Freight Forwarders; Some Export Trucking Companies in New York City; Steamship Services to Foreign Ports; How to Ship to Foreign Markets; Consuls of Foreign Countries in the United States; United States Consular and Commercial Representatives in Foreign Countries; Associations for the Promotion of Export Trade.

Workmen's Compensation Law: Personal Injury by Accident Arising Out of and in the Course of the Employment. By P. Tecumseh Sherman. N. Y., Workmen's Compensation Publicity Bureau, New York, 1916. Paper, 6 x 9 in., 67 pp. $2.

This is a compilation of the decisions construing the British law on the subject, with abbreviated summaries of the relevant portions of the French and German laws. These precedents will be useful, the author believes, in defining the meaning of "accidents due to risk of work" as used in the American statutes.

Gas Chemists' Handbook. Compiled by Technical Committee, Sub-Committee on Chemical Tests, 1916, of the American Gas Institute, C. C. Tutweiler, Chairman, A. F. Kunberger, Editor, New York, American Gas Institute. Cloth, 6 x 9 in., 354 pp., 67 illustrations. $3.50.

The present handbook, a revision of the one compiled in 1914, presents methods for sampling and testing the material used in gas manufacture. Contents: Raw Materials; Products of Gas Manufacture; Impurities in Gas; Tar Products; Miscellaneous and Tables.

United States Artillery Ammunition: 3 to 6 in. Shrapnel Shells, 3 to 6 in. High Explosive Shells and Their Cartridge Cases. By Ethan Viall. McGraw-Hill Book Co., Inc., New York, 1917. Cloth, 9 x 12 in., 98 pp., 171 figs. $2.

This work is intended to give shop men, engineers and manufacturers an accurate knowledge of the sizes, tools, shop work and gages for the more commonly used United States shells and cartridge cases. The descriptions are in minute detail and accompanied by numerous dimensioned drawings.

Office Organization and Management. By Carl C. Parsons. La Salle Extension University, Chicago, 1917. Leather, 6 x 8 in., 313 pp., 59 figs. $2.50.

A work treating of organization, management, layout, equipment, methods, systems, records, forms, employees, etc., and based on observation of the methods used in the offices of various large companies.

Industrial Preparedness. By C. E. Knoeppel. The Engineering Magazine Co., New York, 1916. Cloth, 5 x $7\frac{1}{2}$ in., 145 pp. $1.

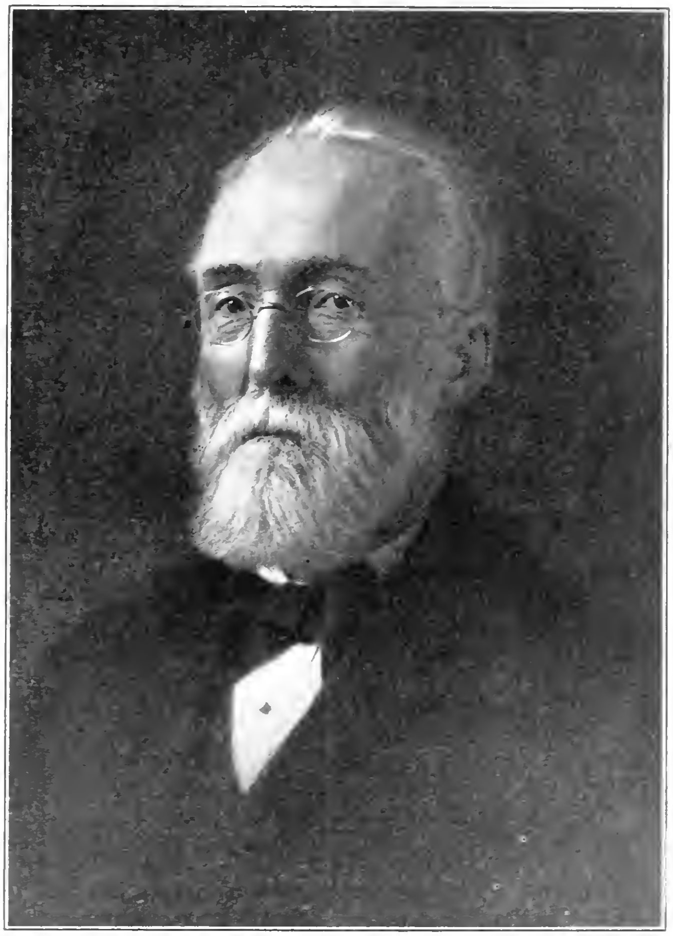
A study of Germany's military and industrial preparedness intended, the author states, to point the way to national greatness through the right kind of social, industrial and military preparedness.

AN ACCOUNT OF THE ENGINEERING WORK OF E. D. LEAVITT

By F. W. DEAN, BOSTON, MASS.

Member of the Society

A brief account of the life of the late E. D. Leavitt, Past-President, Am.Soc.M.E., was published in THE JOURNAL for April, 1916. In view of the interesting character of Mr. Leavitt's work, however, and of the influence which it had upon good design, particularly in relation to water works and mining machinery, it was desired to place on record a more complete statement of his life and work with illustrations of some of his most characteristic designs. Accordingly, a paper was prepared by Mr. F. W. Dean, who was closely associated with Mr. Leavitt and is intimately acquainted with his accomplishments. This paper is to be presented at the Annual Meeting and is here published in abstracted form with a selection of a few of the engravings.



THE LATE ERASMUS DARWIN LEAVITT, PAST-PRESIDENT AND HONORARY MEMBER OF THE SOCIETY, AN ACCOUNT OF WHOSE STRIKING WORK IN THE DESIGN OF LARGE STEAM ENGINES AND OTHER MACHINERY WILL BE GIVEN BY MR. F. W. DEAN AT THE FORTH-COMING ANNUAL MEETING

E. D. LEAVITT received his education in the public schools in Lowell, Mass., learned the machinist's trade in the Lowell Machine Shop, was assistant foreman at Harrison Loring's works at South Boston, was chief draftsman at the works of Thurston, Gardner & Co., at Providence, entered the Navy in 1861, and resigned therefrom in 1867. At this time he began the office practice of mechanical engineering, and on account of the times and his ability he achieved great success; not, however, without some discouragements.

I have understood that his first steam engine was designed for Crozer's cotton mill, in Chester, Pa., and built by I. P. Morris & Co., Philadelphia. This was a simple horizontal engine with a steam chest as long and wide as the cylinder. The chest contained a very large main valve worked by an eccentric and having a cut-off valve on its back at each end worked by a cam. The steam exhausted into the main valve which was hollow, and from this passed out through a special exhaust port. The main valve, being in a chest of live steam and having exhaust steam within, formed a condenser to some extent, and to persons who knew of Mr. Leavitt's great efforts in general to secure economy this was a subject of comment. Later he used the same design for the Brooklyn Bridge engines and for those of the El Callao Mining Co. of Venezuela. He appeared to be attached to this design and spoke of it as his cheap engine, but never mentioned its obvious defect.

Mr. Leavitt was firmly of the opinion that the best valve for a steam engine was the gridiron and he always used it except in the few cases mentioned above. Mr. Leavitt claimed that the gridiron valve was the only one that would remain tight indefinitely. The reason for this was that it has a great deal of wearing surface and no tendency to cock over and press more on one edge than the other, and that when operated by cams has a constant travel, except, of course, the cut-off valves as early cut-offs.

Mr. Leavitt used cams because they enabled him to secure exact and unchangeable motion to the valves.

The automatic cut-off feature was obtained by placing a cam on a hollow piece of shaft or sleeve through which the camshaft passed, and by suitable connection with the governor the cut-off cam could be advanced or retarded. This was accomplished by having a spiral slot cut in the camshaft and a straight one in the sleeve, a key made to fit both and moved by a sliding collar, which in turn was moved by the governor.

It is obvious that the governor moved the valve and therefore had to be large and powerful. For good governing this was not satisfactory, except for pumping engines, which ran slowly, and finally the governing apparatus was changed to that having a small high-speed governor whose function was to operate a balanced piston valve which admitted and exhausted water or oil under pressure to and from a hydraulic plunger and this moved the cut-off collar. Thus the governor had no

For presentation at the Annual Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York, December 4 to 7, 1917. The paper is here printed in abstract form, and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

resistance to overcome except friction, and could be made as sensitive as desired. After the first trial of this governor it was always used.

Mr. Leavitt's fame began with the installation of the Lynn, Mass., pumping engine, built by I. P. Morris & Co., which made an advance in economy over anything which preceded it. Its economical performance was based upon coal consumed, and upon its trial in December 1873 it gave a duty of 103,923,215 ft-lb. per 100 lb. of picked Lackawanna anthracite coal, based upon water discharged over a weir. While the feedwater was weighed and indicator diagrams taken, no evaporative rate for the boilers nor rate of steam consumption for the engine was given in the report.

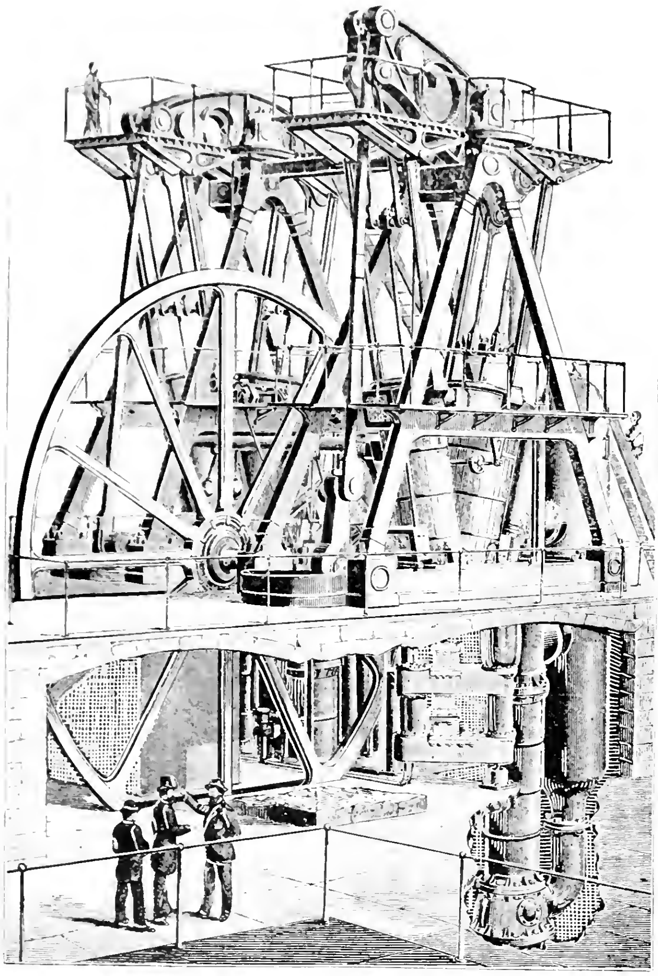


Fig. 1 The Lawrence Pumping Engine

The Lynn engine was soon followed by the Lawrence engines, also built by I. P. Morris & Co., which were tested for duty based upon 100 lb. of coal consumed and water discharged as determined by weir measurement. The test was made on May 2 to 6, 1876, and the duty was 96,186,979 ft-lb. per 100 lb. of Cumberland coal. The boilers were of an excellent design of the locomotive type and ought to have given a very high evaporation if properly fired. They only evaporated 8.27 lb. of water and 8.69 lb. on different tests per pound of coal from feed at 100 deg. fahr. and pressure at 89 lb. This was attributed to poor coal, but must have been due to poor firing. In those days calorimeter tests of coal and analyses of escaping gases were seldom made. Here again, while feedwater was weighed and indicator diagrams taken, the steam rate of the engine was not worked out.

Fortunately Park Benjamin's Scientific Expert Office tested one of the Lawrence engines in 1879 after the engine was over three years old. The principal data and results were as follows:

Date	July, 1879
Duration of test, hr	15.1
Kind of coal used	Cumberland bituminous
Diameter of high-pressure cylinder, in	18
Diameter of low pressure cylinder, in	38
Diameter of plunger, in	18.5
Stroke of steam pistons and plunger, ft	8
Diameter of flywheel, ft	30
Clearance of high pressure cylinder, per cent: top, 2.56; bottom,	2.31
Clearance of low-pressure cylinder, per cent: top, 1.54; bottom,	1.82
Steam pressure above atmosphere, lb	89.5
Vacuum, in	27.4
Revolutions per minute, average	13.62
Discharge of pump in 24 hr. by plunger displacement, gal.	4,461,272
Duty per 100 lb. of coal consumed, based upon plunger displacement, ft-lb	111,548,925
Temperature of feedwater, deg. fahr	119
Temperature of escaping gases, deg. fahr	358
Coal consumption per sq. ft. of grate per hr., lb	8.38
Actual evaporation per pound of coal, lb	10.13
Equivalent evaporation from and at 212 deg., lb	11.49
Equivalent evaporation per pound of combustible from and at 212 deg., lb	12.24
Coal used per indicated horsepower per hr., lb	1.63
Feedwater used per hr., lb	2437
Feedwater used per indicated horsepower per hr., lb	16.48
Condensation in high-pressure cylinder jacket per hr., lb	118
Condensation in low-pressure cylinder jacket per hr., lb	160

In this table we have means of judging of the economical performance of both boiler and engine. The former was among the best and the latter was probably as good as that of any steam engine up to that time. There appears to have been no determination made of the moisture in the coal or in the steam.

The perspective drawing given in Fig. 1 and taken from the Park Benjamin report gives a good idea of the Lawrence engines, and serves the same purpose for the Lynn engine, there being one engine in the latter case.

THE BOSTON SEWAGE ENGINES

When the City of Boston undertook to dispose of its sewage by discharging it into the ocean south of the harbor limits, it became necessary to raise it about 40 ft. near the north shore of Dorchester Bay. Mr. Leavitt designed two vertical compound flywheel engines for this purpose, which are shown in Fig. 2. These were built by the Quintard Iron Works, New York, and were vertical inverted compound flywheel beam engines of the following general dimensions:

Diameter of high-pressure cylinder, in	25¼
Diameter of low-pressure cylinder, in	52
Diameter of each of the two plungers, ft	4
Stroke of each piston and plunger, ft	9
Number of plungers	2
Number of revolutions per minute, nominal	10¾
Capacity in 24 hr., nominal, gal	25,000,000

The cylinders were steam-jacketed and there were tubular reheaters between the high- and low-pressure cylinders, one being between the upper ends of the cylinders and the other between the lower ends.

In 1885 one of the engines and its twin-furnace locomotive-type boiler were tested by Dexter Brackett with the following results:

Dates of trials, 1885	Mar. 24-25	May 1-2
Duration	24h. 43m.	24h. 3½m.
Revolutions per minute, average	13.17	13.42
Total lift, ft	37.80	42.43

Total dry coal consumed, lb.	8,307	9,478
Duty per 100 lb. dry coal, ft-lb.	125,450,000	122,400,000
Mean boiler pressure, lb. per sq. in.	99.4	98.6
Mean vacuum in condenser, in.	28.1	28.0
Total plunger displacement, gal.	33,038,000	32,778,000
Total discharge by weir, gal.	30,224,000	31,256,000
Average slip, per cent	8.5	4.6
Approximate indicated horsepower	251.5	290.2
Plunger horsepower, no allowance for slip	212.9	243.5
Mechanical efficiency, per cent	84.66	83.90
Approximate coal used per i.hp. per hour, lb.	1.33	1.35
Approximate steam used per i.hp. per hour, lb.	13.89	14.09

In 1889 he designed a larger triple-expansion engine for the same place.

THE LOUISVILLE PUMPING ENGINE

The next pumping engine of Mr. Leavitt's design to attract attention was the Louisville engine, built by the I. P. Morris Co., and it was the first to be thoroughly tested. The test was conducted by Dexter Brackett and F. W. Dean and lasted 144 hr. 10 min. without stopping.

The engine was arranged similar to the Boston sewage engines, but had the flywheel shaft near the floor level and at one end of the bedplate instead of being elevated and between or just below the lower ends of the cylinders. The reheaters were of the same type.

The following are the general results of the test:

Diameter of high-pressure cylinder (hot), in.	22.21
Diameter of low-pressure cylinder (hot), in.	54.13
Diameter of high-pressure piston rod, in.	5.50
Diameter of low-pressure piston rod, in.	6.00
Stroke of each piston, ft.	10
Mean clearance volume of high-pressure cylinder, per cent.	1.585
Mean clearance volume of low-pressure cylinder, per cent.	1.530
Diameter of each differential plunger, in.	34 & 24 1/16
Stroke of each differential plunger, ft.	7
Diameter of flywheel, ft.	36
Duration of trial	144h. 10m.
Revolutions per minute, average	18.574
Average steam pressure at the engine, lb. per sq. in.	137
Back pressure on low-pressure piston, lb. per sq. in.	0.95
Total head, ft.	193.35
Total dry steam used by engine in cylinders and jackets, lb.	1,127,533
Dry steam used per i.hp. per hour including jacket steam, lb.	12.156
Horsepower of high-pressure cylinder	279.00
Horsepower of low-pressure cylinder	364.40
Horsepower of both cylinders	643.40
Horsepower of plungers	599.10
Mechanical efficiency of engine, per cent.	93.12
Duty per 1000 lb. of dry steam by plunger work, ft-lb.	150,838,000
Duty per 1,000,000 B.t.u. by plunger work, ft-lb.	151,672,000
Avg. capacity of engine in 24 hr. by weir, U. S. gal.	16,489,420
Avg. capacity of engine in 24 hr. by plungers, U. S. gal.	17,681,350
Average slip of plungers, per cent	6.74

THE WASHINGTON MILLS ENGINES

These are the only Leavitt power engines that have ever been thoroughly tested as far as I know. They were put in under a guarantee and tested by John T. Henthorn and E. D. Leavitt, Mr. Leavitt being represented by A. M. Mattice. They were built by the Dickson Mfg. Co., Scranton, Pa., and were a pair of 30-in. by 60-in. steam-jacketed horizontal non-condensing engines running at 60 r.p.m. and driving a 30-ft. wheel grooved for thirty $1\frac{3}{4}$-in. ropes. The test was made after the engines has been in operation about three years, and the general results obtained are as follows:

Duration of test (June 12-19, 1890)	One week, mill hours
Running time	61 hr. 41 min
Average steam pressure at engines, lb. per sq. in.	132.2
Average revolutions per minute	58.82
Average back pressure, lb. per sq. in.	7.98
Average indicated horsepower both engines	1199.2
Net moist steam used by engines (including jackets) per i.hp. per hour, lb.	23.16
Per cent of steam used by jackets	3.05

DETAILS OF ENGINE DESIGN

Cams. In the early Leavitt engines the cams were made with grooves in the side and the throws were inserted hardened steel. The high-pressure cut-off cam, although it appeared to be grooved, was not in fact. It consisted of two cams, one recessed and overhanging the other. The opening cam was secured to the camshaft and the cut-off cam to the hollow shaft which was controlled by the governor. The rolls which were actuated by the cams were on pins overhung from rockers.

When the hoisting engine Superior was built, having cylinders 40 in. and 70 in. by 6 ft., grooved cams were used. The camshaft was located near the floor level, and as the engine was vertical and inverted, the valve rods were very long and heavy. It was intended to run the engine at 60 r.p.m., but the valve gear would not operate satisfactorily, I have understood, at over 35 r.p.m. The noise was so great at higher speeds that conversation could not be carried on nearby without shouting at close range, and breakages of the cut-off cams and levers occurred. The outcome of the trouble was that a new valve gear was designed which was light and possessed small inertia stresses. In the case of the Superior the camshaft was raised to a level with the middle of the cylinders and was supported, together with the valve gear, by means of brackets attached to the valve-chest bonnets. The valve rockers for the lower valves extended downward, and for the upper valves upward, from the camshaft.

The outside cams had rolls on opposite sides rotating on pins in forked rockers so that there were no overhung pins. The pair of rockers of one cam were connected together by links, and the throws of the cams were so formed that both rolls always touched the cams. The Superior was started with the new valve gear in the latter part of 1883, and has been running ever since, from 20 hours to 24 hours per day, with the utmost satisfaction.

Fig. 3 shows the Superior with a new valve gear, while the paper by Mr. Leavitt in Vol. 2 of Transactions (facing p. 120) shows it with the original gear.

Cylinder Design. The Leavitt cylinders were always steam-jacketed and had the jacket cast on. Mr. Leavitt always feared leakage with cylinders having liners. The jacket was cast with an opening all round the center and this was covered with a copper ring with one corrugation. The ring was secured by two rows of tap bolts on each side. The division of the jacket wall in this way was the result of some serious disasters. The jackets of the Lynn and Lawrence pumping engines were cast without the division and straight, with the result that one or more of them cracked and had to be replaced. A cylinder of a steam stamp at the Calumet and Hecla Mine made without provision for jacket expansion broke and went through the roof of the building.

The steam chests of the cylinders were always cast on, and sometimes the crank-end head was cast in, and sometimes it was separate. Fig. 4 shows a typical cylinder. This design shows the inner wall serrated in order to provide more surface for contact with steam and thus render jacket action more active. This was a feature not always used, and was borrowed from the practice of a well-known Belgian engineer.

Valves and Valve Seats. The valves were rectangular plates with one end formed to receive T-ended valve stems. The ports were slotted. The seats were secured to the cylinder by means of studs, and the surfaces of contact between the cylinder and seat were scraped to continuous contact. The bridges between the ports of the seats were each provided with

an oil groove. There were two yokes secured to the seats for preventing the valves from leaving the seats too far. In vertical cylinders the seats were somewhat inclined so that the valves would tend to rest against them.

In order to fill up all unoccupied spaces blocks were screwed in or cast on to reduce the clearance volume.

In designs made since about 1888, the clearance volume was still further reduced by casting V shaped forms on the cylinder ports under the bridges of the valve seats. This added to the condensing surface of the clearance, and in fact all other devices for diminishing clearance did this also, and I have

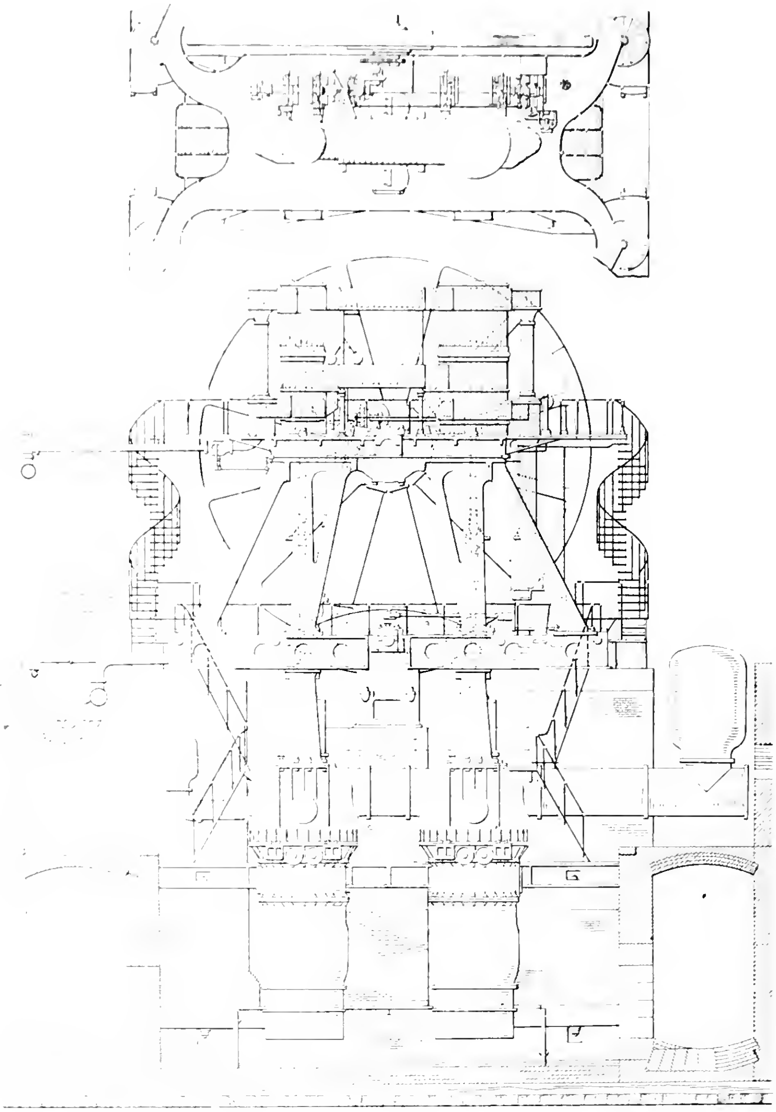


FIG. 2 BOSTON SEWAGE PUMPING ENGINE

no doubt that whatever may have been gained by reducing clearance was lost by the increase in surface. All Leavitt engines gave an indicator diagram with a long drop in the compression line. The compression would go on for a time and then there would be a collapse which would not be recovered. I think that this was caused by condensation in the clearance which in turn was caused by the great amount of surface in the valve-seat ports and other parts.

There was always means of operating the valves by hand, and this involved a handwheel something like the steering wheel of a steamboat except that it was of steel. There were two clutches moved by a lever, one of which engaged the cam-shaft with a driving shaft and the other engaged it with the handwheel. One of course was engaged when the other was disengaged. The operation of starting consisted chiefly in placing the valves in the proper position, opening the throttle and throwing the clutches at the proper time. The skill required to do this was easily acquired.

THE LEAVITT BEAM ENGINE

Mr. Leavitt was very fond of the inverted beam engine for the reasons that it made a very low engine and was long and stable in the direction of motion of the parts, and cheapened the building by making it lower. The beam was generally made of air-furnace or gun iron, but later of steel castings. The weights of the beams and reciprocating parts were very great and they all moved in the same plane, but no trouble came from this in practice.

The usual place for crossheads was above the beam, but they have been placed below, and in this case the links from the crossheads extended upward to the beam pins. The beams were generally made in two "flitches" (to use Mr. Leavitt's word), but sometimes in a single piece. The connecting-rod

pin sometimes was overhung from the beam, but oftener was between the flitches.

In compound engines the high-pressure cylinder was above one end of the beam and the low-pressure cylinder above the other, but in 1886 Mr. Leavitt began the design of triple-expansion engines, which he arranged by having the high and intermediate cylinders above one end of the beam and the low-pressure cylinder above the other. The high and intermediate pistons had coincident motions. The steam pressure used for compound engines was 135 lb. and for triple-expansion engines 185 lb.

Reheaters were used in each case, and it may here be remarked that Mr. Leavitt had great difficulty in making the reheater tubes tight in the tube plates.

In some of the later triple-expansion or three-cylinder compound engines three beams were used and each piston was connected to one end of each beam, and there were three connecting rods and three cranks 120 deg. apart. These were certainly beautiful pieces of mechanism and operated to perfection. The first such engine was the Riedler pumping engine of the Boston Water Works, built in 1894 and shown in Figs. 5 and 6.

The engine at the Bethlehem Steel Co., designed by Mr. Leavitt for pumping water for the forging press and built by the I. P. Morris Co., is another example of this arrangement, and there are three of them driving electric generators at the stamp mill of the Calumet and Hecla Mining Company, as well as several hoisting engines of this type. In the stamp-mill engines, although gridiron valves were used, they were not operated by cams. They were opened by eccentric rods and were provided with latches and dashpots as in Corliss gears. This feature of the valve gear was caused by the engines having been built for a reversing hoisting gear, and the valves could be better controlled by a reversing link when so made than if reciprocating cams were used as on the engines Minong and Siscowit.

HOISTING MACHINERY

For many years the method of hoisting at both the Calumet and the Hecla mines was by means of constant-running engines, which also drove air compressors. The hoisting drum was on a shaft to which it was not secured except by means of a clutch. There was also a brake to prevent the drum from moving and holding it fast whether the engine was running or not. Both the clutch and brake were operated by means of hydraulic pressure from an accumulator, and the levers for controlling them were interlocked so that the clutch and brake could not be thrown on simultaneously. The clutch cylinder was secured to an arm of the flywheel and the water was introduced through the shaft which was bored for the purpose. The brake was secured to a post which was firmly bolted to the foundation. The brakes and clutches were of the strap type and worked on wood. There was an indicator to show the position of the skip in the shaft, and an anti-overwinding device, which I believe was never used. The drum centers were in halves, and were lined continuously with babbitt metal. The rope faces were sometimes straight and sometimes conical, and the arms were of wrought rods.

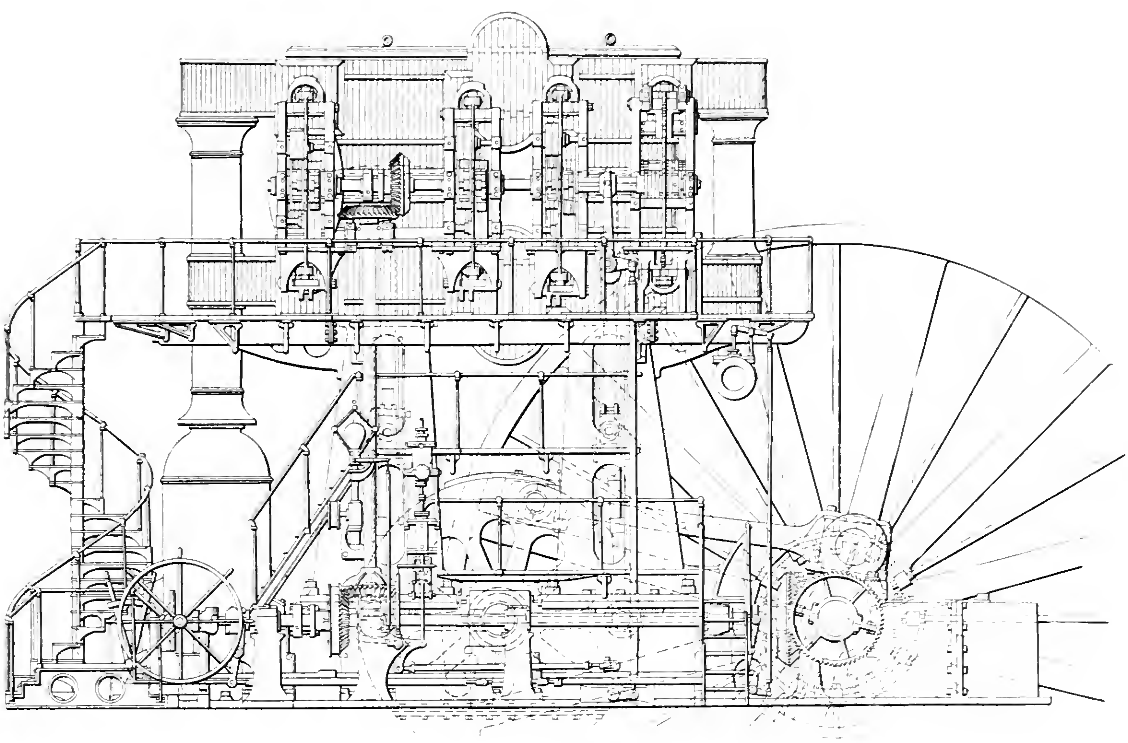


Fig. 3 The "Superior" Engine

When Mr. B. S. Whiting entered the employ of the Calumet and Hecla Mining Company the Whiting system of hoisting was introduced. This was first used at the Red Jacket shaft, and consisted of two cages, one descending and the other ascending, with a rope from the bottom of one to the bottom of the other, and thus being balanced. The engine drove a pair of narrow-faced drums with two wraps over both drums. The drum shafts were coupled together like the wheels of a locomotive and the engines were reversing.

The introduction of reversing engines brought new problems in engine design and the first engines were the Minong and Siscowit. These were vertical, triple-expansion condensing beam engines using 185 lb. steam pressure. They had cam-operated gridiron valves with automatic cut-offs on the high-pressure cylinders. The cams were reciprocating. The

Walschaert's gear was used, the lap and lead were derived from the beam [illegible], and the reversal was affected by hydraulic mechanism.

Afterward there were several other installations of the Whiting system with other types of engine.

COMMERCIAL ENGINES

Mr. Leavitt recommended quite a number of commercial engines for hoisting, pumping and for driving air compressors, but they were usually for spare units or for temporary purposes. For instance, the Superior originally drove hoisting drums on one side and air compressors on the other. On the air compressor side and beyond the compressors there was a spare Corliss engine which could be coupled on to drive the compressors if the Superior had to be stopped. At the other side there was a 40-in. by 60-in. horizontal condensing Leavitt engine for driving the hoisting drums in an emergency. At the Hecla mine there was an exactly similar arrangement with the Leavitt vertical compound condensing beam engine Frontenac in the middle driving in both directions, with a spare commercial Corliss engine at each end. Similarly there were various commercial engines in other hoisting houses, and not

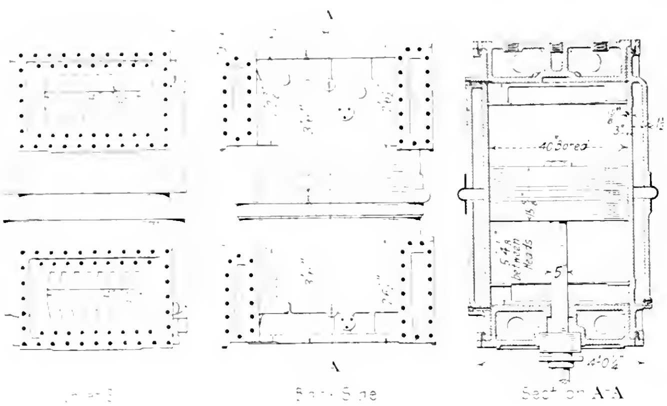


Fig. 4 Typical Engine Cylinder

always spare engines. In such cases the commercial part was the smallest.

AIR COMPRESSORS

A great many air compressors are needed at the Calumet and Hecla Mines, and up to a certain time commercial compressors were used. Soon after the installation of wet compressors at the St. Gothard Tunnel in Switzerland, Mr. Leavitt was impressed with the advantages of the type and designed a pair of 42-in. by 60-in. by 30-r.p.m. wet compressors. These were placed in the Hecla hoisting house and were similar to double-acting pumping engines, the plunger causing water to rise and fall in two vertical cylinders or chambers—one at each end. At the top of each of these chambers there was a valve deck having inlet and discharge air valves, and below there were spray nozzles for cooling the air. The spray water was pumped by a small attached pump. There was a separator in which the water settled, and the quality of the air was satisfactory. These compressors were successful, but later when similar ones were installed at the Calumet hoisting house to run at double the speed, as I understand, they were unsuccessful on account of that speed and were replaced by dry compressors.

PUMPING ENGINES

Something has already been said about Leavitt pumping engines, and it is well to state that the Lynn type of engine was used only at Lynn and Lawrence. When the first engines were designed for the Calumet and Hecla Mining Company they were inverted, and with the high-pressure cylinder inclined for the purpose of having the cylinders as near together as possible and thus reducing certain losses. Between the near ends of the cylinders there was a single valve which was both high-pressure exhaust and low-pressure inlet. At the distant ends there were two valves which moved simultaneously, one being the high-pressure exhaust and the other the low-pressure inlet, although the Lynn engine had only one valve between the distant ends of the cylinders. Later, when the Boston sewage, Fig. 2, and the Calumet Pond pumping engines were designed the cylinders were all vertical and reheaters were used.

The greatest requirement for water at the Calumet and Hecla mine is at the stamp mill, which is some six miles from the mine, on Torch Lake, which is an inlet from Lake Superior. The pumping engine Ontario and the large-capacity spare pumps Huron and Arcadian are there. The engine Michigan is the largest engine at the stamp mills, and has cylinders 18 in., 27¾ in. and 48 in. by 90 in. and two plungers with the suction ends 48 in. by 90 in. The number of revolutions per minute was intended to be 30 and the capacity 60,000,000 gal. in 24 hours. It runs usually at 28½ r.p.m. The head is about 40 ft. This engine uses steam of 185 lb. pressure. The Michigan was a bold design, as it is supported by wide, straddling cast-iron columns as shown by Fig. 7. This engine had pump cylinders which were oval at the valve level for accommodating the valves, and were of great size, being 9 ft. 10 in. wide the narrow way and 14 ft. 2 in. the other way. They were cast of gun iron.

The Lynn and Lawrence engines had each one plunger, this being of the Thames-Ditton type, being single-acting on the suction and double on the discharge, with a few large double-beat metal valves. This type of plunger was not used later, but instead of this the differential plunger was used. This plunger is of two diameters, the lower part having twice the cross-section of the upper. The lower section passed through the discharge valve deck and the upper section through the top of the pump. This plunger is single-acting on the suction and double on the discharge, and two were always used, one being under each end of the beam. The differential plunger was invented by Mr. Leavitt, but he soon found that he was anticipated in this.

The sewage engines designed for the City of Boston had each two plungers of a single diameter.

The largest Leavitt pumping engine, designed in 1889 and built by the I. P. Morris Co., was the last sewage engine for Boston, already referred to, the cylinders being 18½ in., 33 in., and 52¾ in. by 10 ft. stroke. The plungers, of which there are two, are 60 in. in diameter by 10 ft. stroke, and the rated capacity 75,000,000 gal. in 24 hours against a head of about 40 ft. The speed is 18 r.p.m.

The Cambridge engine, designed in 1895 and built by the De La Vergne Machine Co., New York, was a triple-expansion engine using 185 lb. pressure. The cylinders were 18½ in., 33 in., and 52¾ in. by 7 ft. 6 in. stroke, and the plungers (two differential) 19⅜ in. and 27¾ in. by 7 ft. 6 in. stroke. Its rated speed was 32 r.p.m., and this gave a piston and plunger speed of 480 ft. per min. and a capacity of 20,000,000 gal. in 24 hours. If the engine had run slower it would have been more satisfactory.

At about the time the Cambridge engine was designed Mr. Leavitt was commissioned with the design of a pair of engines for the city of New Bedford, Mass., which were built by the Dickson Mfg. Co. It was decided to make these engines compound and to use 185 lb. pressure, in order to compare their economy with that of the Cambridge engine using the same steam pressure and being triple. I do not know whether the comparison was ever made, but the station economy of the New Bedford engines is better than that at Cambridge. The steam cylinders of the New Bedford engines are 16⅜ in. and 36¼ in. by 7 ft. 6 in. stroke, and the pump plungers are 13.7 in. and 19⅜ in. by 7 ft. 6 in. stroke.

A feature of some Leavitt pumps is that under each suction valve there is a tube several inches long with a bell lower end, the object being to form a suction air chamber between the tubes. I am not aware that any benefit from this construction was identified. It was used on some Calumet and Hecla engines, and also on the Cambridge and New Bedford engines.

Mr. Leavitt was a great believer in steam jackets, and used boiler pressure for this purpose, even in low-pressure cylinders of engines using 185-lb. steam. It is known that these engines exhausted steam considerably superheated into the condensers, but I believe that Mr. Leavitt held that there was great benefit in drying the steam as much as possible before it left the cylinder.

The Leavitt pump valves were not as small as those used in commercial engines. They were usually faced with leather and had separate adjustments for the lift and tension of the spring. For sewage engines the valves were rectangular and hinged on one side, each covering an opening of 4 in. by 16¾ in. in the latest engine.

Mr. Leavitt became acquainted with Professor Riedler, of Berlin, and I believe acquired the right for a time to use the Riedler pump in the United States. The Riedler pumping engine for the city of Boston, already referred to (Figs. 5 and 6) was a triple-expansion three-cylinder, three-beam, three-connecting rod, three-crank and three-pump engine, and was the only one designed by Mr. Leavitt.

The pumps were inclined and double-acting, located at the rear of the engine and operated by connections to the beams. Each pump had a single suction and a single discharge valve at each end operated by mechanism.

The engine was built by the Quintard Iron Works, New York. As it was intended to surpass all previous efforts at economy, the results of a test made by some students of the Massachusetts Institute of Technology under the direction of Prof. Edward T. Miller are herewith given:

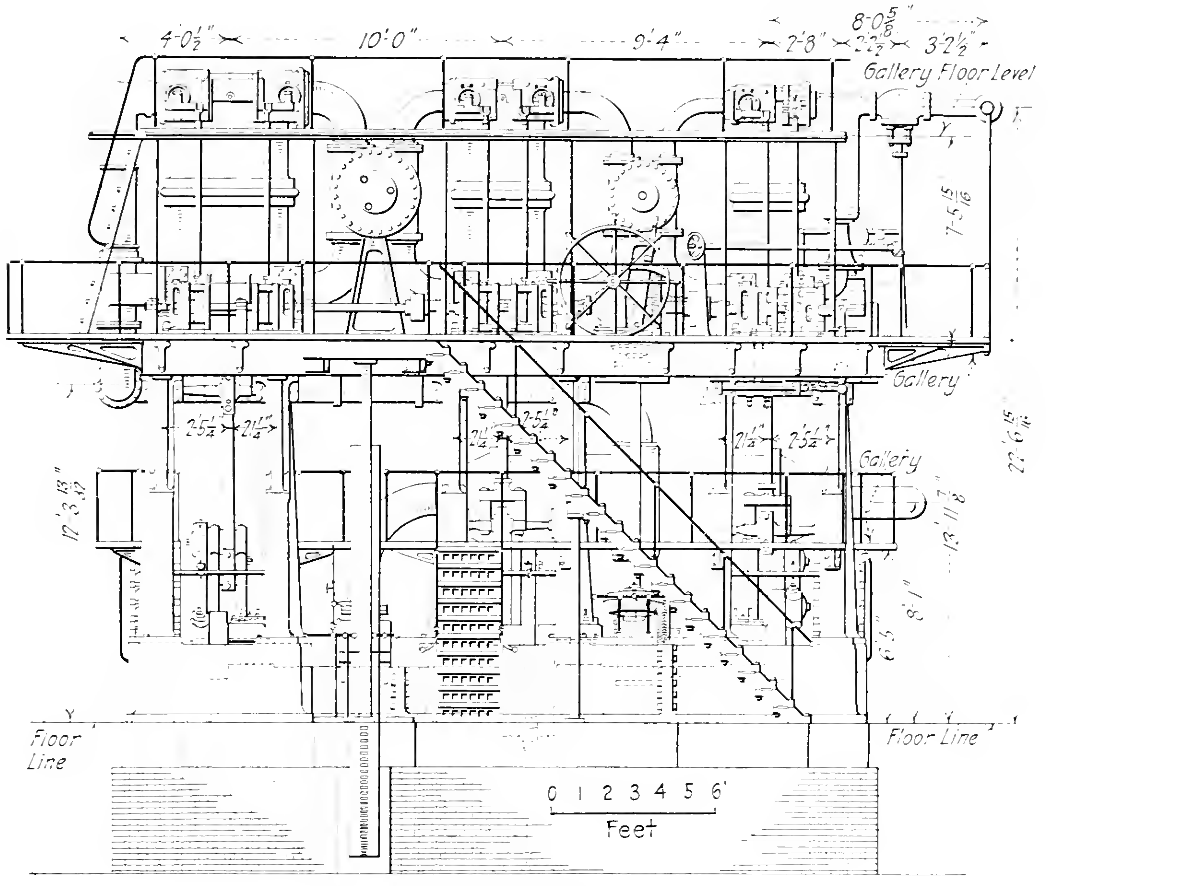


Fig. 5 Riedler Pumping Engine

Diameter of high-pressure cylinder, in.	13.7
Diameter of intermediate-pressure cylinder, in.	24.375
Diameter of low-pressure cylinder, in.	39
Stroke of each piston, in.	72
Diameter of each plunger, in.	17.5
Stroke of each plunger, in.	48
Rated capacity in 24 hours at 50 r.p.m., gal.	20,000,000
Type of condenser	surface
Steam pressure, lb. per sq. in.	185
Type of boiler	Belpaire locomotive
Duration of trial, hours	24
Average number of revolutions per minute	50.585
Average steam pressure at throttle, lb.	175.7
Average vacuum in condenser, in.	27.25
Average pressure in first receiver, lb.	46.5
Average pressure in second receiver, lb.	2.4
Average pressure in high and intermediate cylinder jackets, lb.	175.7
Average pressure in low-pressure cylinder jacket, lb.	99.6
Indicated horsepower of high-pressure cylinder	150.86

Indicated horsepower of intermediate cylinder	186.44
Indicated horsepower of low pressure cylinder	238.66
Total steam horsepower	575.66
Total pump horsepower ..	529.86
Mechanical efficiency, per cent	92.
Friction, per cent	8.
Water discharged in 24 hours by weir measurement, gal	24,016,000
Slip, per cent	1.83
Dry steam used per I.hp. per hour, engine only, lb	11.22
Coal used per I.hp. per hour, whole plant, lb	1.18
Duty per 100 lb. coal, ft lb	150,045,000
Duty per 1,000,000 B.t.u., ft lb...	115,470,000
Duty per 100 lb. combustible, ft lb	160,000,000

THE LEAVITT STAMP

The steam stamp devised by Mr. Leavitt for stamping rock containing native copper is a gigantic steam hammer about thirty-eight feet high above the foundation. See Fig. 8. When Mr. Leavitt began to study economy of steam for stamps he found great room for improvement, and then devised his well-known stamp. It has two pistons on the same rod, the upper one being considerably larger than the lower. Steam for the blow acts upon the top of the upper or larger piston and is admitted by a gridiron valve and exhausted by another to a condenser. Both valves are operated by cams. The space between the upper and lower pistons is constantly connected to the condenser. The space under the lower piston is occupied by live steam and serves to lift the stamp, and the steam thus used is churned into and out of a reservoir, and thence to and from the steam pipe. The lower piston enters a compression chamber at the bottom to limit the downward stroke, while the upward stroke is limited by a lower piston entering a dashpot.

As appears to have been the custom at the Lake Superior mines, the stamp anvil, which has been made of various weights, rested formerly on large maple spring timbers. In about 1900 these were omitted and the anvil placed directly on the foundation. By this means the output of the stamp was increased and the vibration of the surrounding territory diminished. There are 27 Leavitt stamps at the Calumet and Hecla stamp mills, each making 108 blows per minute.

The valve gear and condenser pump are driven from a shaft which serves a long line of stamps. Later, I understand, the exhausts of all of the stamps were taken to low-pressure turbines, with the result that some of the power engines were shut down, and considerable economy resulted.

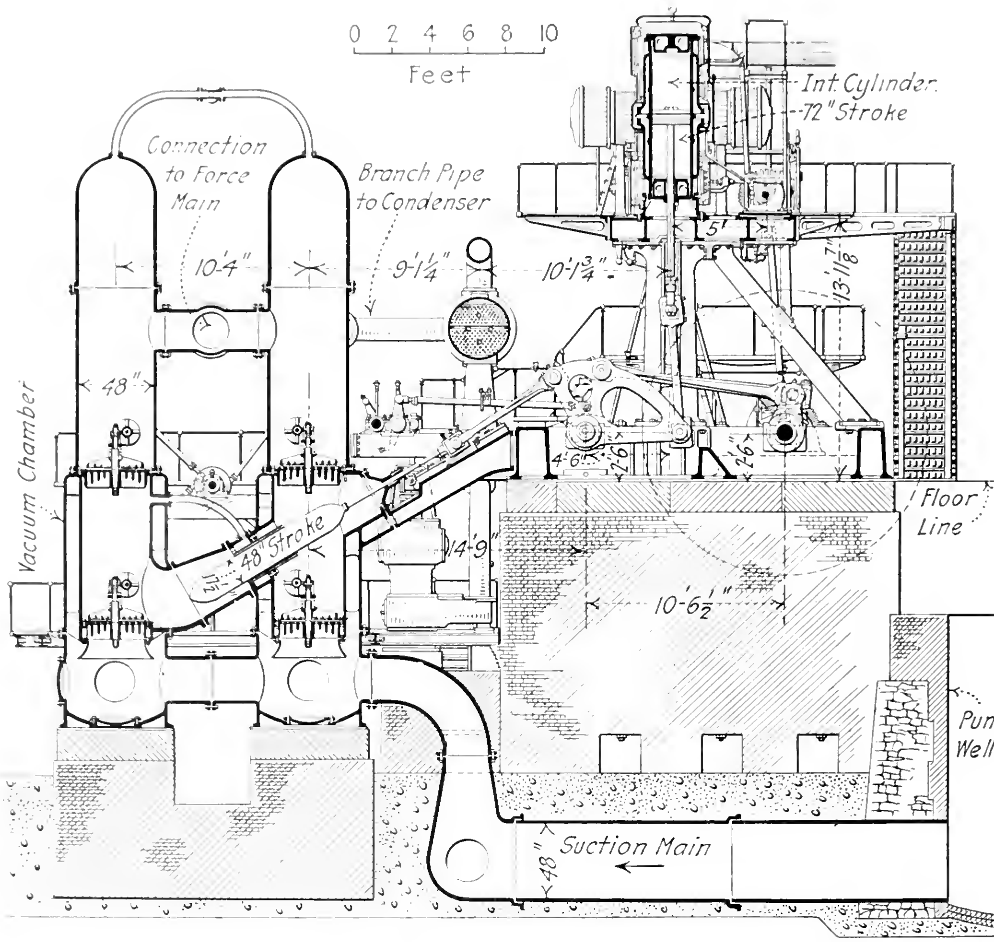


FIG. 6 RIEDLER PUMPING ENGINE

BOILER PRACTICE

Mr. Leavitt was a great advocate of the locomotive boiler and usually installed this type. I understand that before adopting it he designed some boilers for the Calumet and Hecla mine which were a sort of "elephant" boiler, and these were failures. After this the locomotive type was always used, and these were a great success. They had a firebox with a mid-water leg, thus forming two fireboxes. The mid-water leg extended forward from the firebox and formed two so-called flues to a single combustion chamber which ended at the tubeplate. The length of the flues was often 3 ft. 6 in. and the combustion chamber 4 ft. At the end of the grate there was a 20-in. firebrick wall, thus making the distance from the end of the grate to the tubeplate 9 ft. 2 in. In 1882, or thereabout, brick arches began to be used, as in locomotive practice.

Originally the boilers had a round top above the crown sheet,

but later, due to the writer's influence, the Belpaire form of firebox and method of staying was adopted. Up to about this time the joints in the barrel of the boiler were butted, both longitudinal and circumferential, but Mr. Leavitt was influenced to abandon the latter for lap joints. The longitudinal butt joint was, of course, preserved, and it is interesting to know that the prevailing form of butt joint used in this country, viz., that having a narrow outside and wide inside strap, was devised by Mr. Leavitt and Edward Kendall, of Cambridge, Mass., where Mr. Leavitt also lived. This joint was then thought to be the final word in joint efficiency and the drawing of the first boiler having it was made in 1879.

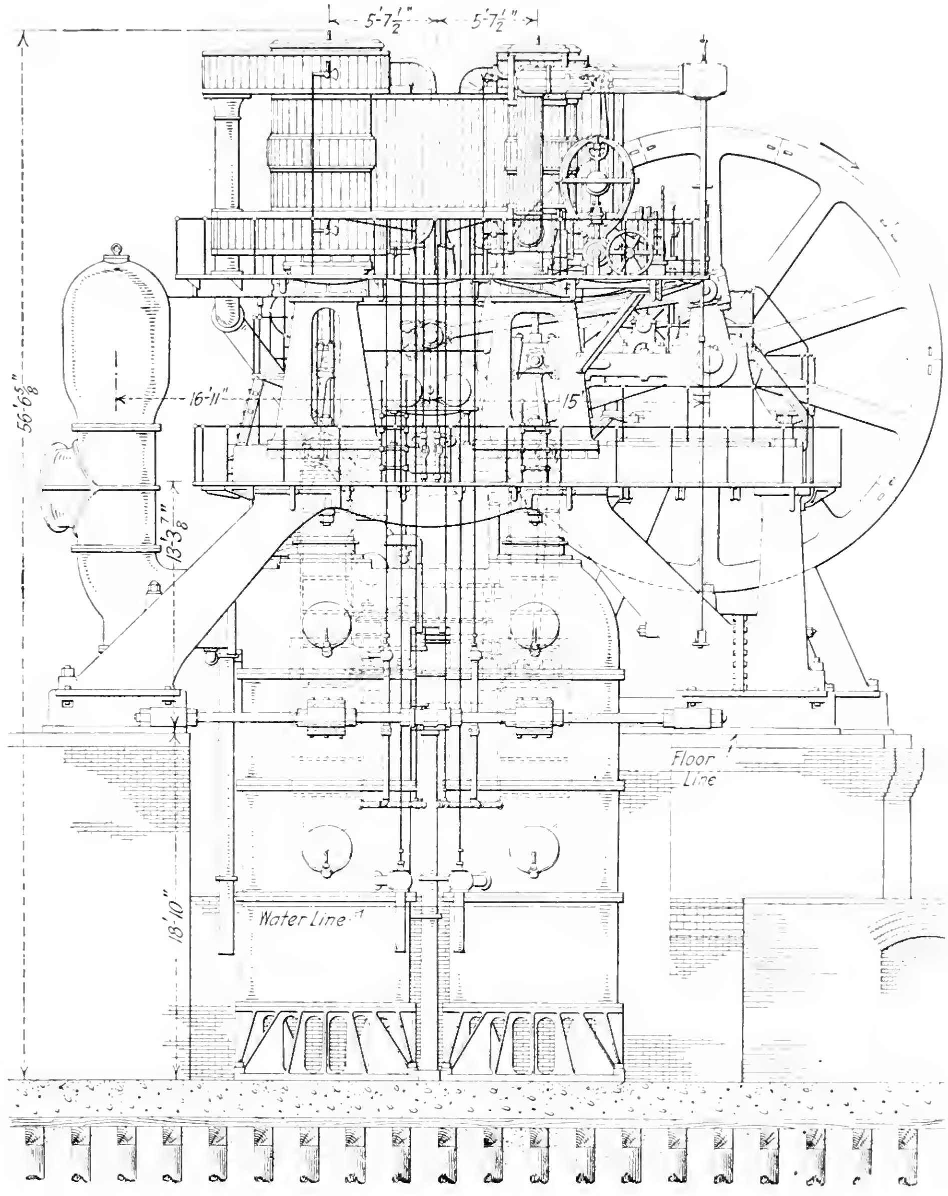


Fig. 7 Michigan Pumping Engine

Why Mr. Leavitt did not adopt English practice in butt joints, with which he must have been acquainted, I do not know, but I suppose that he was seeking a joint of higher efficiency than that, as then designed, which had the straps of equal widths and all rivets in double shear.

The first Belpaire boiler he designed was for 135 lb.; others were designed for 185 lb. pressure. These boilers were very expensive, and as the largest had only 2900 sq. ft. of heating surface, the cost per square foot of heating surface was very high. It was, in fact, about $5.20 in 1887 for 90-in. boilers for 185 lb.

For mill work Mr. Leavitt used the horizontal return-tubular boiler, and some of them 78 in. in diameter carried 185 lb. pressure. For the New Bedford pumping engines he used cylindrical boilers with two Purves furnaces each and 3-in. tubes from the furnaces to a smokebox.

Consulting Engineering

So far as I know, Mr. Leavitt did not do much general expert work, but he acted as consulting engineer for a number of companies. Among them were Henry R. Worthington and the Dickson Mfg. Co. He designed the Penn Avenue shop for the latter company at Scranton, Pa. This was a well-lighted shop with a high center bay and traveling crane, and a gallery on each side.

Mr. Leavitt's influence upon good designing in this country must have been great, and the many draftsmen whom he em-

ployed and who have scattered throughout the country must have exerted a great and silent influence upon excellence in design, which they owe to him. I feel that William Sellers, E. D. Leavitt, John E. Sweet and Charles T. Porter were the best machine designers that this country has produced up to their time. Mr. Leavitt willingly gave credit to the other three for much of his own good work.

According to the *Frankfurter Zeitung*, the newly manufactured compressed cellulose piping has proved very satisfactory in chemical factories and also in mining works. The new material, it is said, is absolutely non-porous, is considerably lighter than iron, can be worked like wood, and is consequently easily moved and repaired. As cellulose is a bad conductor of heat, it requires no particular protection against heat; it also resists chemical influences better than iron. Cellulose tubes are suitable for conducting hot and cold air, and for corrosive gases which eat into iron conductors very quickly. They are not suitable, however, for steam.—*The Engineer* (London), August 17, 1917.

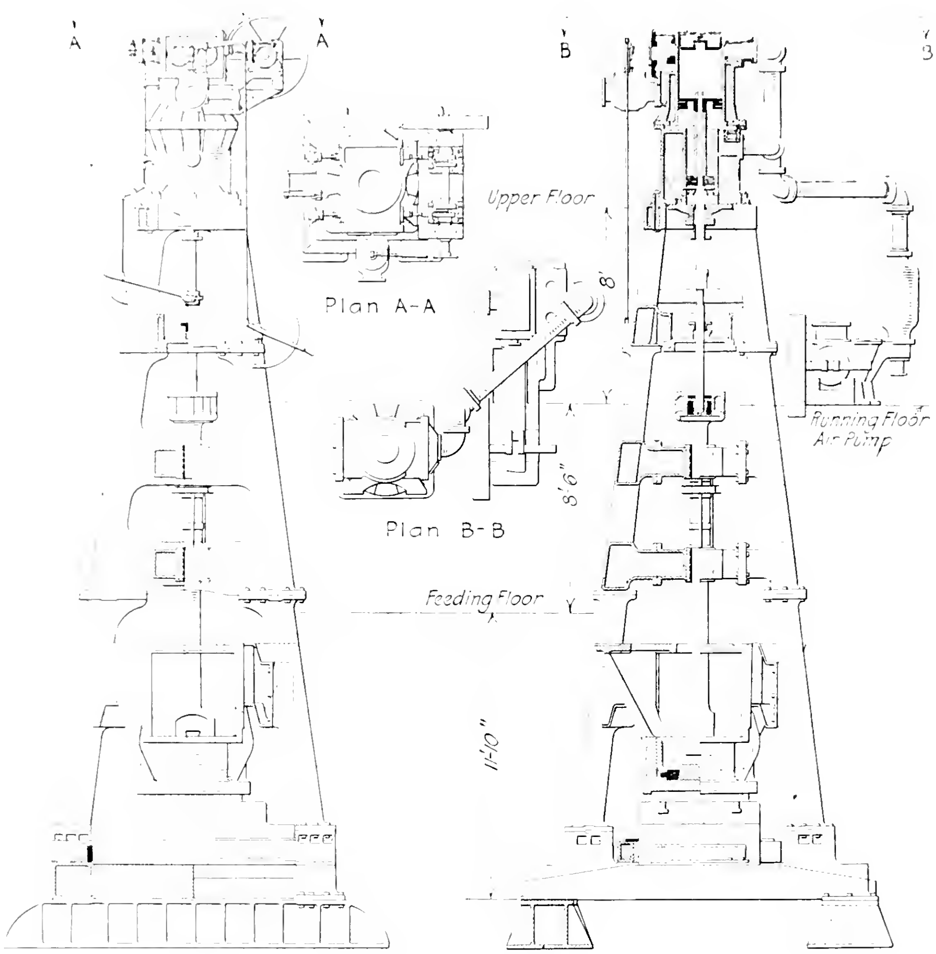


Fig. 8 Leavitt Ore Stamp

Further improvements are unquestionably possible in turbines operating under present conditions, and improvements are also possible in boiler-room equipment and practice, but the results now reached in modern plants are so near to those theoretically attainable under the conditions of operation that no improvements of sweeping magnitude may be expected along such lines. It seems probable that the conditions of operation will have to be radically changed if any great reduction in fuel per unit is to be achieved.

Two revolutionary suggestions to this end have been made within the last few years. It was pointed out by Robert Cramer that increasing the initial pressure by several hundred pounds would make it possible to increase materially the theoretical efficiency of present-day cycles, and S. Z. de Ferranti suggested a new form of turbine cycle in which much greater use was made of superheated steam.

The highest steam pressures now commonly used with steam turbines are in the neighborhood of 200 to 250 lb. per sq. in., and the highest steam temperatures are about 600 deg. fahr., corresponding roughly to about 200 deg. of superheat. The highest pressures for which boilers can be built and the highest temperatures which turbine parts can be made to stand are still unknown. The steam tables carry pressures to 600 lb. abs. and total temperatures to about 1000 deg. fahr.

The suggestion of Ferranti contemplated a radical change of cycle. At the present time it is impossible to say whether turbines will ever be constructed commercially to operate on this cycle. There are many mechanical difficulties to be overcome, but they do not appear to be of as great magnitude as were those that were met and overcome in the early days of turbine construction. It is therefore conceivable that turbines may be built to operate on the Ferranti cycle or some modification thereof.—C. F. Hirshfeld, Mem. Am.Soc.M.E., in *Power*, September 18, 1917.

THE TRUMBLE REFINING PROCESS

A New Departure in the Methods of Oil Distilling, Effecting a Marked Saving in the Percentage of Oil Required as Fuel

By N. W. THOMPSON,[1] SAN FRANCISCO, CAL.

The first step in the refining of oils is to obtain the different fractions or distillates of the crude oil. Some of these are ready marketable products and others need treatment. To obtain these distillates it is necessary to distill or boil them over in a still and separate them according to boiling points.

The old method was to fill a cylindrical still with the crude oil and boil off the lighter distillates, then the next heavier, and so on. After being condensed these distillates were run through a steam still and the still kept to a certain temperature until all of the lighter fraction or first cut was obtained, then the temperature was raised for the next fraction, and so on.

A large number of the refineries at the present time continue this system, and others put a number of crude stills in series and run them continuously,—that is, the residuum or bottoms of the first still run to the second still where they are heated to a higher temperature, and so on to the last still, from which the residuum flows to a cooler and then to the tank. This residuum is generally fuel oil.

In these stills there is a large volume of oil over the fires and also an expensive installation to build and maintain. There can be no seams in the bottom of the stills necessitating very large plates, and it is necessary to have perforated steam pipes in the bottoms to agitate the oil so as to keep the bottoms from burning, etc.

Large surfaces are necessary when the heating is done in this way. There is low heat transfer on account of slow velocities and the low specific heat of the liquid and about one-third of the surface of the still cannot be heated and must be highly insulated to avoid excessive radiation. However, the radiation losses are considerable even in the best settings.

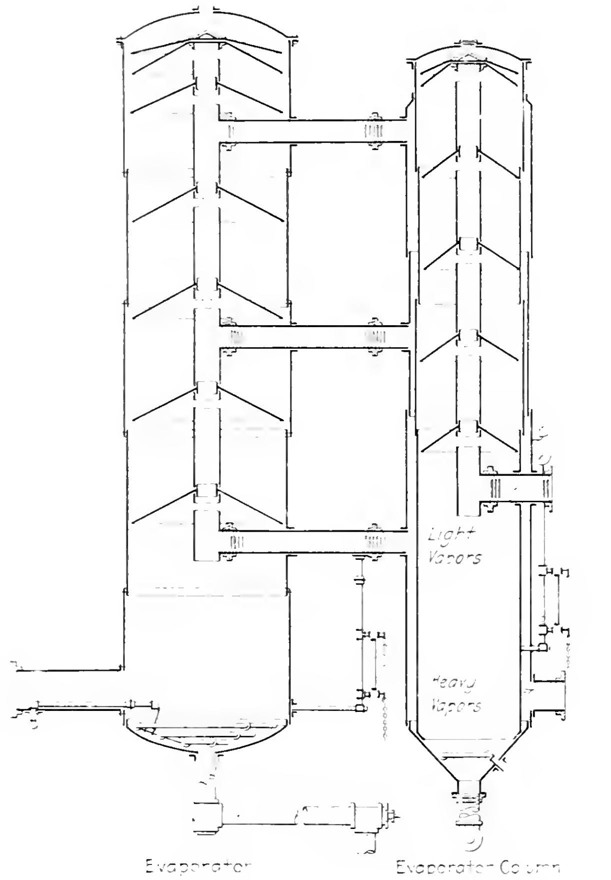


Fig. 1 Evaporator and Evaporator Column

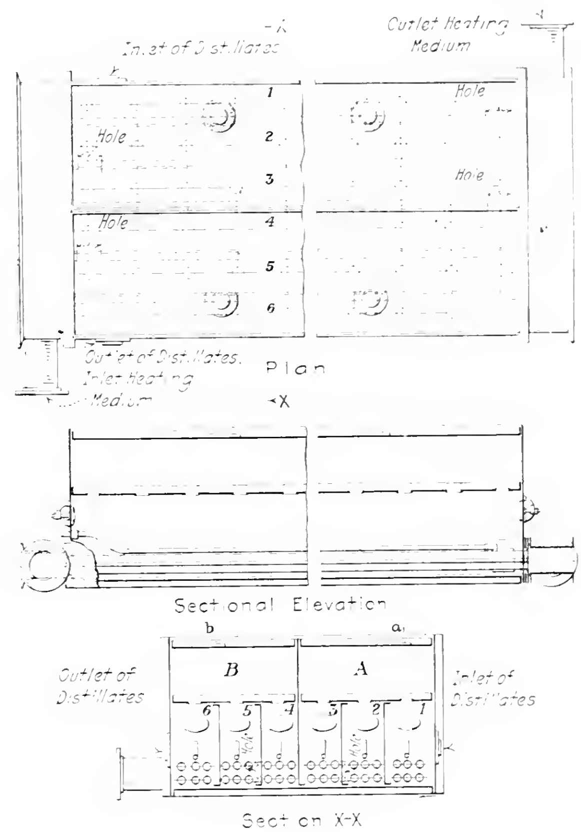


Fig. 2 Separator

The Trumble distilling apparatus is quite a departure from that used in the method described and has proved very successful in the plants where it has been installed. The principal parts of the apparatus are shown in Figs. 1, 2 and 3.

In Fig. 1 is shown a Trumble evaporator, to which in this case is connected an evaporator column. The evaporator con-

[1] Engineer, Simplex Refining Company, San Francisco, Cal.

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sists of a closed cylindrical metal shell, vertically disposed, to which heat is applied from the outside in any convenient manner, as for example, by flue gases or by vapors from another evaporator.

Inside the evaporating chamber is arranged a central vertical pipe having umbrella shaped devices attached thereto at intervals, which are called "spreader hoods," so that oil when fed to the apex of these hoods will flow down over their sides in a thin film after the analogy of rain flowing down the outside of an umbrella. The lower edges of these hoods are at a little distance from the sides of the wall of the evaporating chamber, and in operation the oil flows down and over the hood and strikes against the interior wall of the evaporating chamber and flows down the wall in a thin continuous film. In case any of the oil should not strike against the wall in the evaporating chamber, but should drop off the edge of the hood and fall vertically; or in case there should be a tendency to bubbling or foaming on the wall of the evaporating chamber whereby a portion of the oil may be thrown back toward the center of the evaporating chamber, such oil will be caught by the next spreader hood and will flow down the surface thereof, thereby insuring an ultimate spreading of the oil on the wall of the evaporating chamber.

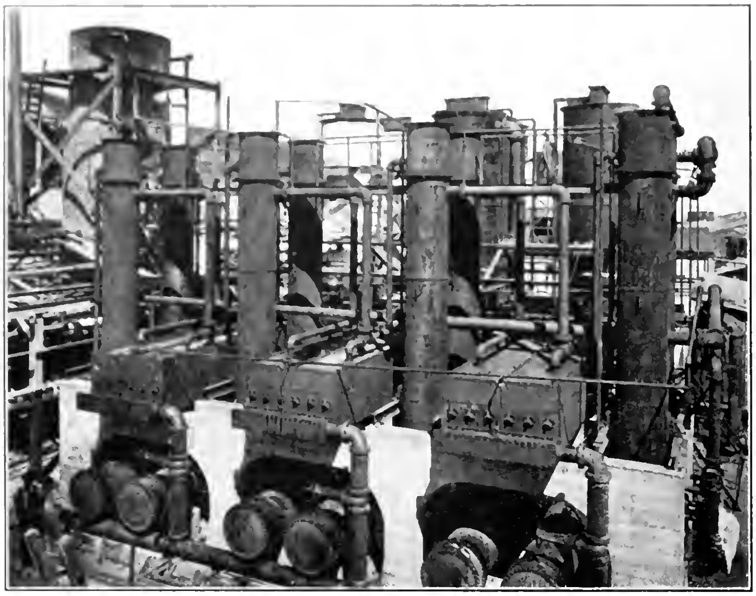

Fig. 3 General Arrangement of Plant

The oil to be operated on is fed through a supply pipe to the top of the evaporating chamber and discharges downward on the apex of the uppermost hood. The oil then flows down this hood in a thin stream and is delivered against the interior wall of the evaporating chamber as above described.

The centrally arranged vapor take-off pipe in the evaporating chamber, to which the spreader hoods are attached, is provided with perforations underneath each of the hoods, and through these perforations the vapors pass from the evaporating chamber into the vapor take-off pipe. Located in this vapor take-off pipe are lateral branch pipes, and these branches extend through the wall of the evaporating chamber to the outside of the apparatus.

Fig. 2 shows the construction of the separator. This is a rerun still for distillates from bottom of dephlegmators, or from any other source, if these need fractioning. The distillate flows into compartment (1) over a number of pipes through which a heating medium is passed, either residuum or vapors as the case may be, and then passes through opening at end of compartment (1) into compartment (2) and back through compartment (3), and so on, leaving at end of compartment (6). The vapors evolved in compartments (1), (2), and (3) pass through openings into vapor compartment A and out through opening a_1 to the condenser or through dephlegmator to condenser, depending upon the fractionation required. The vapors evolved in compartments (4), (5), and (6) pass into vapor compartment B and out through opening b_1, to condenser, etc.

The manifolds on the ends of the separators are provided with covers having stuffing boxes through which valves are operated to regulate the flow through tubes in each compartment, thereby controlling the heat in these compartments.

The illustrations, Figs. 3 to 6 inclusive, are from photographs taken during the construction of a plant employing the Trumble system. Fig. 3 gives a general view. In the foreground, at the left, is the pipe heater and located in the brick stack at the left is the evaporator. In the distance are the dephlegmators, in the foreground the separators and the vertical condensers for the vapors from the separators. Under the arches are the coolers for distillates. The pipe lines in the trench are the distillate lines from the condensers and coolers carrying the cooled products to the receiving boxes. The arrangement of these receiving boxes is shown in Fig. 4. Behind the boxes are dewatering traps for separating the water from the distillates. Fig. 5 shows the dephlegmators with the heat exchangers underneath. Fig. 6 shows the operating valves for the distillates from the dephlegmators. These valves as well as all operating valves are handled from one platform.

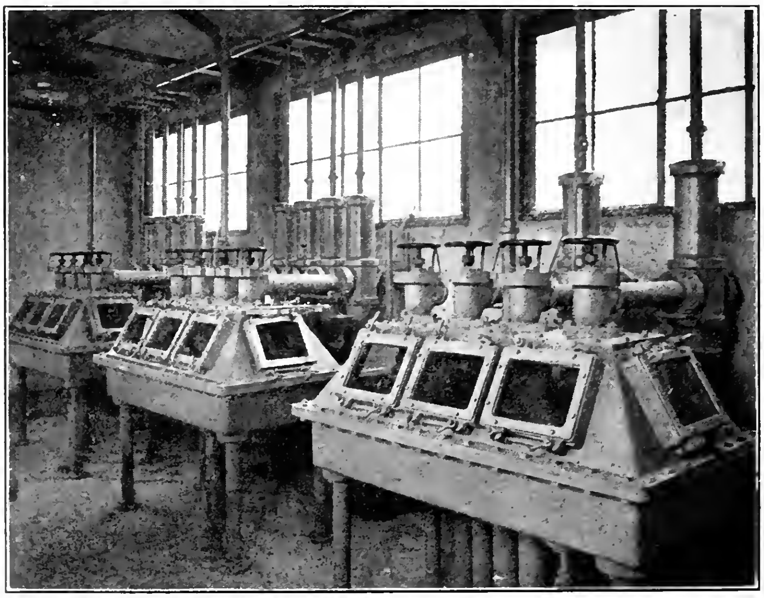

Fig. 4 Arrangement of Receiving Boxes

All plants are designed to meet the conditions under which they are to be used, but they are very flexible and are able to take care of a very wide range of conditions by controlling the heat of the furnace and the velocity of the oil which runs through it. It will be impossible to go into the many different arrangements of plant design but the following will make clear the running of a typical and successful plant.

The flow of the crude oil through the plant is indicated by the flow sheet in Fig. 7. The oil enters through a 6-in. line and is used as a cooling medium in the six coolers shown. These coolers are of the horizontal tubular type, 30 in. in diameter, with sixty-two 2-in. by 18-ft. tubes. The oil enters at the bottom and passes through the tubes, making four passes, and comes out at the top and goes into a header, through which it passes into the four heat exchangers or coolers for the residuum.

These heat exchangers are 48 in. in diameter and have 178 2-in. by 18-ft. tubes. The crude oil enters the first heat exchanger at the bottom and passes through the tubes, making six passes, and out at the top into the bottom of the next exchanger, and so on, to the heater pipes, where it is split in two, each half passing in series through seventy-two 18¾-ft. lengths of 4-in. pipe, flowing back and forth and upward at all times, and then into the top of the evaporator, where it flows down the sides in a thin film.

The oil in passing through the heater pipes and evaporator is heated by the flue gases. The vapors evolved are separated in the evaporator and taken care of later. The oil is maintained at a constant level in the bottom of the evaporator and runs out of the bottom of it as residuum. A perforated steam coil is placed in the bottom of the evaporator under the liquid and superheated steam is passed through it in order to drive off any of the lighter distillates which may drop back from the vapors. However, very little steam is necessary in this case, as the heat losses are supplied by the flue gases.

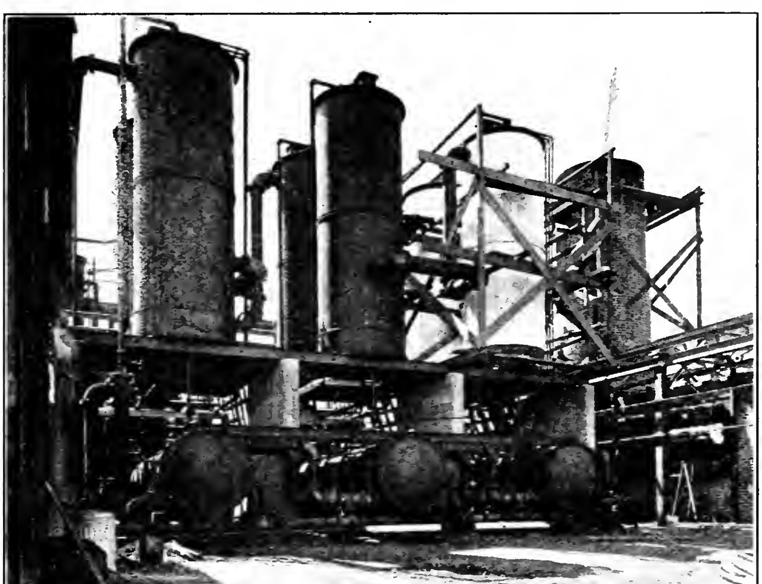

Fig. 5 Dephlegmators with Heat Exchangers Underneath

After leaving the evaporator the residuum is used as a heating medium for redistilling the distillates passing through the separators, and then flows through the heat exchangers countercurrent to the crude oil. The residuum enters the first heat exchanger at the top and makes two passes around the tubes and out at the bottom, then into top of the second exchanger, and so on through the five heat exchangers and through a standpipe, which is vented and which controls the head of residuum in the bottom of the evaporator, and then to the storage tanks.

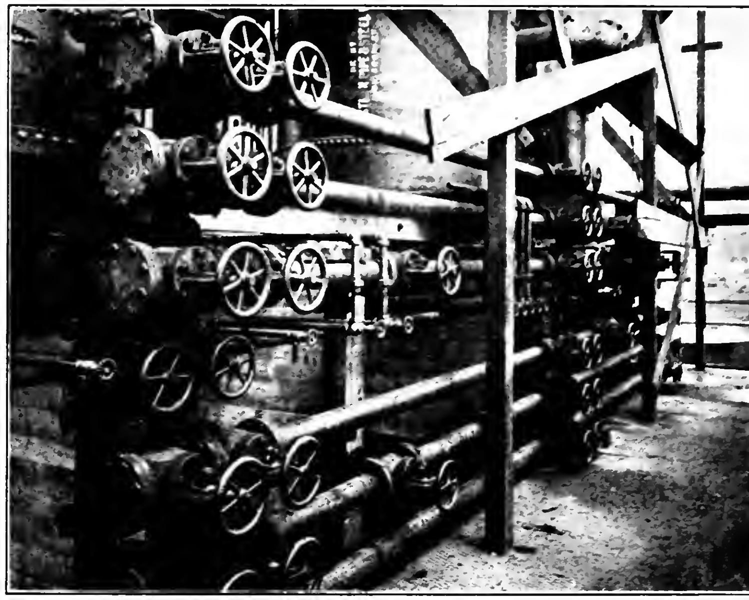

Fig 6 Operating Valves for Distillates from Dephlegmators

Having followed the course of the crude oil through the apparatus, showing the separation of it into vapors and residuum, it remains to dispose of the vapors shown on flow chart in Fig. 8. The vapors from the central vapor column of the evaporator are taken out through a shell and connected into a header. The vapors pass from this header through an oil catcher similar to a steam separator, the condensate passing out of the bottom of it into the bottom of the evaporator. They then pass through six large dephlegmators in series, flowing into the bottom of each and out at the top. In each dephlegmator a partial condensing of the vapor takes place, thus forming a liquid in the bottom of that particular dephlegmator. From some of the dephlegmators this condensed liquid is a ready product; from others it lies just between two different products.

A system of water circulation is used as a cooling medium for the vapors from the dephlegmators and separators. The vapors are cooled in vertical tubular condensers and about twenty barrels of water are required per barrel of distillate cooled. Superheated steam is used in the bottom of the evaporator, separators and dephlegmators as an agitator to relieve the lower boiler point fractions from the bottoms. About 30 lb. per barrel of distillate are produced.

With two Trumble plants in operation continuously for eight months, the company for whom these plants were installed has averaged a run of 16,000 barrels of crude oil per day of 24 hours through both plants, 30 per cent of this crude

oil being vaporized and fractionated into ready marketable distillate products. During this time 1.1 per cent of the total amount of crude oil run was used as fuel to do this work, and the refining losses were 0.75 per cent of the total amount of crude oil run.

Five men are required for operating the two plants per shift, i.e., one head stillman over both plants, one stillman at each plant, one fireman for both plants, and one receiving-house man for both plants.

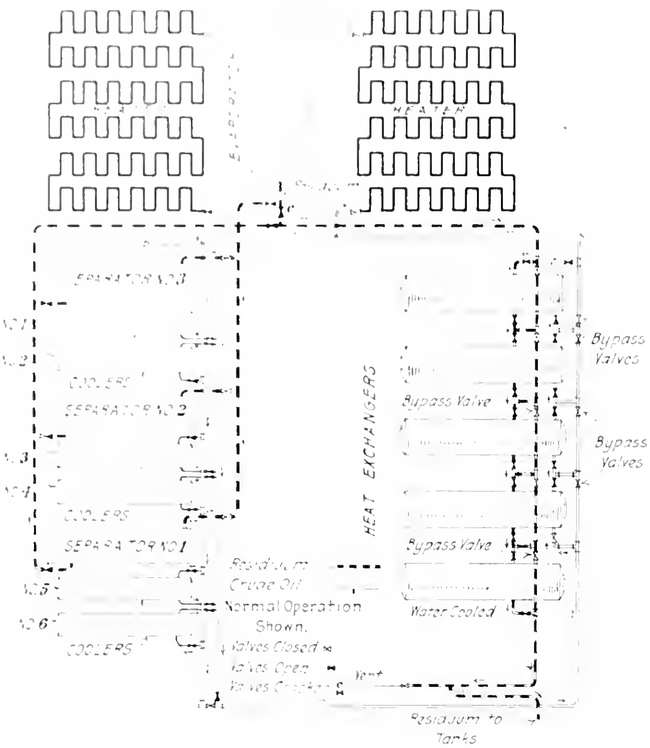

Fig. 7 Crude Oil and Residuum System

At the present time the necessity for conserving the fuel oil and labor around an oil refinery is imperative. The whole subject is a matter of heat units and their proper conservation.

In the Trumble system the products to be re-run in the separators are condensed but not cooled, thereby saving heat. The oil is in a very thin film on the shell of the evaporator and is being heated in its downward flow. The vapors being evolved have a free relief and have no opportunity of dropping back into the residuum.

There is considerable work for the mechanical engineer in conservation of heat units around an oil refinery and in most all branches of the oil industry. There are large refineries operating today and using four to five hundred per cent more fuel than is necessary to do the work. It is possible to save, by proper distribution of the heat available around the oil refineries in the United States, at least 2 per cent of the total crude oil put through these refineries. There are large oil refineries operating today that are using as fuel 4 per cent of the crude oil run through them to do less work than the plant described is doing on 1.1 per cent of the crude oil run through as fuel, and the losses due to non-condensable gases, etc., are 2 per cent against 0.75 per cent.

A typical layout such as is required for accommodating the officers and men at a National Army cantonment comprises, in round numbers, 1500 separate buildings, requiring approximately 30 million feet of lumber. Each cantonment requires a complete system of water supply and sewage disposal, the piping alone for which amounts to more than 50 miles. General warehouses, with necessary trackage, have also been provided. Where the facilities are not available in near-by cities, complete refrigerating and laundry plants have been built.

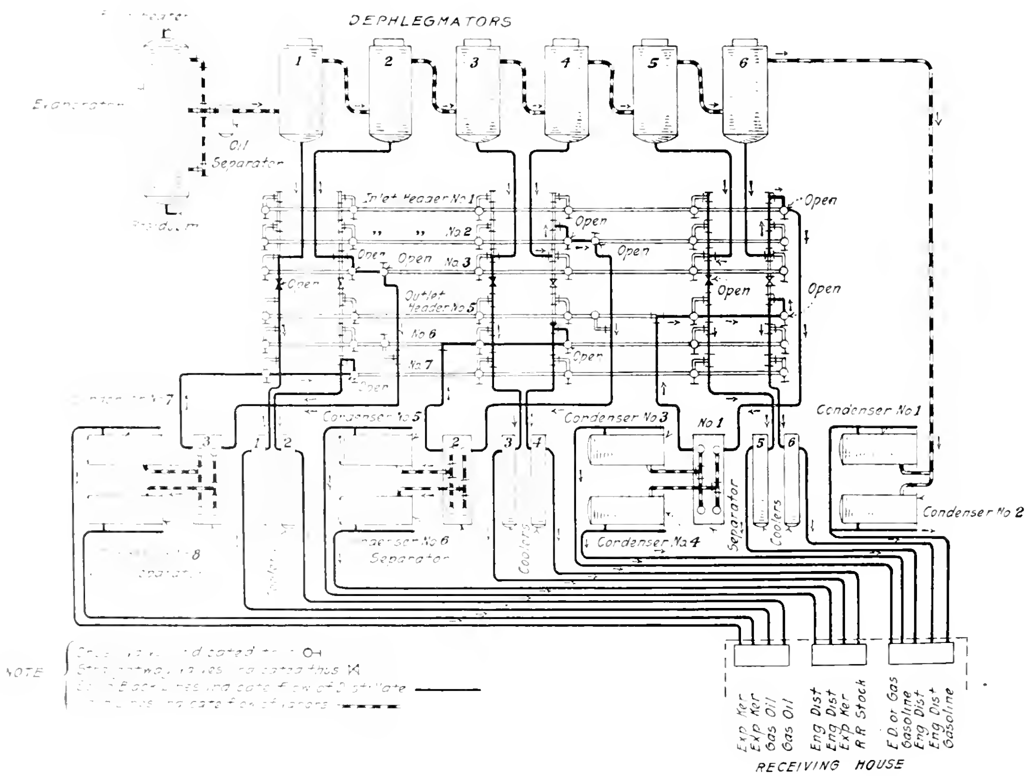

Fig. 8 Vapor and Distillate System

CROSS-CURRENT PREDETERMINATIONS FROM CRANK-EFFORT DIAGRAMS

A Research Study into the Cause of Excessive Cross-Current Flow Between Paralleled Alternators When Driven by Reciprocating Engines

By LOUIS ILLMER, MILFORD, CONN.

Member of the Society

WHENEVER alternating-current generators are driven by reciprocating engines, the fluctuating crank effort causes oscillatory movements to be superimposed upon the rotating armature parts. In parallel operation, such displacement movements are subject to a peculiar cumulative action, which, under adverse conditions, is liable to become so violent as to drive the armature far out of its course of uniform rotative speed. The present paper deals with the cause and effect of such cumulative action.

Acting alone, the irregular primary crank effort of the reciprocating engines accounts for but a relatively small portion of the excessive displacement movement to which the armature is subjected in parallel operation. Such small armature oscillations do, however, give rise to cross-current forces, which in turn tend to set up independent armature-displacement movements. The combined action of these two distinct periodic forces is likely to superimpose cumulative armature-displacement movements upon the rotating armature of far greater amplitude than could be produced by either component force acting alone.

The method deduced in this paper for arriving at such resultant armature-displacement increments is based upon finding the equivalent effect of the crank-effort and the cross-current-pull forces in terms of their respective sinuous sequence of force application. It will be shown that the actual crank-effort curve of any normal reciprocating engine may be approximated quite closely by means of an equivalent sine curve and that its characteristic accelerating effects may be expressed in terms of fairly simple harmonic-motion formulæ. Furthermore, the independent sinuous oscillations which the periodic cross-current pull tends to superimpose upon paralleled armatures may likewise be taken into account by formulæ of this kind.

It will further be shown that when a sinuous crank effort of a reciprocating engine works against a variable resistance, as fixed by the surging cross-current pull of the generator, the conditions become favorable for imposing cumulative oscillations upon the rotating armature and wheel parts. These parts are then alternately accelerated and retarded by the combined action of two distinct periodic forces, each of which has an independent period and each tends to set up independent armature oscillations. At times these two forces will be acting together, while at other times they will be acting in opposition, thus subjecting the armature and wheel parts to a cumulative oscillation about an imaginary position corresponding to that of uniform rotation.

The derived formulæ make possible the predetermination of the probable ultimate armature-displacement shift as measured from an imaginary reference position, for any given set of assumptions as to characteristics of generator construction, crank effort, and wheel weight. The character and maximum amplitude of the cumulative armature movements are found to depend largely upon the relation between the time period of the sinuous crank-effort curve and that of the cross-current-pull curve. Under normal conditions, the difference in period between these two curves is most readily controlled by the selection of a suitable wheel weight.

When a light wheel is used for paralleled reciprocating engines, the armatures oscillate in a relatively rapid period and the maximum cumulative armature-displacement shift is shown to be approximately twice as large as when a relatively long resultant period of oscillation is obtained by the use of a heavy wheel.

The secondary effects which accompany the use of a light wheel are more likely to upset the engine regulation and in other ways lead to detrimental electrical disturbances. In the event that the wheel weight and governor characteristics are not aptly chosen, the resulting cumulative armature oscillations may set up a heavy cross-current flow of such magnitude as to interfere seriously with the successful operation of the paralleled generators.

The subject will be treated in the following order, viz.:

a Principles underlying harmonic motion and their application in estimating initial armature displacements that result from the uneven primary crank effort of a reciprocating-engine drive

b The effect of such periodic displacement movements upon a single a.c. generator when connected to independent bus bars

c The effect of periodic armature oscillations upon paralleled generators in setting up a variable resistance against which the engine must work; discussion of the cumulative oscillations which are likely to occur whenever a variable load of this kind is driven by the fluctuating crank effort of a reciprocating engine

d Conclusions

e Appendix: Characteristic behavior of an alternating-current generator and other electrical aspects of the parallel-running problem relating especially to cross-current pull and its effects in causing periodic variations in the engine load.

INTRODUCTORY

When a reciprocating engine works against a *constant* load, the increment of flywheel displacement resulting from its uneven crank effort is dependent upon the inertia of the wheel. Its mass is alternately accelerated and retarded in proportion to the undulating character of the crank-effort forces, and for present purposes the resultant change in the wheel velocity may be taken as a convenient measure of such crank-effort irregularity.

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The average wheel velocity may be assumed to coincide with that of an imaginary wheel rotating at absolutely uniform speed, such that any velocity change induced by the variable crank effort will cause the actual wheel to lag or lead with respect to the virtual position fixed by the reference standard.

Expressed mathematically, the foot-pounds of energy absorbed in raising the flywheel velocity from V_2 to V_1 is

$$\frac{1}{2}m\,(V_1^2 - V_2^2) = m\left(\frac{V_1 + V_2}{2}\right)(V_1 - V_2) = 2\,mV_0v_0 = \Delta W_0 \ldots [1]$$

where $V_0 = (V_1 + V_2)/2$ = reference standard for uniform rotation, i.e., synchronous speed as measured by the average crankpin velocity in ft. per sec.

$v_0 = (V_1 - V_2)/2$ = maximum crankpin velocity change as measured with respect to the reference standard V_0

$2v_0/V_0 = \delta_0$ = coefficient of speed fluctuation as determined from the primary crank-effort diagram

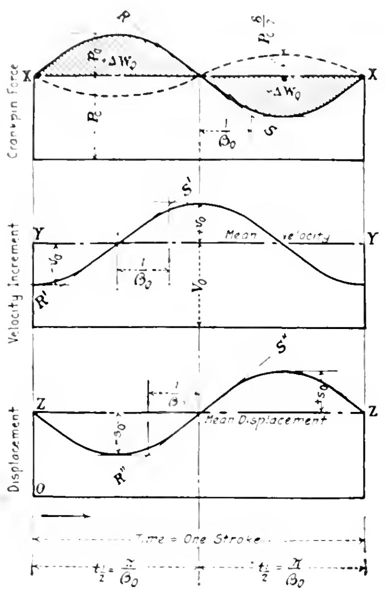

FIG. 1 SINUOUS CRANK-EFFORT DIAGRAMS

$m = \frac{G}{g}\left(\frac{\rho}{R}\right)$ = equivalent units of wheel mass transferred to the *crankpin* radius R.

$\Sigma\frac{G}{g}\rho^2$ = equivalent moment of inertia of the crankshaft weights, g being gravity acceleration at 32.2 ft. per sec. per sec.

G = equivalent rim weight of wheel, lb., which is equal to the weight of the rim plus about 1/10 rim weight for arm allowance, plus the armature weight as transferred to the center of gravity of the wheel rim ρ.

ΔW_0 = foot-pounds of fluctuating energy as measured by one-half the total lobe areas enclosed by the crank-effort diagram per stroke

Assuming a reciprocating engine to work with a sinuous crank effort, the phase relation between the velocity change and displacement increment which it imparts to the wheel is shown in Fig. 1. The common abscissa is taken on a time basis which is proportional to the travel of the crankpin.

The upper sine curve represents the variable crank-effort force drawn about the base line XX, which ordinate represents the mean turning force P_c acting normal to the crankpin radius. The sectional area $\pm\Delta W_0$ denotes the fluctuating energy that must be successively taken up and given out by the flywheel parts in order to equalize the sinuous crank effort.

The resulting velocity change as measured at the crankpin is indicated by the sinuous line superimposed upon the mean or synchronous velocity base YY. The sequence of the displacement increments is indicated by the lower sine curve plotted with respect to the base line ZZ, which represents the reference position assumed by the crankpin when rotating at the uniform synchronous speed V_0.

Restricting the interplay of the fluctuating energy ΔW_0 to that exchanged during any one stroke period of the engine, the coefficient of energy fluctuation becomes equal to

$$K = \Delta W_0/W_0 \ldots\ldots\ldots [2]$$

where

K = coefficient of energy fluctuation, which is also equal to one-half the mean ordinate of the lobe area ΔW_0 divided by mean turning effort P_c

$W_0 = P_c \times \pi R$ = foot-pounds of effective work done per stroke, i.e., mean engine turning effort P_c multiplied by the crankpin path during one stroke

P_c = b.hp. $\times\, 550/V_0$ = average crankpin force (in lb.) acting normal to the crankpin radius R, measured in feet.

HARMONIC-MOTION FORMULÆ

A sinuous crank effort, as measured with respect to the mean axis XX of Fig. 1, sets up a change in the synchronous velocity of the rotating-wheel parts within the limits $V_0 - v_0$ and $V_0 + v_0$, in accordance with the law of simple harmonic motion. The principles underlying such motion are easily established since the average ordinate of the sine-lobe area ΔW_0 bears a simple fixed relation to the maximum accelerating force P_0.[1]

[1] Starting with the general equation for accelerated motion,

$$a_0 = P_0/m \ldots\ldots\ldots [3]$$

where

a_0 = maximum acceleration acting upon the mass m as measured in ft. per sec. per sec.

P_0 = maximum accelerating force in pounds, as measured at the middle of the sinuous crank-effort lobe.

Since the average ordinate under the sectioned sine lobe ΔW_0 is equal to $(2/\pi)P_0$, the maximum velocity increment will be

$$v_0 = (2/\pi)\,a_0t_m \ldots\ldots\ldots [4]$$

where

t_m = time equivalent one-half length of the sine lobe as measured in seconds, which in angular measure corresponds to $\pi/2$ radians.

The resulting maximum displacement being proportional to the average velocity change multiplied by time, it follows that

$$s_0 = (2/\pi)\,v_0t_m = (2/\pi)^2\,a_0t_m^2 \ldots\ldots\ldots [5]$$

where

s_0 = maximum linear displacement or amplitude of oscillation (in ft.) resulting from a sinuous velocity change whose maximum is v_0.

As a further condition for simple harmonic motion, the maximum acceleration a_0 must be directly proportional to the displacement s_0, which expressed mathematically takes the convenient form

$$a_0 = \beta_0^2s_0 \ldots\ldots\ldots [6]$$

where

β_0^2 = specific acceleration of the sinuous crank effort at unit displacement, as measured with respect to the synchronous reference position ZZ of Fig. 1.

For the critical value $s_0 = 1$ ft., the factor a_0 becomes equal to β_0^2; substituting this value in [5] and transposing, the following relation is obtained, which shows that the time period for harmonic motion is independent of its amplitude; thus,

$$t_m = \pi/2\beta_0;\quad t_n = \pi/\beta_0;\quad t_1 = 2\pi/\beta_0 \quad\ldots\ldots [7]$$

where t_m, t_n and t_1 are the respective times of a quarter, half and complete period of harmonic oscillation.

It will be seen that the constant β_0 converts the time factor into angular or π measure. It also fixes other important characteristics of simple harmonic motion, as is evident from the following substitution in Equation [4], viz.:

$$v_0 = (2/\pi)\,a_0\,(\pi/2\beta_0) = a_0/\beta_0 = \beta_0 s_0 \quad\ldots\ldots [8]$$

When a body oscillates harmonically, the characteristic relations existing between the acceleration, velocity and displacement factors are definitely fixed by the basic constant β_0 as given in Equation [8].

Applying these deductions to the case of a sinuous crank-effort diagram for a single-cylinder engine, the time period of a complete oscillation is that required for one stroke, which is equal to

$$t_1 = 60/2N = 2\pi/\beta_0 \quad\ldots\ldots [9]$$

where N = revolutions per minute.

The corresponding basic value of the primary crank-effort constant β_0 may be found by substituting the above value of t_1 in Equation [7]; thus,

$$\beta_0 = 2\pi/(30/N) = 0.21\,N \quad\ldots\ldots [10]$$

The other basic values required to characterize the harmonic wheel motion set up by a sinuous crank effort when making a complete oscillation in a time period of one stroke as per

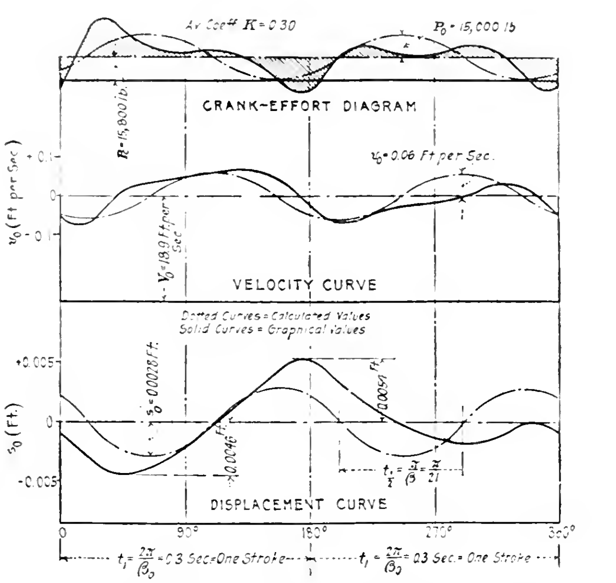

FIG. 2 CRANK-EFFORT DIAGRAMS FOR SINGLE-CYLINDER 500-B.HP. KOERTING GAS ENGINE

Cylinder dimensions, 25 × 43⅜ in.; speed, 100 r.p.m.; piston-rod diameter 6½ in.; wheel weight at 17½ ft. outside diameter, 24,000 lb.; equivalent mass m at crankpin, 12,000 units; load condition, maximum.

Eq. [9], may be found by substituting in Eq. [1]; thus,

$$v_0 = \Delta W_0/2mV_0 = \beta_0 s_0 \quad\ldots\ldots [11]$$

where $V_0 = 2\pi RN/60$ = mean crankpin velocity in ft. per sec.

v_0 = maximum velocity increment superimposed upon V_0

s_0 = corresponding maximum displacement (in ft.) as measured from the synchronous reference position ZZ.

For a single-cylinder engine the pitch length of its crank-effort lobe, i.e., the space passed over by the crankpin in the time period of one-half stroke, is equal to $\pi V_0/\beta_0$, and since $(2/\pi)P_0$ represents the average accelerating force acting upon the crankpin during this period, then

$$\Delta W_0 = \frac{2}{\pi}P_0\left(V_0\frac{\pi}{\beta_0}\right) = \frac{2P_0V_0}{\beta_0} = 2mV_0v_0 \quad\ldots\ldots [12]$$

In a similar manner it will also be found that

$$\Delta W_0 = KW_0 = KP_cV_0\,(2\pi/\beta_0) \quad\ldots\ldots [13]$$

For a single-cylinder engine the maximum velocity increment v_0 may be found in terms of known constants by substituting the above values in Eq. [11]; thus,

$$v_0 = \frac{2\pi KP_cV_0}{\beta_0}\cdot\frac{1}{2mV_0} = \frac{\pi KP_c}{m\beta_0} = \beta_0 s_0 \quad\ldots\ldots [14]$$

From the above it also follows that

$$P_0 = m\beta_0^2 s_0 = \pi KP_c \quad\ldots\ldots [15]$$

Fig. 2 shows that the average results obtained graphically from an actual single-cylinder crank-effort diagram can readily be evaluated on the basis of the sine-curve approxi-

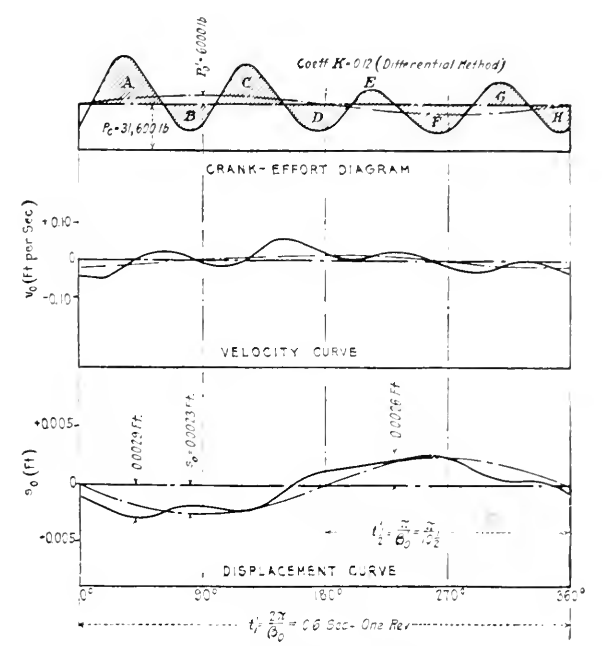

FIG. 3 CRANK-EFFORT DIAGRAMS FOR TWIN-CYLINDER 2 x 500-B.HP. KOERTING GAS ENGINE

Cylinder dimensions, 25 × 43⅜ in.; wheel weight at 17½ ft. outside diameter, 48,000 lb.; equivalent mass m at crankpin, 24,000 units; load conditions, maximum.

mation, and that the resulting average velocity and displacement increments may be determined with a fair degree of accuracy by means of the given equations. This figure represents a crank-effort diagram for a single-cylinder 500-b.hp. double-acting Koerting gas engine operating at maximum load.

A corresponding diagram for a set of twin-cylinder engines of the same make and size is shown in Fig. 3. In both diagrams due allowance has been made for the inertia effect of the reciprocating parts, angularity of connecting rod, and the like.

ARMATURE-DISPLACEMENT INCREMENTS FOR SINGLE NON-PARALLELED GENERATOR UNITS

It is to be borne in mind that the harmonic-motion formulæ thus far deduced apply only to the case of a reciprocating engine whose sinuous crank effort works against a *uniform* or straight-line resistance XX, such as would be encountered in a lineshaft drive and the like.

These simple relations may be materially modified when reciprocating engines are used to drive alternating-current generators, especially those connected in parallel. In that event the armature oscillations resulting from the irregular crank effort set up a periodic cross-current pull which is capable of producing a cyclic variation in the engine load. This reactive effect is dependent upon the characteristic behavior of the driven a.c. generator, the essential features of which are best represented graphically by means of vector diagrams as elucidated in the Appendix included in the full paper.

Touching upon the principles underlying electric-power generation by means of an alternator, it may be pointed out that such a generator running at synchronous speed can only deliver current to the bus bars when the armature is made to lead with respect to the neutral position assumed by the armature when running at no load. That is to say, the application of engine power forces the armature ahead of this neutral phase position by a certain angular displacement lead such that it will still be running at synchronous speed but out of phase with its neutral phase position by an angular displacement lead $+\alpha_0$, on the other hand, when an external resisting force causes the armature to lag with respect to the neutral phase position by an angle $-\alpha_0$, this reverse action will convert the machine into a synchronous motor.

TABLE 1 COMPARATIVE DISPLACEMENT VALUES FOR SINGLE ENGINE

Items	Estimated by Formulæ	Graphical Determinations
P_c	15,800 lb.	....
β_0....	21	....
K...	0 30	0 24 to 0.39
P_0......	15,000 lb.	10,000 to 27,000 lb.
ΔW	27,000 ft-lb.	20,400 to 33,200 ft-lb.
$(2\pi v)$ (avg. velocity) ...	0 038 ft. per sec.	0 011 ft. per sec.
$(2\pi s_0)$ (avg. displacement)....	0 0018 ft.	0 0021 ft.

As explained in the Appendix, the mean angular displacement lead α_0 is dependent upon the construction characteristics of the alternator and serves as a measure of the full-load output delivered by this type of generator. Assuming the driving torque and output to remain constant, then the uniformly rotating armature will maintain a constant lead angle α_0 with respect to its neutral or no-load phase position. In case, however, the generator is driven by a reciprocating engine, its irregular crank effort will cause a periodic shift in the armature displacement equal to $\pm\alpha_x$, as measured with reference to the mean lead angle α_0.

Applying these deductions to the case of a *single* alternating generator driven by a reciprocating engine, the resulting speed fluctuation as measured by the coefficient δ_0 will cause the armature lead angle to vary within the limits $\pm\ {}^1\!/_2\,\delta_0\alpha_x$. This periodic shift in the armature lead angle α_0 serves to produce a corresponding change in the generator output. Hence the effect of varying the resistance against which the engine has to work may be embodied in its crank-effort diagram by substituting a sinuous curve for the straight base line XX of Fig. 1. As shown dotted, the phase and period of this new resistance curve for a single-cylinder unit coincide with those of its primary displacement curve, while the amplitude of such initial armature oscillation may be fixed at ${}^1\!/_2\,\delta_0 P_c$, as plotted upon the reference line XX.

CUMULATIVE DISPLACEMENT EFFECTS FOR PARALLELED GENERATOR UNITS

Turning now to the electrical conditions under which alternators operate in parallel, such armatures are no longer locked with the external circuit in the manner of a single generator; instead, the electrical tie assumes characteristics closely analogous to those of a flexible coupling between the two paralleled armature shafts, all of which is rather fully set forth in the Appendix.

The flexible nature of this coupling allows one of the paralleled armatures to lead periodically with respect to its mean lead angle α_0, provided the other armature simultaneously lags with respect to its α_0 by an approximately equal angular displacement shift α_x. This difference in armature positions sets up an equalizing or cross-current flow between the generators whereby the lagging armature may momentarily generate less power than its mate without materially affecting the combined output delivered to the common bus bars.

The cross-current pull is, however, capable of superimposing oscillations of considerable magnitude upon the rotating armature. The amplitude of such oscillations is generally much larger than was found to be the case for the single generator connected to independent bus bars.

It will now be shown that this increment of displacement is due to the cumulative action which results in parallel generators whenever the variable generator load, as fixed by the periodic cross-current pull, is combined with an uneven sinuous crank effort having a different period.

The resultant periodic armature oscillation produced by the combined action of two such forces, i.e., excess crank effort P, and cross-current pull P_{cc}, is likely to become cumulative when the period of the pull P_{cc} bears certain critical relations to the period of the force P_0.

As given by Eq. [A] of the Appendix, the factor P_{cc} as taken in terms of the mean crankpin force P_c is equal to

$$P_{cc}/P_c = (\sin \alpha_x/\sin \alpha_0) \cos \alpha_0$$

Owing to the relatively small angular armature displacements permissible in good practice, the mathematical treatment of this portion of the discussion may be much simplified by substituting angular measure for the sine values of the lead and shift angles α_0 and α_x, and by further assuming that the value of $\cos \alpha_0$ in the above equation may be taken as equal to unity without serious error. On the basis of this approximation, Eq. [A] reads

$$P_{cc}/P_c = \alpha_x/\alpha_0 = s_x/s_0$$

or

$$P_{cc}/s_x = P_c/s_0 = F = m\,\beta_x^2 \ldots\ldots\ldots\ldots [16]$$

where α_0 = mean angular displacement lead of the armature as measured in electrical radians

α_x = angular displacement shift of the armature as measured with respect to mean lead position α_0

$s = \alpha_0 R$ = arc length in feet, corresponding to the armature-displacement lead angle α_0 as measured at the crankpin circle

$s_x = \alpha_x R$ = arc length in feet, corresponding to the armature-displacement shift angle α_x.

In the above equation the constant F represents the specific accelerating force (in lb.) of the cross-current pull when the linear displacement $s_x = 1$ ft., as measured at the crankpin circle. Eq. [16] further shows that the cross-current pull P_{cc} may be taken as directly proportional to the linear shift s_x

and that it becomes approximately equal to the mean engine turning force P_c when $s_x = s_a$. The constant β_x fixes all of the characteristic relations of the harmonic armature movements resulting from the action of the cross-current pull except that of the amplitude limit.

Since the angles α_0 and α_x are measured in electrical radians, Eq. [16] may also take the form

$$\frac{F}{m} = \beta_x^2 = \frac{P_c}{m}\cdot\frac{n}{Ra_0}\ldots\ldots\ldots\ldots\ldots\ldots[17]$$

where β_x^2 = specific acceleration of the cross-current pull at $s_x = 1$ ft. linear armature displacement as measured at the crankpin circle

$\pi R/n$ = generator pole pitch as measured (in ft.) at the crankpin circle = π electrical radians.

n = number of pole pairs = cycles per sec. $\times(60/N)$.

The resulting cross-current pull corresponding to a given armature shift s_x is dependent upon the constructive characteristics of the generator, which are largely fixed by the

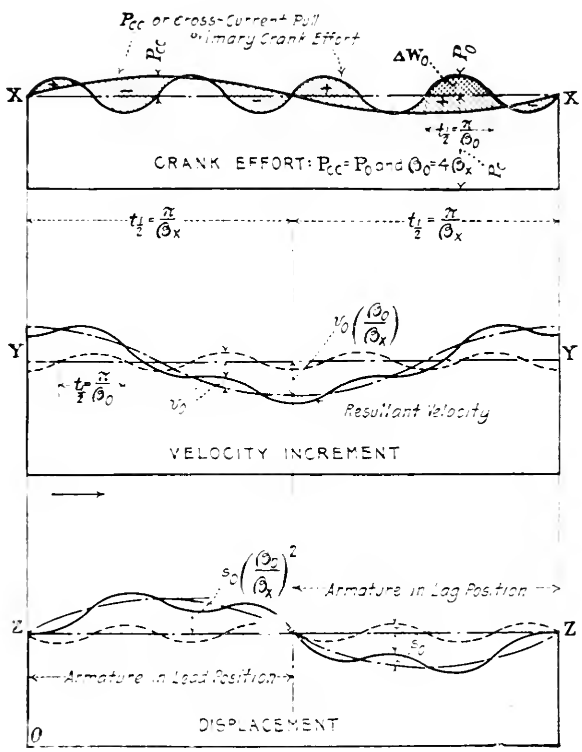

FIG. 4 DIAGRAM SHOWING CUMULATIVE EFFECT OF CROSS-CURRENT PULL FOR $\beta_0/\beta_x > 7/2$

value of s_a. Accordingly, the relation of the basic constants β_0 to β_x may also be expected to be dependent upon the factor s_x. For single-cylinder engines the numerical value for this relation may be arrived at as follows:

Transposing Eq. [14] to the form $\beta_0^2 = \pi K P_c/ms_0$ and dividing by Eq. [17], gives

$$\frac{\beta_0}{\beta_x} = \sqrt{\frac{(\pi K/s_0)}{(n/Ra_0)}} = \sqrt{\pi K\frac{s_x}{s_0}} = 0.21\,N\sqrt{\frac{Ra_0}{n}\cdot\frac{m}{P_c}}\ldots\ldots[18]$$

When $\beta_0' = \frac{1}{2}\beta_0$, the corresponding equation for twin-cylinder engines becomes equal to

$$\frac{\beta_0'}{\beta_x} = 0.105\,N\sqrt{\frac{Ra_0}{n}\cdot\frac{m}{P_c}}\ldots\ldots\ldots\ldots[18a]$$

The above equations fix the vital relations required for cross-current determinations in paralleled generators; they show that the important ratio of the constants β_0/β_x is independent of the coefficient K, and secondly that this ratio is largely dependent upon the speed factor N.

Since the value of the primary displacement s_0 is usually quite small in comparison with s_a, the period of oscillation set up by the cross-current pull when acting alone is a relatively long one, being equal to

$$t_{\frac12} = \pi/\beta_x \quad\ldots\ldots\ldots\ldots[19]$$

It will be seen that the paralleled armatures are acted upon by two distinct periodic forces, i.e., excess crank effort and cross-current pull, whose time periods are π/β_0 and π/β_x, respectively. Each of these forces tends to set up independent oscillations, but they combine to swing the armatures in a

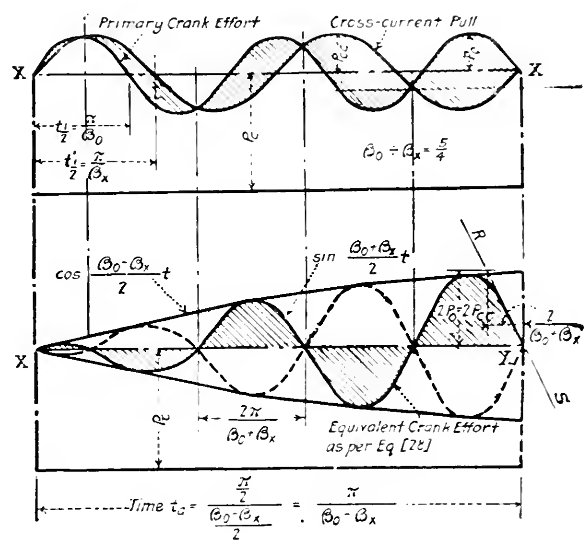

FIG. 5 DIAGRAM SHOWING CUMULATIVE EFFECT OF CROSS-CURRENT PULL FOR $\beta_0/\beta_x > 7/2$

resultant period which may be found by replacing the straight resistance line XX of the crank-effort diagram by a sinuous resistance or load curve having a relatively large amplitude equal to the cross-current pull P_{cc}, as indicated in Fig. 4.

In the case of paralleled generators, the resultant sectioned lobe area of the crank-effort diagram is to be taken with respect to the resultant sinuous resistance line P_{cc}, since this area fixes the period and generally determines the character of the final armature movements.

The cross-current pull will continue to superimpose cumulative oscillations upon the rotating armature, until the condition of indifferent equilibrium is finally reached where $P_{cc} = P_0$.

The consideration of this problem may be further simplified by taking into account only the two limiting conditions as to time of oscillation: namely, (1) the case in which the ratio of β_0/β_x is a relatively large one, i.e., 7/2 or over, by which assumption the period and amplitude of the cross-current pull is made to dominate and fix the character of the resulting armature movements as shown in Fig. 4; and (2) the case in which the factors β_0 and β_x are approximately equal, the effect of which is to produce a series of comparatively rapid armature oscillations, whose amplitude rises and falls periodically in accordance with the sine law, as indicated in Fig. 5.

CASE I: CUMULATIVE ARMATURE DISPLACEMENTS FOR $(\beta_0/\beta_x) > 7/2$

Taking up the first of these cases in detail and referring to Fig. 4, the average velocity change produced upon the armature and wheel parts will be a function of the resultant sectioned area lying between the crank effort and the sinuous resistance or load curves. For the condition that $P_{cc} = P_x$, it will be apparent that the total area under one of the cross-current or P_{cc} sine lobes as measured with respect to its straight base line XX becomes equal to $(\beta_0/\beta_x)\Delta W_0$, i.e., equal to the sum of all the ΔW_0 lobe area enclosed by the primary crank effort curve in the time period π/β_x. If then such a cross-current pull were acting alone upon the armature parts, the energy absorbed during the time period $\pi/2\beta_x$ would, according to Eq. [1], impart a maximum velocity change equal to $(\beta_0/\beta_x)v_0$. This value serves to fix the amplitude of the fundamental velocity curve shown dotted and dashed in Fig. 4.

The cross-current pull when acting alone may be expected to set up armature oscillations closely following the laws of simple harmonic motion, because the accelerating force P_{cc} is approximately proportional to the displacement shift s_x. In addition to this motion, the irregularity of the crank effort sets up independent sinuous velocity changes of smaller magnitude as drawn dotted upon the axis YY, which superimposed upon the fundamental curve produces the resultant velocity shown by the full-lined curve of Fig. 4.

The corresponding maximum linear armature-displacement shift resulting from the combined action of the cross-current pull and irregularity of crank effort, becomes equal to

$$s_x = v_x/\beta_x = s_0(\beta_0/\beta_x)^2\,[1 + (\beta_x/\beta_0)] \;\ldots\ldots \qquad [20]$$

by Eq. [18] $= \pi K s_0 [1 + (\beta_x/\beta_0)]$ for a single-cylinder engine.

Equation [20] fixes the actual limiting displacement shift s_x that may be expected when two paralleled alternators have settled into equilibrium as regards the interchange of cross-current energy.

The corresponding mean shift angle α_{xav} measured with respect to α_0 becomes approximately equal to

$$\alpha_{xav} = \frac{2}{\pi}\frac{s_0}{R}\left(\frac{\beta_0}{\beta_x}\right)^2\left(1 + \frac{\beta_x}{\beta_0}\right) = \frac{2}{\pi}\,\alpha_x\left(1 + \frac{\beta_x}{\beta_0}\right) \qquad [21]$$

This angle α_{xav} is fixed by the average ordinate of the sectioned area lying between the crank effort and the sinuous load curve as indicated in Fig. 4.

The correctness of the above deductions has been checked by means of actual cross-current measurement tests conducted upon a set of single-cylinder 500-b.hp. Koerting gas engines having heavy flywheels and driving three-phase alternators on an induction-motor load.

The crank-effort diagram for these engines is almost identical with that given in Fig. 2. The comparative results attained with these two similar units, running at a practically constant load, are given in Table 2.

The pulsations recorded by the ammeter readings, as measured from maximum to maximum, showed 35 to 38 beats per min. as against an estimated period for such beats of $2\pi/\beta_x =$ 1.9 sec., or about 32 beats per min.

CASE II: CUMULATIVE DISPLACEMENTS FOR $(B_0/B_x) < 7/2$

The foregoing formulæ for the displacement shift angle α_x were based upon the condition that the ratio β_0/β_x shall not fall below the critical value 7/2. At this juncture the time periods of the crank-effort and of the generator-load curves become more nearly equal, and as a result the combined or resulting sectional area lying between these curves assumes an essentially different character from that shown in Fig. 4. The armature movements which take place when the ratio of β_0/β_x is relatively small are still found to act cumulatively until the cross current pull p_{cc} reaches its critical value P_0, but the effect produced is a series of rather rapid armature oscillations which periodically rise and fall in amplitude as indicated in Fig. 5. In order that such armature movements may occur without giving up energy to the external power circuit, one of the paralleled armatures must lead at approximately the same instant that its mate lags, in the manner shown respectively by the full- and dotted-lined oscillations in the lower crank-effort diagram.

The equation for any ordinate P_x of the sectional area lying

TABLE 2 COMPARATIVE VALUES FOR SINGLE-CYLINDER ENGINES $(\beta_0/\beta_x = 6.4)$

SPECIFICATIONS	
Type of engine......	Double-acting two-stroke Koerting gas-engine without tail rod
Cylinder dimensions..	25 x 43¾ in.; speed, 100 r.p.m.
Average engine load..	425 b.hp. (about)
Piston-rod diameter.	6½ in.
Weight of flywheel	73 000 lb. at 18 ft. O. D.
Total mass m......	38,600 units at R = 1.8 ft.
Coefficient δ_0......	1/660
P_0 at K = 0.30..	11,700 lb. = 0.95 P_c
Cos ϕ_0 in external circuit	0.73 (about)
Lead angle α_c.......	14½° (about) = 0.255 elec. radian
n at 25 cycles per sec..	15 pole pairs
RESULTS	
Displacement s_0 by Eq. [14]......	0.00068 ft.
β_x by Eq. [18]............	3.3 for β_0 = 21
Ratio β_0 to β_x........	6.4
Displacement shift s_x by Eq. [20]..	48 s_0 (about)
Shift angle α_{xav} by Eq. [21]...	0.7 α_0
Ratio Z by Eq. [C]......	1.08
Same by test measurement.......	1.065
Cross-current I_{cc} by Eq. [B]..	0.51 I_0

in the upper crank-effort diagram of Fig. 5 takes the following form:

$$P_x = P_0\,(\sin\beta_x t + \sin\beta_0 t)\ldots\ldots\ldots\ldots\ldots [22]$$

Combining the factors of this equation on the basis of the trigonometrical relation for the sum of sine values,

$$P_x = 2P_0\left(\sin\frac{\beta_0+\beta_x}{2}t\,\cos\frac{\beta_0-\beta_x}{2}t\right)\ldots\ldots\ldots\ldots [23]$$

This equation, as graphically analyzed in the lower crank-effort diagram, shows that the component oscillations as fixed by the sine factor vibrate cumulatively within the limit line fixed by the cosine factor. The time period of the component oscillation is determined by the mean value of β_0 and β_x, while the period of the limit line is fixed by their difference. The characteristics of the resulting velocity and displacement curves will be identical with those of the equivalent crank-effort curve shown in the lower diagram.

The time required for the cumulative oscillations to change from minimum to maximum amplitude is equal to

$$t_a = \pi/(\beta_0 - \beta_x)\ldots\ldots\ldots\ldots\ldots\ldots [24]$$

which holds good for all values of β_0/β_x less than 3 and greater than unity. The maximum velocity increment attained by the wheel parts due to the accumulation of energy cannot

at any time exceed the energy equivalent of the sectioned area as fixed by the largest one of the sin $\frac{1}{2}(\beta_0 + \beta_x)$ lobes, shown in Fig. 5. The corresponding maximum acceleration is limited to $2P_0/m$, and since the resulting velocity is proportional to $1/(\beta_0 + \beta_x)$ and not to $1/(\beta_0 - \beta_x)$, it will be seen that even for long periods that accompany small differences of β_0 and β_x the cumulative energy does not under any conditions tend to produce an infinite armature deflection. This point is brought out because Bonte,[1] among others, has advanced contrary views as based upon the Rosenberg theory previously discussed.

For the cumulative oscillatory movements indicated by Fig. 5 the maximum angular displacement shift cannot exceed

$$\alpha_x' = \frac{2P_0}{P_c}\alpha_0 = \frac{2P_0}{P} \cdot \frac{san}{R} \qquad [25]$$

$$\alpha_{x\,av}' = \frac{2P_0}{P_c}\alpha_0\left(\frac{2}{\pi}\right)^2 - \frac{2}{\pi}\left(\frac{\alpha_x'}{2}\right)^4_\pi \qquad [26]$$

The deductions embodied in the last two equations have been checked by the graphical determinations shown in Fig. 6, as based upon the assumed specifications noted below. These curves were kindly worked out for the author some years ago by Mr. Erich C. Rassbach. At that time the present mathematical basis had not yet been developed, and in order to determine the probable course of the resultant armature oscillations for small values of β_0/β_x, it became necessary to resort to a tedious graphical solution. The comparative figures given in Table 3 show satisfactory agreement.

The principles underlying the formulæ herein developed may also be used in solving the more general problems relating to cumulative oscillatory movements, such as are involved in hunting rotary converters and the like.

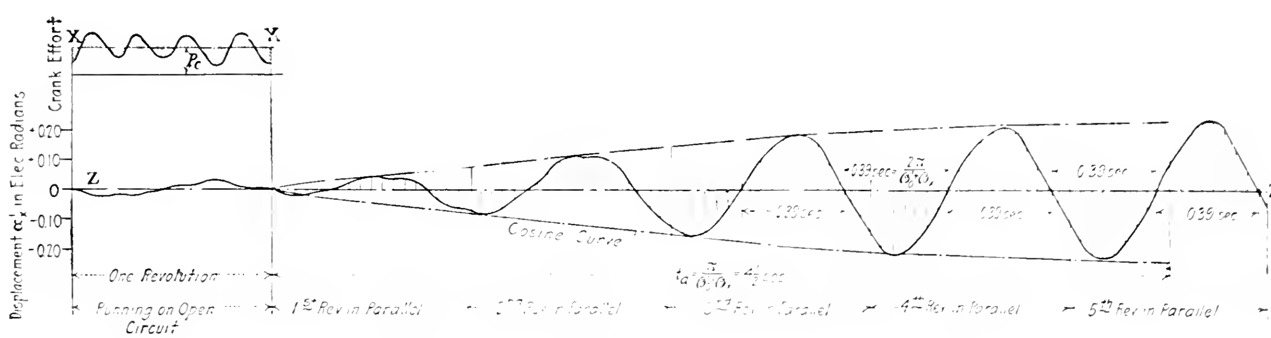

Fig. 6 Graphical Determination of Cumulative Armature Oscillations for $\beta_0/\beta_x = 1.09$

The measured cross-current flow is determined by the average armature-displacement shift, and while α_x' for Case II is approximately twice as large as α_x as found for Case I, the average shift is almost identical with that given by Eq. [21], as is evident from the following relation:

TABLE 3 COMPARATIVE VALUES FOR TWIN ENGINES ($\beta_0/\beta_x = 1.09$)

ASSUMED SPECIFICATIONS

Type of engine......	Twin-cylinder double-acting two-stroke gas engine with tail rod
Cylinder dimensions.....	38 x 66 in.; speed, 80 r.p.m.
Piston-rod diameter.......	10 in.
Assumed load....................	4000 b.hp. = max. capacity
Moment of inertia of wheel.......	$\frac{113{,}000\text{ lb.}}{32} \times 9.65\text{ ft.}^2$
Total mass m.....	43,500 units at R = 2.75 ft.
K' by differential method	0.072
P_0 from crank-effort curve........	48,000 lb. = 0.48 P_c
Lead angle α_0	about 16½° = 0.29 elec. radian
n...........................	20 pole pairs
β_0'..........................	0.105 N = 8.4

RESULTS

	Calculated by Formulæ	Graphical Determinations
$(2/\pi)\ r_0'$ when K' = 0.072.	0.02 ft. per sec.	0.026 ft. per sec.
$(2/\pi)\ s_0'$ when K' = 0.072.........	0.0027 ft.	0.0022 ft.
β_x by Eq. [18a]..................	7.7 = $\beta_0'/1.09$	....
$\pi/(\beta_0' - \beta_x)$ by Eq. [24]..........	4½ sec. = 6 rev.	about 5½ rev.
Angle α_x' by Eq. [25]............	0.96 α_0	About 0.85 α_0
Angle α_{xav}' by Eq. [26]...........	0.37 α_0	....
Displacement shift s_x'............	About 9 s_0'	About 8 s_0'
$2\pi/(\beta_0' + \beta_x)$................	0.39 sec.	0.39 sec.

[1] Zeitschrift des Vereines Deutscher Ingenieure, Aug. 25, 1906, p. 1365.

CONCLUSIONS

On the basis of the principles enunciated, it may be concluded that when two alternators are thrown into parallel the resulting cross-current flow, as measured by means of ammeters, will be largely independent of the wheel weight used, except in so far as this weight may influence the character of the regulation rendered by the governor.

The difficulty that may be involved in the use of a light flywheel resides in the detrimental secondary effects that may arise. When the ratio of β_0/β_x is less than 7/2, as is likely to be the case when using a light wheel, the oscillatory peak movement indicated in Fig. 5 becomes about twice as large as would be produced by the use of a heavy wheel operating under conditions represented by Fig. 4. This difference in maximum angular displacement shift may become so marked that the armature working with a relatively light wheel may be thrown far over into the negative or motor position. Such excessive shift in the armature displacement may readily create serious electrical disturbance, for should the angle α_x' plus α_0 at any time exceed $\pi/2$ electrical radians, i.e., one-half pole pitch, the paralleled generators would immediately fall out of step.

The best results in parallel operation may, therefore, be expected when the ratio β_0/β_x is kept as high as 6 or possibly 8. As is evident from Eq. [18] and [18a], this condition is more readily complied with in the smaller short-stroke engines running at a relatively high speed. However, in order to avoid excessively heavy wheels for the long-stroke, slow-speed engines, it is found advisable to keep the wheel weight in a constant relation to the engine output.

The foregoing deductions do not take into account any beneficial effects which dampening coils and like devices may be able to exert upon the cumulative armature oscillations. The purpose of the present investigation was simply to find

the most favorable inherent conditions when operating without compensating adjuncts of any kind.

The formulæ given are further conditioned upon identical constructive characteristics for all the paralleled engine and generator units. Any important difference in this respect may involve a considerable increase in the minimum expected cross-current flow as fixed by the given formulæ.

Finally, attention is called to the need of properly selecting the coefficient of speed fluctuation for the engine governor. The extent to which the primary speed coefficient may be increased by the cumulative displacements arising in paralleled engine units is indicated by the ratio of s_1/s_0 as given in Tables 2 and 3. The governor characteristics should be such that this increased "factor of irregularity" will not throw the governor gear into resonant oscillation with the cumulative wheel period.

The use of additional wheel weight is able to effect an important change in the period of the cumulative wheel swing, and this, in turn, may make it far easier to meet the governing requirements. On the whole, therefore, it may be concluded that owing to the beneficial secondary effects the most satisfactory results in the parallel operation of reciprocating-engine units are to be attained by the use of reasonably heavy flywheels, as prescribed.

The author desires to express his indebtedness to Prof. C. D. Albert, of Cornell University, for reviewing the manuscript of this paper and for the helpful criticisms which he has made.

In marked contrast with the ordinary formal official report, the chapter on fuels and mechanical-equipment investigations in the year book of the Bureau of Mines (Department of the Interior) is of readable interest and practicable value to all concerned in fuel economy and conservation. It is stated that last year 500,000,000 tons of coal was burned, but of this amount the bureau estimates fully 125,000,000 tons, or 25 per cent. was wasted through incomplete combustion and other preventable waste. The function of the Bureau of Mines and the results obtained through its extensive investigations are also set forth in the publication.

A cobalt-chrome-carbon steel is now being made by a Sheffield works, for which it is stated that the property of red-hardness is obtained without the addition of tungsten. This steel is said to melt at lower temperatures than tungsten high-speed steel, and to be so fluid as to be readily cast into intricate forms for milling cutters, gages and similar products. It may also be annealed in the usual manner to a sufficient degree of softness to be readily machined, and can be forged without difficulty. It can be hardened by heating to 1000 deg. cent. and cooling in still air without an air blast.—*The Ironmonger*, August 11, 1917.

Before means can be found to reduce smoke, it is obvious that the causes of its production must be understood. The erroneous opinion prevails that black smoke contains a large amount of combustible matter and that it is a sign of greatly reduced economy. The most dense black smoke does not commonly contain more than ½ of 1 per cent of the combustible fired. The extreme fineness and the distribution of the carbon particles bestow upon them a high coloring power. The losses are negligible in comparison with those due to incomplete combustion or excessive air, which generally accompany combustion without visible smoke. The carbon particles producing visible smoke are not derived from a lifting of fixed or solid carbon from the grates, but they are formed from gases during the combustion process.—*Power*, September 18, 1917.

The War Convention of American Business, brought together at the call of the Chamber of Commerce of the United States, met at Atlantic City, September 17 to 21. The chief topic of discussion was the regulation and control of prices by the Government, the organization of war production, and the adjustment of business during and after the war. Suggestions were made that a war board should be created, similar to the Ministry of Munitions in England, which would control purchases for the Government, determine prices and control priority in distribution in order to do away with the competition between Government demands and those of private industry, which at present is working considerable hardship on business men over the country.

Among the educational institutions which have been patriotically devoting the summer recess to the intensive training of enlisted men should be mentioned Wentworth Institute. The institute has been giving such training to the men of the 101st Massachusetts Engineers, who have received quite a comprehensive outline of the essentials of machine-shop operations, steam engines, pumps, electrical construction and steam and electrical power-plant practice. An enormous amount of practical work has been accomplished and the thorough manner in which these young engineers have constructed a long series of trenches, bomb-proof shelters of reinforced concrete, dug-outs, etc., with all of the latest devices, emergency exits, drainage provisions, wire entanglements, suspension and pontoon bridges, electrical generating stations for use in the field to supply power, light and telephone and telegraph facilities for field operations, ensures their early participation in the actual operations in the field.

The present national crisis brings home to us the crying needs of the nation in availing itself of the knowledge and ability at its command. Fifty thousand specialists in applying scientific knowledge to practical problems as well as scores of research laboratories have offered their services to the nation. But problems requiring investigation are slow in being developed. Once they are formulated and given to the engineers of the country, few will remain unsolved very long.

It is for the engineer to apply the results of research to practical problems and to carry practical problems demanding general research back to the research laboratories. To the engineer, every special problem requires a special application of fundamental principles. Is it too much to hope that the day is rapidly approaching when all great problems, particularly those of our national and state governments, will be automatically placed in the hands of trained specialists? Not self-seeking politicians, nor yet men with mere theories, but engineers with a real command of fundamental principles, men with an unbroken record of big achievements and no failures, men ever ready to stake their all on their ability to handle problems in their specialty.—*Science*, September 14, 1917.

THE TRANSFER OF HEAT BETWEEN A FLOWING GAS AND A CONTAINING FLUE

By LAWFORD H. FRY, BURNHAM, PA.

Member of the Society

THE transfer of heat between a flowing gas and the wall of a metallic flue through which the gas flows is one of the most important processes in mechanical engineering, and as such has been the subject of much study by physicists and by engineers. All attempts, however, to bring the process under the yoke of a general formula have been very imperfectly successful.

The author now offers the formula described below, which within a wide range of conditions will represent with all the accuracy needed for practical work the processes of heat transfer between a gas and a metallic flue wall.

The formula applies equally well to the loss of heat by a hot gas in a cooler flue and to the gain of heat by a cool gas in a hotter flue, and although it has been established by purely empiric methods, yet the accuracy with which it conforms to the results obtained by various observers using widely differing experimental methods leads to the belief that it represents closely the fundamental law by which heat is transferred under the conditions under consideration.

The wide range of the experimental data on which the formula is based is shown in Table 1 and may be summarized briefly as follows:

Gases. The gases experimented with were products of combustion, lighting gas, CO_2 and air, all at atmospheric pressure; also air at pressures ranging from 0.15 to 140 lb. per sq. in. abs.

Rate of Flow of Gas. The rates of flow ranged from 0.5 to 650 lb. per hr.

Flues. Flues of annular and circular cross-section were used, with effective diameters ranging from 0.5 to 2.0 in., and of lengths from 0.64 to 20 ft.

Temperatures. The inlet gas temperatures ranged from 2340 deg. fahr. with the products of combustion being cooled, to 55 deg. fahr. with air being warmed.

In all of the experiments throughout this wide range of conditions the transfer of heat is satisfactorily represented by the general formula proposed below.

GENERAL FORMULA FOR HEAT TRANSFER

The type of formula used is adapted from that suggested by Fessenden and Hedrick.[1] No attempt is made to measure the rate of heat transfer per square foot of heating surface per degree of temperature difference, but an expression is given for the rise or fall in temperature of a gas in its passage along a flue the wall of which is at a higher or a lower temperature than the gas.

If a gas flows at the rate of W lb. per hour through a flue of which the hydraulic depth is $d/4$ in. (in a flue of circular section the diameter corresponding to this hydraulic depth is d in.), and if the temperature of the gas be T_1 deg. in any given section and T_2 deg. in a section x ft. distant in the direction of the flow, and if the mean flue temperature between these two sections be t deg., all temperatures being measured from the absolute zero in any scale; then, if the gas temperature be higher than the flue temperature,

$$^{2}\text{lolog } T_1/t - \text{lolog } T_2/t = Mx \ldots\ldots\ldots [1]$$

and if the flue temperature be higher than the gas temperature,

$$\text{lolog } t/T_1 - \text{lolog } t/T_2 = Mx \ldots\ldots\ldots [1a]$$

where M is a constant in any given case, being dependent only on W the rate of flow of the gas, and on $d/4$ the hydraulic depth of the flue. In the experiments under consideration there is a critical rate of flow at about 5 lb. of gas per hr. At all rates of flow above this the value of the coefficient M is accurately given by the equations

$$\text{Log } M = A - m \log W \ldots\ldots\ldots [2]$$

where

$$A = 1.558 - 0.185d \ldots\ldots\ldots [3]$$

and

$$m = 0.14 + 0.083d \ldots\ldots\ldots [4]$$

The application of Equation [1] is illustrated by Figs. 1, 2 and 3, which are based on one of the Babcock and Wilcox experiments in which products of combustion at a high temperature were passed through a water-jacketed flue and the temperature determined at a number of points along the flue.

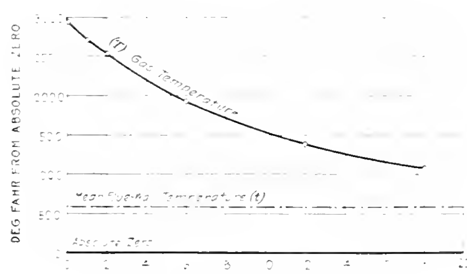

FIG. 1 MEAN GAS TEMPERATURES AND MEAN FLUE TEMPERATURE

(B. & W. Test 1, April 13.)

The abscissæ in all three figures are distances in feet from the furnace end of the flue. In Fig. 1 the ordinates of the curve are the gas temperatures T in degrees fahrenheit above the absolute zero. A horizontal line is also drawn having as ordinates the mean flue-wall temperature t.

In Fig. 2 the ordinates are the logarithms of the ratio of gas temperature to mean flue temperature, $\log T/t$, while in Fig. 3 the ordinates are the logarithms of the ordinates in Fig. 2, that is, they are the logarithms of the logarithms of the temperature ratios, [log (log T/t) or lolog T/t]. In Fig. 3 the points plotted fall on a straight line and it is obvious that if

[1] Trans. Am.Soc.M.E., vol. 38, p. 407.

[2] Chappell's very convenient logarithmic notation is used, by which "lolog N" denotes "the logarithm of the logarithm of the number N," all logarithms being to the base 10. (Five Figure Mathematical Tables, by E. Chappell.)

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T_1 be the gas temperature at any point and T the gas temperature at a point x ft. further along the flue the relation between the two temperatures is given by the equation

$$\text{lolog } T_1/t - \text{lolog } T/t = Mx \quad \ldots\ldots\ldots [1]$$

where M is the slope of the line.

The purpose of the present paper is (1) to show that this relation is a general one, and (2) to show how M, the coefficient measuring the slope of the lolog line, is affected by the rate of flow of the gas and by the flue diameter. It should be noted that the coefficient M is dependent not on the actual diameter of the flue but on the hydraulic depth, that is, on the quotient of the area divided by the perimeter. In the case of a flue of circular cross-section the hydraulic depth is one-quarter the diameter, and it is immaterial whether diameter or hydraulic depth be taken as argument in establishing the relationship with the coefficient M. As most of the present work concerns circular flues, it is convenient to use the "effective diameter" d in determining the relation between flue section

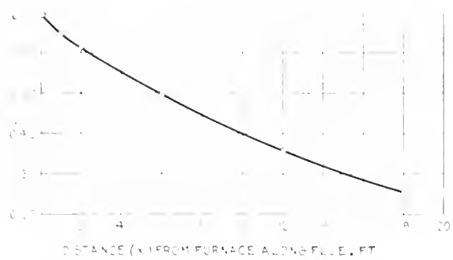


Fig. 2 Logarithm of Ratio of Gas Temperature to Flue Temperature

(B. & W. Test 1, April 13.)

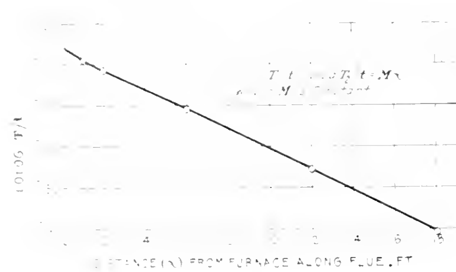


Fig. 3 Logarithm of Logarithm of Temperature Ratio

(B. & W. Test 1, April 13.)

and the coefficient M. This "effective diameter," being defined as four times the hydraulic depth, is the same as the actual diameter in a flue of circular cross-section. Examination of the experimental data has led to the conclusion that the relation between the coefficient M, the rate of flow of gas W, and the effective flue diameter d, is that shown above in Equations [2], [3] and [4].

EXPERIMENTAL DATA

The data on which the conclusions stated above are based have been derived from a total of 205 experiments, the range of conditions covered by them being shown in Table 1. These experiments fall into six groups, each of which is due to a different experimenter. The Jordan[3] experiments are among the most accurate, and as they cover a wide range of flue diameters, have played a considerable part in establishing the formulæ. They comprise five series, each with a flue of a different section. Two of the flues were annular and three circular in section, the effective diameter ranging from 0.506 to 1.968 in. The gas used was air, the rate of flow ranging from 30 to 620 lb. per hr. and the inlet temperature from 238 to 750 deg. fahr. The air was passed through a vertical flue 3.28 ft. long, surrounded by cooling water flowing in the opposite direction to the air. Inlet and outlet temperatures of the air were measured.

The Nusselt[4] experiments were made with air at a pressure of 140 lb. per sq. in., and with air, CO_2 and lighting gas at atmospheric pressure. These gases at atmospheric temperatures were passed through a horizontal flue 0.868 in. in diameter surrounded by steam at atmospheric pressure, and the rise in temperature measured. The length of flue in which the temperature rise took place varied from 0.64 to 1.96 ft. The rate of flow of gas varied from 1 to 400 lb. per hr. These experiments were carried out with great care and are valuable on account of the wide range of rate of gas flow, and because gases of various compositions were used. The Josse[5] experiments, like those of Nusselt, were made with a horizontal steam-jacketed flue, through which air at atmospheric temperature was passed and the rise in temperature measured. Pressures of 1.5, 7.5 and 15 lb. per sq. in. were used, the rate of flow ranging from 0.5 to 71 lb. per hr. The flue was 0.905 in. in diameter and 4.34 ft. long. The Babcock and Wilcox[6] experiments considered here are seven in number, taken at random from an elaborate series in which the products of combustion from a gas furnace were passed through a water-jacketed flue 2 in. in diameter and 20 ft. long. The gas inlet temperatures ranged from 1750 to 2350 deg. fahr., and as the water jacket was divided into twenty compartments each one foot long, the drop in temperature of the gas along the flue could be determined by measuring the amount of heat absorbed in each compartment of the jacket. The mean water temperature was approximately 160 deg. fahr. The Fessenden[7] experiments were very similar to the Babcock and Wilcox, but in one series a flue 1.816 in. in diameter and 10.95 ft. long, and in the other series a flue 0.816 in. in diameter and 10.44 ft. long, was used. In both series the jacket was divided into ten compartments in which water was allowed to boil at atmospheric pressure. Inlet and outlet temperatures were measured, and the drop of temperature along the flue could be found by measuring the amount of heat given up to each compartment of the jacket. The Pennsylvania Railroad[8] experiments are taken from tests of locomotives on the Altoona locomotive testing plant. One boiler had flues 2 in. in diameter and 18.75 ft. long, the other had flues 1.75 in. in diameter and 15 ft. long. The firebox and smokebox temperatures were measured in each experiment and the weight of the products of combustion determined from the flue-gas analysis.

DERIVATION OF FORMULÆ FROM EXPERIMENTAL DATA

The process of studying the validity of Equation [1] and of arriving at the law expressed by Equations [2], [3] and [4] is illustrated by Figs. 4 to 7.

The first step was to calculate from the figures obtained experimentally the value of the coefficient M in Equation [1]. This having been done and the results tabulated, it became evi-

[3] Proc. Inst. M. E., 1909, p. 1317.

[4] Mitteilungen über Forschungsarbeiten, vol. 89 (1910).

[5] Zeitschrift des Vereines deutscher Ingenieure, 1909, p. 322.

[6] Experiments on the Rate of Heat Transfer from a Hot Gas to a Cooler Metallic Surface. The Babcock & Wilcox Co., 1916.

[7] University of Missouri Bulletin, vol. 17, no. 26 (October 1916).

[8] Locomotive Tests and Exhibits; The Pennsylvania R. R. System, 1905. Tests of an E2A Locomotive; Locomotive Testing Plant Bulletin No. 5; Pennsylvania R. R. Co., 1910.

dent that in each series of experiments made with the same diameter flue the values of M decreased regularly as the rate of gas flow increased. In the search for the law governing this change the values of log M were plotted as ordinates over the values of log W as abscissæ, (W = lb. of gas per hr.). Fig. 5 showing the results obtained from Nusselt's experiments is typical and is of interest as covering the widest range of gas-flow rates and as covering gases of three different compositions and of widely different pressures. From this plot it appears that there is a critical rate of flow at about 5 lb. of gas per hr., $W = 5$, log $W = 0.699$, and that for rates of flow greater than this the relation between log M and log W is a well-marked straight line of the form log $M = A - m$ log W (Eq. [2]).

Before examining the numerical values of the coefficients in this equation, attention will be directed to the meaning of the two formulæ which have been set up. In Fig. 6, which is Fig. 5 redrawn in diagram form, AB represents the lolog of the temperature ratio at a given cross-section of the flue and CD the lolog of the temperature ratio at a section x ft. further along the flue. Then the slope of the line AC is determined by the value of the coefficient M. If the coefficient has a larger value, say M', the line will have a sharper slope and the value of lolog t T_2 will be $C'D$, which is less than before. This means that the temperature T_2 will be greater than before. An increase in the value of the coefficient M corresponds to a more rapid interchange of heat between flue wall and gas, and consequently in the case under consideration, to a greater increase in the temperature of the gas.

The influence of the rate of gas flow on the coefficient M in any given flue is well illustrated by Fig. 5. As the rate of flow is increased the value of the coefficient M decreases, that is to say, the amount of change in the temperature of the gas between any two points decreases. For example, in Fig. 5 the line drawn through the plotted points of the Nusselt experiments shows the following values for log W and log M:

log W =	1.0	1.505	2.00	2.70
log M =	$\bar{1}.123$	1.017	$\bar{2}.905$	$\bar{2}.755$

From which the following values are found for W and M:

W =	10	32	100	500
M =	0.1328	0.1040	0.08036	0.05689

If an initial gas temperature of 70 deg. fahr. be assumed, the temperature of the gas after passing 1 ft. along the flue which is maintained at 212 deg. fahr. will vary as follows:

Rate of flow, lb. per hr., W =	10	32	100	500
Temperature, deg. fahr. T_2 =	105.5	98.5	92.5	86.0
Rise in temperature, $T_2 - T_1$ =	35.5	28.5	22.5	16.0

The rise in temperature becomes less and less as the rate of flow is increased. If the amount of heat transferred to the gas is calculated from the foregoing, assuming a specific heat of 0.238, the following figures are obtained:

Rate of flow, lb. per hr. .... W =	10	32	100	500
Heat transfer, B.t.u. per hr.. $0.238\ W(T_2 - T_1)$ =	84.6	217	536	1910

From this it will be seen that when flowing at the rate of 10 lb. per hr. the temperature of the gas is raised 35.5 deg. out of a possible 42 deg., the transfer of heat being at the rate of 84.6 B.t.u. per hr., while if the rate of flow is increased to 500 lb. per hr. the temperature rise is only 16 deg., but the heat is transferred at the rate of 1910 B.t.u. per hr.

NUMERICAL VALUES FOR COEFFICIENTS

Returning to Equations [1] and [2] in order to evaluate the coefficients, Figs. 4 to 8 come under observation. The process adopted in deciding on the values given in Equations [3] and [4] was to plot on a fairly large scale values of log M as ordinates against values of log W as abscissæ. This having been done for the five Jordan series, for the Nusselt and for the Babcock and Wilcox groups of experiments, all of which can lay claim to a high degree of accuracy, it was evident that Equation [2], or log $M = A - m$ log W, was universally applicable if the coefficients A and m were properly chosen to suit each flue. This is made clear by Fig. 4, in which all of the seven series just referred to are brought together in one plot. It is evident from this that the coefficients A and m which determine the position of the lines in this plot depend on the ef-

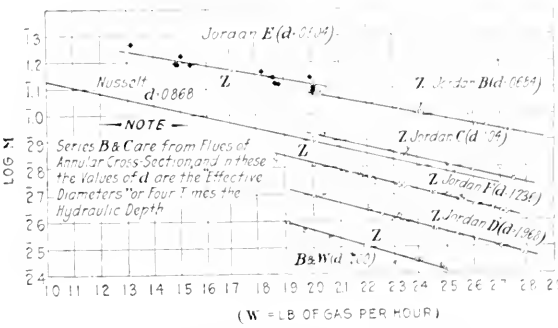


Fig. 4 Relation Between Coefficient M and Rate of Flow of Gas for Various Flue Diameters

All lines are represented by the equation

$$\log M = \bar{1}.87 - (2.23 + \log W)\, m,$$

which may be written log $M = A - m$ log W, where $A = \bar{1}.87 - 2.23\ m$. This indicates that all of the lines if extended will pass through the point at which log $M = \bar{1}.87$ and log $W = -2.23 = \bar{3}.77$.

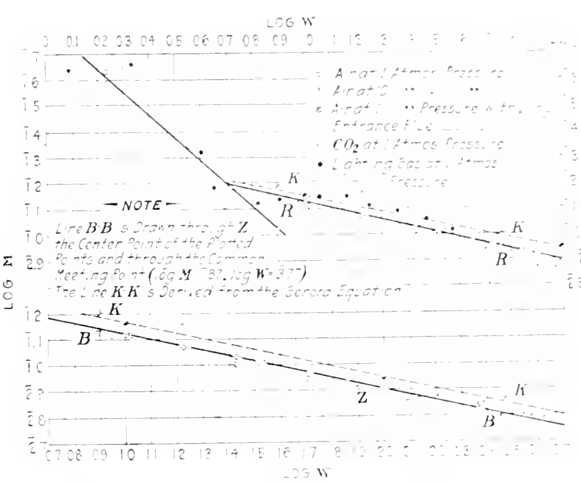


Fig. 5 Relation Between Coefficient M and Rate of Gas Flow from Nusselt's Experiments with Various Gases

fective diameter of the flue. The problem is then narrowed down to the selection of values for these coefficients which shall be in some regular relation to the effective flue diameter, and which shall at the same time harmonize with the individual points derived from the experiments.

In studying this problem it was found that in each series of experiments the points plotted in Fig. 4 could be closely represented by a group of straight lines and all the lines thus obtained passed through point (log $M = \bar{1}.87$, log $W = \bar{3}.87$). In other words, the points representing the relation between log M and log W for all the experiments in the seven series now under consideration lie on a series of straight lines radiating

from the common point ($\log M = \overline{1}.87$, $\log W = \overline{3}.77$). Having discovered this property, the positions of the lines shown in Fig. 4 were established by choosing for each series of experiments a center point (these are the points marked Z in Fig. 1) and drawing lines through the common meeting point and through these center points.

Table 2 shows in columns 3 and 4 the coördinates of the center points selected for each series, and in columns 5 and 6 the values of the coefficients A and m for each of the lines passing through these center points and through the common meeting point. To connect these coefficients with the effective flue diameter they are plotted as ordinates in Fig. 7 over the flue

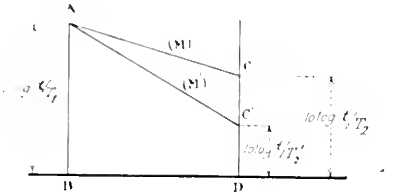


FIG. 6 DIAGRAM SHOWING EFFECT OF A CHANGE IN THE VALUE OF THE COEFFICIENT M

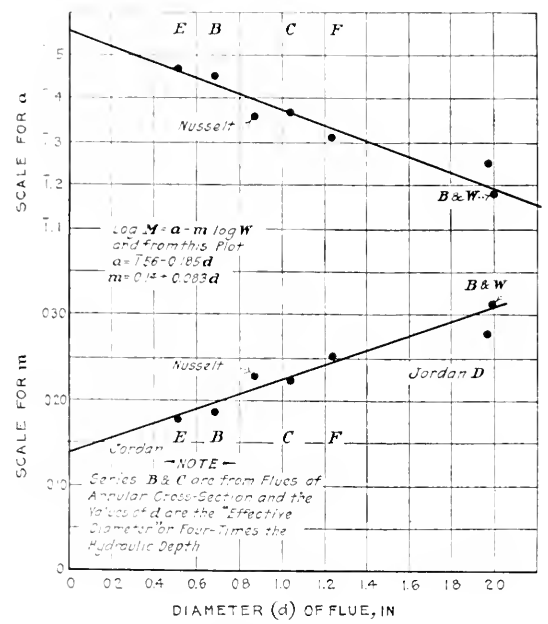


FIG. 7 RELATION BETWEEN FLUE DIAMETER AND COEFFICIENTS m AND A IN THE EQUATION LOG $M = A - m$ LOG W

The value of m being determined by the line drawn through the plotted values of m, the value of A follows from the equation $A = \overline{1}.87 - 2.23\ m$.

diameters d as abscissæ. All of the points lie fairly close to a straight line, and for the coefficient m a line with the equation $m = 0.14 + 0.083d$, or Eq. [4], was chosen as representing most satisfactorily the relation between m and d. Now since all of the lines in Fig. 5 are drawn to pass through the point ($\log M = \overline{1}.87$, $\log W = \overline{3}.77$), they can all be represented by the equation

$$\log M = \overline{1}.87 - (\log W - \overline{3}.77)\ m \quad \ldots\ldots [5]$$

which can be written

$$\log M = \overline{1}.87 - (2.23 + \log W)\ m \quad \ldots\ldots [5a]$$

since $\overline{3}.77 = -2.23$, or by regrouping,

$$\log M = (\overline{1}.87 - 2.23\ m) - m \log W \quad \ldots\ldots [5b]$$

Combining this with Equation [2], it follows that

$$A = \overline{1}.87 - 2.23\ m \quad \ldots\ldots [6]$$

and giving m the value found above in Equation [4], Equation [6] becomes

$$A = \overline{1}.56 - 0.185\ d \quad \ldots\ldots [3]$$

This completes the account of the development of the formulæ proposed. It now remains to consider their application to other independent experiments and to consider critically some portion of the work described above.

APPLICATION OF THE FORMULÆ TO OTHER EXPERIMENTS

In addition to those from the seven series of experiments considered above, experimental data from five other series are available for comparison. These are the two series by Fessenden, one by Josse, and two series of the Pennsylvania Railroad locomotive tests. For these experiments values of M were calculated as before and the values of $\log M$ plotted against $\log W$ in Figs. 8 to 11. In these figures the points are rather more scattered than in those previously considered, and the straight-line relation between $\log M$ and $\log W$ is not so clearly marked. This is probably due to a somewhat lower degree of accuracy in the experiments, and it was for this reason that these series were used for checking rather than for establishing the formulæ. The value of the coefficients A and m as determined by Equations [3] and [4] for the respective flue diameters are given for all twelve series of experiments in columns 7 and 8 of Table 2. The lines corresponding to these coefficients are drawn in in the various figures and marked K-K. In the Josse experiments, Fig. 8, the values of M given by the line K-K derived from Equations [2], [3] and [4] are slightly higher than those calculated from the experiments. The deviation of the line from the points is hardly greater than the discrepancies between the individual points. In view of the fact that no very elaborate precautions were taken to prevent errors in these experiments, it is quite probable that the formula represents the actual conditions at least as closely as do the figures derived from the experimental data. This series is also interesting, as it confirms the indication given by the Nusselt experiments of a critical gas speed at about 5 lb. per hr., $\log W = 0.699$. In the Fessenden experiments the points in Series I, Fig. 9, are very smoothly grouped and could hardly be better represented than they are by the line K-K given by the formulæ. In Series II, Fig. 10, the agreement between the calculated line K-K and the experimentally derived points is apparently not so close, but in this case the experimental conditions were such as to give a comparatively large variation in the coefficient M for a small variation in the heat absorption. In Fig. 10, for a rate of gas flow of 19.7 lb. of gas per hr., that is, $\log W = 1.295$, the value of $\log M$ from the formulæ as shown by the line K-K is $\overline{1}.15$, while the experimental points show $\log M = \overline{1}.05$. The experimental conditions corresponding to this rate of flow of gas show a temperature drop from 2003 deg. fahr. to 281 deg. fahr. in a flue 10.44 ft. long. The use of the calculated value of the coefficient M would change the outlet temperature from 281 to 238 deg. fahr., making the temperature drop 1765 instead of 1722 deg. This only means a difference of 2.5 per cent in the amount of heat absorbed from the gas, which is within the range of errors of observation in these experiments. There is therefore no real conflict between the experimental data and the formulæ proposed. The Pennsylvania Railroad locomotive tests, Fig. 11, show remarkably close agreement between the points derived from the experiments and the lines K-K given by the formulæ. A noticeable feature in this figure is the difference shown by the experiments in the value of the coefficient M in the two series of

TABLE 1 RANGE OF CONDITIONS COVERED BY EXPERIMENTAL DATA

Experimenter and Gas Used	Number of Experiments	Gas: Range of Temperatures Deg. Fahr., Inlet Min.	Inlet Max.	Outlet Min.	Outlet Max.	Rate of Flow, Lb. per Hour Min.	Max.	Flue: Shape of Section	Effective Inside Diam., Inches	Length Used in Experiments, Feet		Range of Mean Wall Temperatures Deg. Fahr. Min.	Max.	Conditions Surrounding Flue
Jordan														
Series B Air	15	258	545	147	235	108	550	Annular	0.684	3.28		68	106	Gas flue surrounded by annular water flue carrying cooling water flowing in direction opposite to that of air flow.
Series C Air	14	357	750	245	373	108	600	Annular	1.04	3.28		55	126	
Series D Air	14	319	604	250	443	108	620	Circular	1.968	3.28		[illegible]	86	
Series E Air	12	365	637	154	258	30	98	Circular	0.506	3.28		72	130	
Series F Air	17	381	736	260	468	72	520	Circular	1.236	3.28		67	102	
Nusselt										Min.	Max.			
1. Air at 14 lb. sq. in. abs.	13	78	155	109	187	1.6	108	Circular	0.868	0.89	[illegible]	212		Gas flue surrounded by steam jacket maintained at atmospheric pressure.
2. Same as 1, with long entrance flue	10	55	115	124	176	1.7	100	Circular	0.868	0.96	3.70	212		
3. Air at 140 lb. sq. in. abs.	12	62	115	81	145	16.6	420	Circular	0.868	[illegible]	1.96	212		
4. CO_2 at 14 lb. sq. in. abs.	10	70	125	108	150	6.4	137	Circular	0.868	1.00	1.96	212		
5. Lighting Gas at 14 lb. sq. in. abs.	12	74	144	124	177	1.0	38	Circular	0.868	0.64	1.96	212		
Babcock & Wilcox Co. Products of Combustion	7	1735	2340	377	649	94	313	Circular	2.0	17		160	200	Gas flue surrounded by water jackets each one foot long, to which cooling water is applied.
Fessenden Products of Combustion														Gas flue in each series surrounded by ten jackets to which water is fed and boiled at atmospheric pressure.
Series I	19	1473	1971	414	563	40.0	117.0	Circular	1.816	10.95		212		
Series II	17	1492	2003	247	306	11.8	25.8	Circular	0.816	10.44		212		
Josse														Gas flue surrounded by steam jacket maintained at atmospheric pressure.
1. Air at 14.7 lb. sq. in. abs.	7	62	70	138	171	5.3	71	Circular	0.905	4.34		212		
2. Air at 7.2 lb. sq. in. abs.	5	67	68	150	186	4.8	34	Circular	0.905	4.34		212		
3. Air at 1.5 lb. sq. in. abs.	5	80	96	162	188	0.5	37	Circular	0.905	4.34		212		
Pennsylvania R. R. Products of Combustion														Experiments with locomotive boilers.
Series 600	11	1476	2177	500	689	64	171	Circular	2.00	18.75		[illegible]		
Series 900	17	1774	2266	562	740	121	252	Circular	1.75	15.00		387		

TABLE 2 VALUES OF COEFFICIENTS A AND m USED IN DRAWING B-B AND K-K LINES IN FIGS. 4 TO 11

1	2	3	4	5	6	7	8
Experiments	Flue Diameter Inches	Coordinates of Point Chosen as Center of Plotted Points		Values of Coefficients A and m Found for Line Drawn through the Center Point and through the Common Meeting Point Having Coordinates Log M = [illegible].87, Log W = 3.77		Values of Coefficients Corresponding to the Flue Diameter as Given by the Straight Lines in Fig. 7 $A = \bar{1}.50 - 0.185d$ $m = 0.14 - 0.083d$	
		Log M	Log W	A	m	A	m
Babcock & Wilcox	2.00	$\bar{2}.500$	2.20	$\bar{1}.18$	[illegible]	$\bar{1}.19$	0.306
Jordan Series B	0.684[1]	$\bar{1}.010$	2.40	$\bar{1}.455$	0.18[illegible]	$\bar{1}.41$	0.197
Jordan Series C	1.04[1]	$\bar{2}.850$	2.3[illegible]	[illegible]	0.22[illegible]	[illegible]	0.226
Jordan Series D	1.968	$\bar{2}.570$	2.45	$\bar{1}.27$	0.278	[illegible]	0.303
Jordan Series E	0.506	$\bar{1}.170$	1.70	$\bar{1}.47$	0.178	$\bar{1}.47$	0.182
Jordan Series F	1.236	$\bar{2}.707$	2.45	[illegible]	0.27[illegible]	[illegible]	0.243
Nusselt	0.868	$\bar{2}.907$	2.00	[illegible]	0.228	$\bar{1}.41$	0.212
Fessenden, Series I	1.816	...	...		...	$\bar{1}.23$	0.291
Fessenden, Series II	0.816	...	...			$\bar{1}.41$	0.208
Josse	0.905	...				$\bar{1}.39$	0.216
Penna. R. R., Series 600	2.00	...	...	...	...	$\bar{1}.19$	0.306
Penna. R. R., Series 900	1.75	...	...	...	...	$\bar{1}.25$	0.255

[1]The flues in the Jordan series B and C have annular cross-sections. The values given in column 2 as diameters are the "effective diameters," or four times the hydraulic depth.

tests. The outside flue diameter was 1¾ in. in Series 900 and 2 in. in Series 600, and the difference between the values found by experiment for M in the two series corresponds exactly to the difference as calculated from the formulae for the two different flue diameters.

The formulae derived from the seven series of Jordan, Nusselt, and Babcock and Wilcox experiments are closely con-

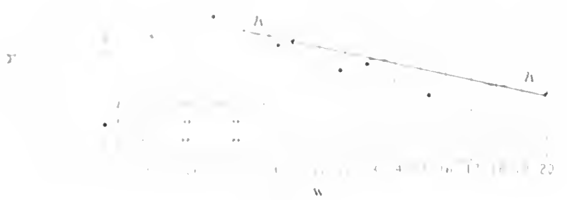


FIG. 8 RELATION BETWEEN COEFFICIENT M AND RATE OF GAS FLOW (W) FROM JOSSE'S EXPERIMENTS

(Line K-K derived from the general formula.)

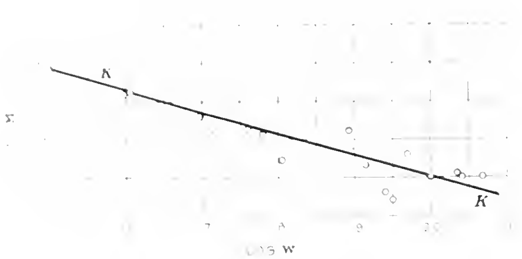


FIG. 9 RELATION BETWEEN COEFFICIENT M AND RATE OF GAS FLOW (W) FROM FESSENDEN'S EXPERIMENTS, SERIES I

(Line K-K derived from the general formula.)

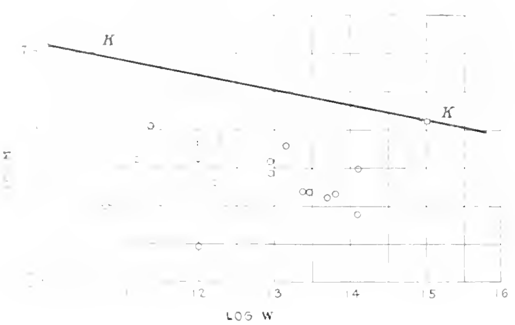


FIG. 10 RELATION BETWEEN COEFFICIENT M AND RATE OF GAS FLOW (W) FROM FESSENDEN'S EXPERIMENTS, SERIES II

(Line K-K derived from the general formula.)

CONCLUSIONS

firmed as to accuracy of results by the five series of Fessenden, Josse, and Pennsylvania Railroad experiments.

A DIAGRAMMATIC METHOD OF CONSIDERING THE PROCESS OF HEAT TRANSFER

Mechanism of Heat Transfer. In considering the problems connected with the transfer of heat between gas and flue wall, it is desirable to form some sort of mental picture of the physical processes which are in action. Fig. 12 is a diagram offered as a means to this end.

The gas is imagined to flow from left to right through the flue indicated in Fig. 12, while the dotted diagonal lines are intended to represent, in a very much simplified way, the path of individual particles of gas. Starting from a point in the center of the flue with a temperature of say T_{c_1}, a particle travels outwards and forwards until it impinges on the flue wall. For an instant the particle will flatten itself so to speak against the wall, and in this intimate contact will take on the temperature of the wall (T_w). It will then rebound at this temperature. During the rebound other particles approaching the flue wall will be encountered and there will be an interchange of heat and consequently of temperature, so that the temperature of the particles approaching the wall tends to approach the wall temperature before actual contact, while the particles leaving the wall tend to recover the center temperature T_{c_1}. As a consequence, when the particle first taken under consideration again reaches the center of the flue it will have a temperature T_{c_2}, which is higher or lower than T_{c_1} according as the wall temperature is higher or lower than the gas temperature. The process is repeated and on again

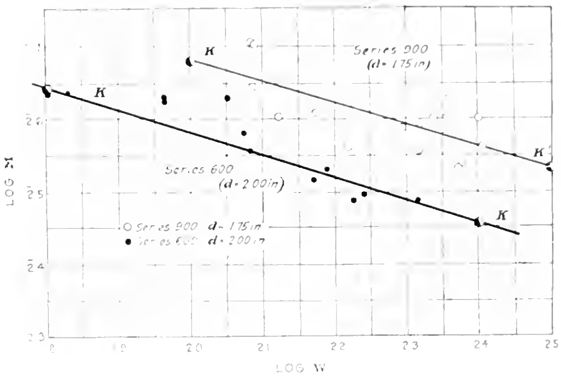


FIG. 11 RELATION BETWEEN COEFFICIENT M AND RATE OF GAS FLOW FROM PENNSYLVANIA RAILROAD LOCOMOTIVE TESTS

(Line K-K derived from the general formula.)

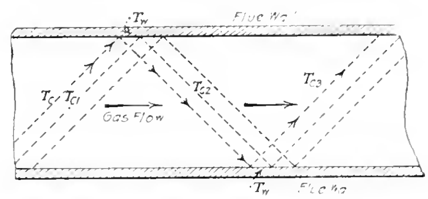


FIG. 12 DIAGRAM REPRESENTING PATH OF GAS PARTICLES AND TRANSFER OF HEAT

reaching the center the particle will have the temperature T_{c_3} and so on. This simplified way of looking at the heat-transfer process will give a correct understanding of the so-called film of dead gas supposed to adhere to the flue and to be scrubbed off to permit a more rapid rate of transfer when rate of flow of gas is increased. The particles, as has been said, are in contact with the flue wall for an instant and come away at the wall temperature, so that there is in effect a film of gas at the wall temperature close to the flue. This will to a certain extent protect the flue wall and cushion it against the particles coming from the center, but if the center particles do not strike the wall they impinge on the wall particles and effect an interchange of heat with these, some of which travel again to the wall, thus continuing exchange of heat between wall and gas.

If the amount of gas passing through the flue be increased heat is transferred between gas and flue at a faster rate, but this is not because the film of gas at wall temperature is swept off the flue wall, but because more particles are introduced to

bombard each unit of wall space. It must be remembered that while an increase in the rate of gas flow increases the rate of heat transmission, it at the same time reduces the efficiency of the process. This has already been dealt with, but in view of much that has been written on this subject, by Nicolson[9] among others, the point is worth emphasizing. Take the case of a boiler flue in which hot products of combustion are being cooled. A certain rate of flow gives a certain temperature drop and a certain amount of heat absorbed. If the rate of flow be doubled it will be found that the temperature drop is less than before; that is, the amount of heat absorbed from each pound of gas is less—the efficiency of the flue in absorbing heat has been reduced. Since, however, the weight of gas has been doubled while the amount of heat absorbed from each pound has not been halved, the total amount of heat absorbed is greater, that is, the effectiveness of the flue in absorbing heat has been increased. It would seem as though with the increase of gas flow there was an interference between the particles in their bombardment of the flue wall; although the number of hits is doubled the blows interfere with each other and are not so direct, with the result that though the amount of heat transferred is increased it is not doubled. In many cases advocates of high rates of gas flow fail to distinguish between effectiveness and efficiency.

The bombardment of the flue wall by the gas particles also serves to explain the effect of hydraulic depth on heat transmission. The hydraulic depth may be decreased either by reducing the diameter of the flue or by inserting a core so as to reduce the cross-sectional area while maintaining the perimeter (hydraulic depth = area perimeter). With a reduced hydraulic depth the particles have a shorter distance to travel between center and wall, and consequently the same number of particles will make a greater number of hits in the same time and they will therefore effect the transfer of a larger amount of heat.

Gas Temperature. In setting out the various formulæ for change of temperature along the length of the flue, the temperature of the gas at various points along the flue has been spoken of. This was done with the understanding that the "temperature of the gas" in this sense is a term needing careful definition. In any section of the flue perpendicular to the longitudinal axis the temperature will vary from center to wall. The gas therefore has no definite temperature at that section, but the term "gas temperature" as used in the paper is to be understood as meaning the mean temperature of the gas crossing the section under consideration, that is, the temperature at which the gas if uniformly heated would carry past the section the same amount of heat as is actually carried. This temperature cannot be measured directly by a mercury thermometer or by a thermocouple. Nusselt measured the mean temperature, apparently with a fair degree of success, by means of a resistance thermometer formed of a spiral of wire wound on a mica cross in such a way as to traverse practically the whole sectional area of the flue. In this connection he points out that with pyrometers or bulb thermometers the radiation effect between instrument and flue wall will prevent accuracy of measurement.

Heat Transfer and Loss of Head. On considering the action of heat transfer as outlined above it will be apparent that there must be an intimate relation between the rate of heat transfer and the loss of head by the gas. As each particle impinges on the flue wall it loses (or gains) a certain proportion of its heat, and at the same time must, unless the flue wall be perfectly smooth—which is of course physically impossible, lose some of its velocity in the direction of the longitudinal axis of the flue.

Nusselt pointed out that Osborne and Stanton have dealt with this phase of the question mathematically, and Stuart[10] in discussing the performance of coolers for lubricating oil says that in the case of the oil and of the water flowing through the coolers the relative friction drops are of the same order as the relative heat-transfer factors.

The laws governing the loss of head by a fluid passing through a flue are still but imperfectly established, and it is suggested that a formula of the type given in the paper for heat transfer might be worked out to serve as a general formula for loss of head.

Such a general formula would be valuable, as loss of heat represents the price that must be paid for heat transfer. In any attempt to increase the rate of heat transfer by increasing the rate of flow of the gas, the limit is set by the loss of head. Beyond a certain point the loss of head, or in other words the amount of energy required to drive the gas through the flue, makes the gain in heat transfer unremunerative.

[9] Trans. Jun. Inst. Engrs., Jan., 1909.

[10] Journal Am. Soc. Naval Engineers, May 1917.

A STUDY OF SURFACE RESISTANCE WITH GLASS AS THE TRANSMISSION MEDIUM

By H. R. Hammond[1] and C. W. Holmberg,[2] Brooklyn, N. Y.

In the study of heat transmission the determinations of the thermal resistances of material have been obtained in a more or less vague manner. At present the majority of coefficients used are combined coefficients; that is, no attempt is made at discriminating between the conduction of the material itself and the conductions of the two air spaces which exist adjacent to it. Consequently there are no standards by which surface resistance may be obtained. A method has been used by which the temperatures of the air, both outside and inside, were measured at a distance of 1 in. from the surface, but this has never been verified.

In an attempt to obtain some data on the subject of surface resistance with glass as the transmission medium, this paper will deal with the following points:

1 A study of the temperature gradients under various temperature differences between the inside and outside of the box

2 The relative values of conduction for the glass and for the air surfaces

[1] 256 Jefferson Ave.
[2] 354 Senator St.

For presentation at the Annual Meeting of The American Society of Mechanical Engineers, New York, December 4 to 7, 1917. The paper is here printed in abstract form, and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

3 The variation of the conduction values under the various temperature differences between the inside and the outside of the box.

THEORY

Heat may be transmitted from one side of a wall to the other in three ways: by radiation, by convection, and by conduction. In this paper, however, the radiation and convection factors will not be dealt with, and the formulæ which follow have to do only with conduction.

For total heat transmitted, we may write:

$$Q = kA(\Delta T) \ldots\ldots\ldots\ldots\ldots\ldots [1]$$

where Q = total B.t.u. transmitted per hour

k = transmission in B.t.u. per hour per sq. ft. per deg. difference in temperature

A = area of the surface in sq. ft.

(ΔT) = temperature difference, deg. fahr.

The value of k depends upon several factors: the surfaces, the thickness and kind of material, air spaces, absolute temperature, temperature difference, and condition of air at the surfaces. The combined transmission coefficient of a com-

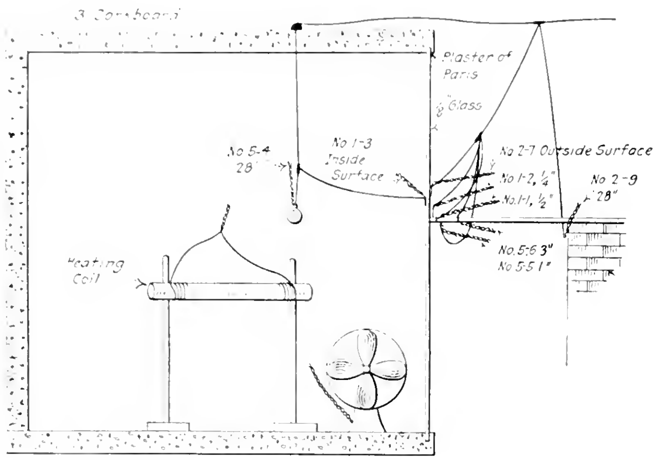


FIG. 1 APPARATUS FOR DETERMINING TEMPERATURE GRADIENT

pound wall is determined from the sums of the reciprocals of the various conduction coefficients, as follows:

$$k = \frac{1}{C_1} + \frac{x_2}{C_2} + \frac{x_3}{C_3} \cdots\cdots \frac{x_n}{C_n} + \frac{1}{C_{n_1}} \ldots\ldots\ldots [2]$$

where C_1 = conduction of inside air surface in B.t.u. per hr. per sq. ft. per deg. difference in temperature

$C_2, C_3, \ldots C_n$ = conduction of material per hr. per unit thickness per sq. ft. per deg. difference in temperature

C_{n_1} = conduction of outside air surface in B.t.u. per hr. per sq. ft. per deg. difference in temperature

$x_2, x_3, \ldots x_n$ = thickness of material in inches.

PROCEDURE

The experiments were carried on in the thermal testing plant of the Pennsylvania State College, which consists of a room 17 x 17 x 10 ft., well insulated with corkboard and kept at a constant temperature by means of brine coils placed around the wall. Bulletin No. 9, Vol. 1, published by the Pennsylvania State College Experiment Station, contains illustrations and a complete description of this plant.

The experiments were made with a corkboard box (Fig. 1) 5 ft. by 5 ft. by 5 ft. 1 in. in outside dimensions and having a mean surface area of 141 sq. ft. The temperatures were recorded by platinum-resistance thermometers made by the Leeds & Northrup Co. and specially designed for this plant. Carefully calibrated voltmeters and ammeters were used to measure the heat input to the box.

Before proceeding with the tests the resistance thermometers and the box were carefully calibrated. The thermometers were calibrated by comparison with a standard mercury thermometer reading to 0.2 deg. and estimated to 0.01 deg. The thermometers were placed in a small box to protect them from any air currents that might affect the readings. The readings on the mercury thermometer were taken through a telescope in order that they might be estimated more accurately and not be affected by heat radiation from the person taking them. The resistance-thermometer readings were indicated by the usual Wheatstone bridge as supplied by Leeds & Northrup Co. Readings were taken of the various thermometers every ten minutes, and after a series of tests under different temperatures, the calibration curves were plotted.

In calibrating the corkboard box for different ranges of temperatures from inside to outside, a thermometer was suspended midway between the top and bottom and 10 in. from the inside surface, and another placed outside in the room. The room was kept at a constant temperature by means of brine circulating through coils around the room. Inside the box was placed a fan for the purpose of circulating the air and thus keeping the box at a uniform temperature throughout. The desired temperature was obtained by means of an electric heating coil placed in the center of the box. During the tests, readings were taken every ten minutes of the temperature inside and outside the box and of the voltage and amperage input. When the readings became constant they were considered acceptable and the rate of transmission in B.t.u. per hour per square foot was calculated from the formula

$$k = \frac{3.412 \times A \times V}{\text{mean area of box surface} \times \Delta T} \ldots\ldots [3]$$

where A = ammeter reading in amperes.

V = voltmeter reading in volts

3.412 = heat equivalent of watts per hour

ΔT = temperature difference.

The calibration curve for the various temperature differences is plotted in Fig. 2.

After calibration the removable corkboard side was taken off and replaced by a glass plate ⅛ in. thick. Thermometers were placed at distances of ¼ in., ½ in., 1 in., 3 in., and 28 in. from the inside surface, also on the inside and outside surfaces and 28 in. from the outside surface. Tests were made in the same manner as when the box was calibrated.

All tests were run until the respective thermometers had maintained constant readings for some time. The arrangement of thermometers afforded ample opportunity to determine the temperature gradients.

Owing to the few available thermometers, it was not possible to run tests for inside and outside gradients simultaneously. Consequently the thermometers were rearranged as follows for the outside gradient tests: 28 in. inside, inside surface, outside surface, and ¼ in., ½ in., 1 in., 3 in., and 28 in. outside. All tests so far had been run with circulating air inside and still air outside. During this set-up, however, air currents were induced by a motor-driven fan which forced

air through a narrow slit-like aperture 1 in. wide and discharged across the surface of the glass with mean velocities at the thermometers of 800 and 1100 ft. per min. for two tests, respectively. Results of the outside gradient tests are plotted in Fig. 3, herewith shown. Two curves obtained under conditions of temperature and temperature range similar to those of the inside gradient tests were plotted in Fig. 4, together with the inside gradients as though they were obtained simultaneously.

On account of breakage, the plain glass window was now replaced by a four-pane window sash. Thermometers were placed at 28 in. inside, the inside surface, the outside surface and 28 in. outside the window. Tests were now run in the same manner as the preceding ones, especial care being taken to keep constant voltage and amperage in the heating coil, since these tests were primarily transmission tests. The combined transmission coefficient (k_1) of the window glass was calculated from the following formula:

$$k_1 = \frac{3.412\ V\ A - k_2\ S_1\ (\Delta T) - 0.8\ S_3\ (\Delta T)}{S_2 \times (\Delta T)} \ldots . [4]$$

where V = volts in heating coil

A = amperes in heating coil

S_1 = mean area of surface of 5 sides of corkboard box, sq. ft.

S_2 = mean area of surface of window panes, sq. ft.

S_3 = mean area of surface of sash (wood), sq. ft.

(ΔT) = temperature difference (inside—outside), deg. fahr.

0.8 = coefficient of transmission of wood

k_2 = coefficient of transmission of corkboard

The coefficient k_1 was calculated for various temperature differences as shown above and the results plotted in Fig. 5.

The conductions of the two air surfaces and the glass were determined similarly to the combined transmission coefficient, save that the value of (ΔT) in the denominator varied as the temperature differences of the various layers of material concerned. These curves are likewise plotted in Fig. 5 for the purpose of comparison.

SAMPLE CALCULATIONS

When (ΔT) = 23.15 deg. fahr.,

k_1 (combined transmission coefficient of glass) =

$$\frac{(3.412 \times 49.5 \times 4.51) - (0.8 \times 0.58 \times 23.15) - (117.3 \times 23.15)}{21.4 \times 23.15} =$$

$$\frac{770 - 10.75 - 277}{495} = \frac{482.25}{495} = 0.974$$

$$C_2 = \text{conduction of glass} = \frac{482.25}{21.4 \times 1.26} = 17.88$$

$$C_1 = \text{Conduction of inside air surface} = \frac{482.25}{21.4 \times 7.93} = 2.84$$

C_{o_1} = conduction of outside air surface =

$$\frac{482.25}{21.4 \times 13.96} = 1.615$$

DISCUSSION OF RESULTS

When plotted, all of the temperature gradients from the surface proved to be smooth curves. This result amply justified the method of testing which was employed during the entire series of tests, both gradient and transmission. In this method of testing the authors continued the test until constant readings in the respective thermometers had been maintained for some time. The time elapsing before this condition was obtained varied between two and eight hours.

The inside gradients bent down sharply within the first quarter of an inch. Then the curves grew flatter, until at a distance of ½ in. from the surface of the glass the curves became constant. The outside gradients were more gradual in character, the major part of the drop occurring in the first two inches from the glass for still-air conditions, while the gradients obtained under moving air were considerably flattened and reached a nearly constant value within the first inch.

These results would indicate that the circulating air inside

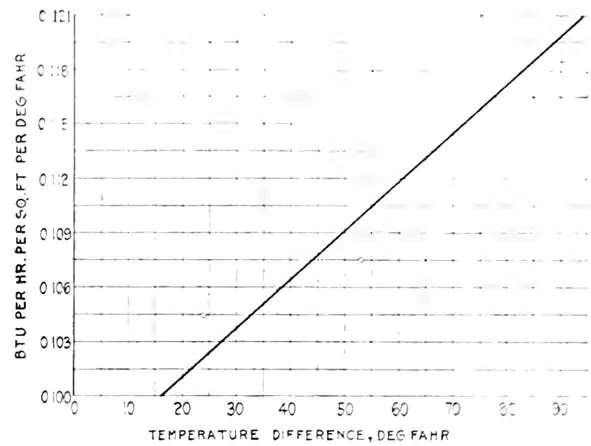


FIG. 2 TRANSMISSION OF CORKBOARD BOX

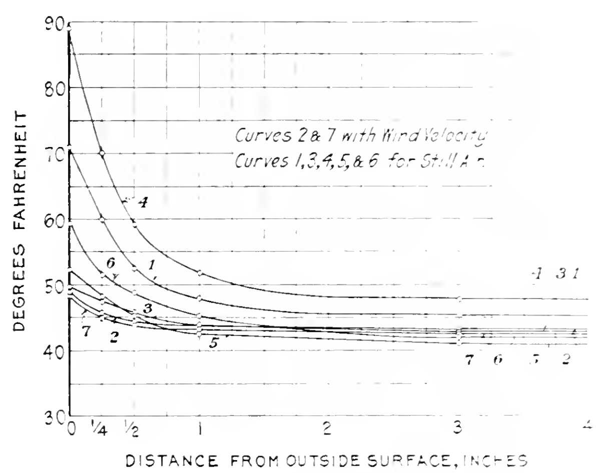


FIG. 3 OUTSIDE TEMPERATURE GRADIENTS

cut down the air resistance film at the surface of the glass and thus increased the conduction of the air layer.

Under still-air conditions the outside surface resistance was considerably greater than with moving air. This was undoubtedly due to the fact that much heat was carried away by convection.

These tests indicate that the resistance is greatest very close to the surface of the glass and that when performing experiments in heat transmission it is best to place the outside thermometer not less than 2 in. from the surface under still-air conditions; and not less than 1 in. under moving-air conditions when the air velocity is greater than 800 feet per minute.

The combined transmission coefficients and the conduction

values for the glass inside air surface and outside air surface were calculated by formula (1) and are as follows:

	Temperature Range, Deg. Fahr.			
	[illegible]	10–37	51–45	73–59
Combined transmission	0.971	1.070	1.130	1.165
Conduction of glass	17.880	18.050	19.800	19.890
Conduction of inside air surface	2.840	3.315	3.650	3.560
Conduction of outside air surface	1.615	1.750	1.850	1.900

The combined coefficient values check up fairly well with the values 0.96 (dry glass) and 1.1 (wet glass) for a single window 1/8 in. thick, given in Greene's Elements of Heating and Ventilation. Moreover, they show that the transmission varies linearly with the temperature differences, as the curve plotted in Fig. 5 will demonstrate.

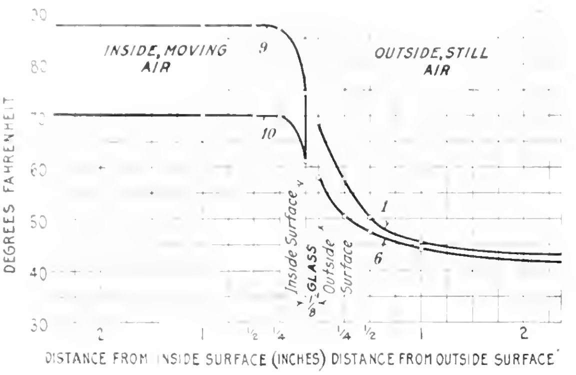


Fig. 4 Combined Inside and Outside Gradient

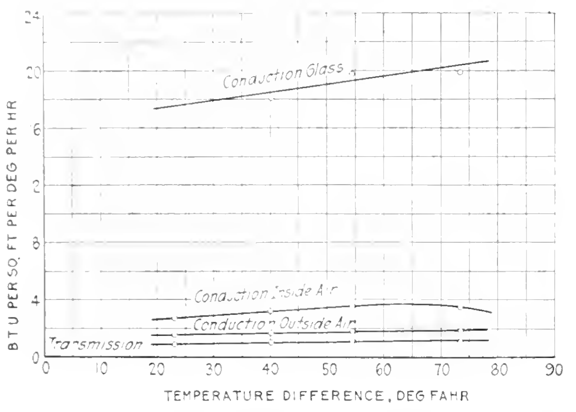


Fig. 5 Conductions Through Air Surfaces and Glass

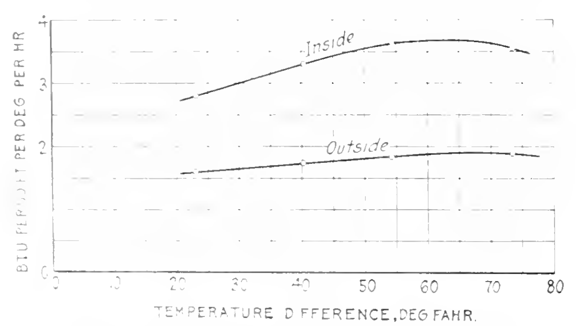


Fig. 6 Conduction Through Air Surfaces

The conduction values for the glass under the same temperature differences show that they also varied in the same way as the combined transmission values.

The conduction values for the air surfaces confirm the results of the gradients, in that the resistance of the outside air surface is shown to be considerably less than that of the inside air surface. Curves of the surface resistance plotted to an enlarged scale in Fig. 6 show that the conduction of the surfaces is greatest at points where the temperature ranges vary from 65 deg. to 75 deg. This seems to indicate that there is a saturation point at which the transmission through the air layer cannot be increased. The writers believe that it would be highly desirable that further investigations be undertaken in order to check up this point.

Fig. 5 shows the relationship between the conductions of the air surfaces and the glass. It can be seen that the resistance of the glass is very slight as compared with that of the air surfaces. This proves that in figuring transmission through glass the resistance of the air layers at the given conditions will be the primary factors, since from the figure it is shown that they form the bulk of the resistance which goes to make up the combined transmission factor. In connection with this point it is interesting to note the investigations carried on by Professor Moyer in the Pennsylvania State College Thermal Testing Plant, and described in the *A. S. H. E. Journal*, Vol. 2, No. 3. Professor Moyer's results indicated that the influence of air velocity on transmission through glass caused the transmission coefficient to vary from a value of 1.263 at zero velocity to 4.207 at a velocity of 1200 ft. per min. This illustration further proves the extreme importance of the air surface resistance on the combined transmission factor.

Consequently, the subject of air resistance seems worthy of careful investigation as to its behavior under varied conditions. The writers in suggesting further investigation along this line would say that they consider thermocouples preferable to resistance thermometers. Resistance thermometers, on account of their appreciable size and consequent susceptibility to radiation, make very accurate surface readings impossible, while the fine-point contact of the thermocouple makes it very desirable in this connection. Delay in obtaining thermocouples caused the writers to use resistance thermometers in these tests.

The writers are indebted to Prof. R. B. Fehr of the Pennsylvania State College Thermal Testing Plant for some of the data used.

CONCLUSIONS

A summary of the more important results obtained in the tests is as follows:

1 The gradient tests demonstrate that the greater part of the air-layer resistance occurs at the outside and within the first half inch of the surface.

2 Whenever glass or any other good conductor is used as the transmission medium, the resistances of the inside and outside air surfaces play the major part in determining the combined transmission coefficient.

3 The tests show that the transmission through glass and through corkboard with temperature differences ranging from 20 deg. to 80 deg. varies linearly with these temperature differences.

The writers wish to acknowledge much valuable assistance received from Prof. A. J. Wood and R. B. Fehr, and from the Penn State College.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

Steam Locomotive Practice

To the Editor:

Among the papers constituting the Symposium on Steam Locomotives held by the Minnesota Section, I find a number of points of interest, which might be considered more extensively with profit. Prof. G. L. Hoyt calls attention to the fact that, in many cases, the use of special heat-treated steel has not been accompanied by a modification in design, so that the advantages of the higher-priced metal could be fully obtained. This is a point that is not readily understood, and is especially true in the case of springs, where the alloy steel costs double and should have double strength, but the manufacturers recommended the same load limits, viz., 70,000 to 80,000 lb. per sq. in., that had been used for years in plain carbon steels. It was explained that you had double the "factor of safety" that you obtained with carbon steel, but this never appealed to the writer as being a sound engineering argument. Factors of safety are too often "factors of ignorance," and as such are not desirable quantities to increase, especially at double the price.

These recommendations to use high-priced heat-treated alloy steels without realizing the benefits for which we pay by a reduction in the quantity of metal used, always convey the impression that the particular heat treatment used may *not* give us all that is claimed for it. Heat treatment is quite a difficult process to control properly in a large plant, where the conditions of operation are evidently very different from those that obtain in an experimental laboratory, where the whole treatment is under the eye of a specialist instead of depending upon ordinary labor. Pyrographic charts will tell what temperatures *have existed* at certain *points* in the *furnace,* but the temperature of the particular piece under treatment is quite another matter.

The writer does not wish to be considered skeptical of the value of alloy steels—far from it, but he has seen so many instances of things being "seldom what they seem" in the heat-treated line that he does not always have as much faith in the results of that process as he would like to have, and it seems possible that such fears may be the basis for maintaining old dimensions in the parts made of alloy steels.

Coming to Pulverized Fuel in Locomotives, the writer is in hearty accord with the efforts of Mr. Muhlfeld to obtain greater output from locomotives by this method of combustion. Many years before locomotive stokers achieved the success which they now enjoy, he (the writer) pointed out the necessity for increasing the steam output beyond the human muscular limits of the fireman, which were about 5000 to 6000 lb. of coal per hr., and favored the introduction of stokers on locomotives which should have the firebox especially designed for this purpose, instead of trying to crowd in the stoker apparatus and mechanism where the construction was not suitable for producing the best results. The same must be true of pulverized coal, and prejudice in adhering to conventional lines should not be allowed to interfere with the success of this method of firing locomotives. This has been the crucial point in many improvements, and fear to leave what our fathers have done has sounded the death knell of many valuable efforts for progress.

At the present time the success of feedwater heaters on locomotives seems to be more dependent upon the pump than any other feature of the device. Simple as this part of the problem seems to be, it is one very difficult of satisfactory solution. Reciprocating pumps jar themselves and their parts loose and go out of commission just when the engineer has neither time nor opportunity to "tinker" with them. Rotary pumps at high speed have difficulties of their own, due largely to the unsatisfactory foundations which must be furnished by the locomotive structure. Bent spindles and other troubles follow insufficient rigidity, and the small space available for this apparatus prevents securing the best results. The weakest link in a chain is often located where we least expect, and compromises the whole structure by its breakdown. So an unsatisfactory pump will put a "curse" upon a feedwater system that it cannot survive, no matter how efficient the heater.

Geo. R. Henderson.

Philadelphia, Pa.

To the Editor:

The symposium on steam locomotives, held by the Minnesota Section on March 10, was certainly most instructive, but I feel that one point in connection with the various appliances and devices described was not given sufficient importance. To one familiar with development of steam locomotives in the past few years, there is no question but that the superheater and brick arch have had a very intimate connection with the increase in size and power of our locomotives. The railways have been continually seeking for larger and larger units of power, with but slight changes in physical limitations under which this power must operate (weight per pair of wheels, height and width limits and amount of coal which can be fired per hour), and the increased capacity afforded by superheat and the brick arch has permitted an increase in the size of locomotives far beyond that which would have been possible without them.

In the papers which were read descriptive of various improvements, emphasis was laid upon the economies in operation which these improvements effected. It has been the history of railroading that advantage is at once taken of any device which makes for economy or efficiency in obtaining *additional capacity.*

How much has already been accomplished in this matter is evident from a comparison of the horsepower output of a typical first-class locomotive built about 1904-05 and that of one of recent design. An average fireman can handle about 5000 lb. of coal per hour. In 1904 we were obtaining from our best designs of simple locomotives without superheaters about 1100 to 1200 i.hp. per hour from 5000 lb. of coal. To-day we are obtaining from the same amount of coal about 2000 to 2100 i.hp. per hour.

These latter figures were obtained from locomotives having superheaters and brick arches, together with other refinements of design introduced in the past few years. It is evident that the enormous strides in increased capacity and size could not have been made had it not been possible to obtain more work from a pound of coal by taking advantage of the increased efficiency due to these improvements.

Two of the latest developments which will make possible still further increases in capacity and power, and which were not included in the above comparison of locomotives in 1901 and 1905 and at the present time, are the feedwater heater and the use of pulverized fuel. Both of these developments are unquestionably capable of yielding material economies which will undoubtedly be utilized in still further increases in the capacity of locomotives.

In the past there have often been statements made that we had reached the limit of size and power of locomotives, but it is significant that of late there have been fewer of such statements. The improvements and developments which were described at the meeting of the Minnesota Section have removed many of the limitations which previously confronted locomotive designers, until at the present time men who are familiar with the latest developments in this field hesitate to make any predictions as to limits of capacity and size of future steam locomotives.

W. E. WOODARD.

Lima, Ohio.

Mobile Armament for Defense

TO THE EDITOR:

Replying to the comments of Mr. Arthur F. Cary on Mobile Armament for Defense, published in the September issue of THE JOURNAL, I beg to state:

1 The standardization of ammunition for various calibers of guns is a very interesting matter, but is foreign to the subject under discussion.

2 As to the practicability of the gun having a breech block sliding against a surface plate: There is no tendency to dent the surfaces, which are hardened and are of sufficient area to withstand the load imposed. This load is a static pressure and is not in the nature of a blow; means being provided to bring the surfaces in contact, although a working clearance is allowed when elevating the gun.

3 With reference to the methods of supporting railroad cars from which guns of moderate size are fired: The outriggers and jackscrews have been adopted for the reason that they admit of adjustment to almost all conditions of the roadbed. In order to secure mobility it is necessary to keep the supports as nearly as possible within the limits of the roadbed. Beyond the actual roadbed the ground may be unsuitable to support any load. The tripod arrangement suggested by Mr. Cary presents several difficulties. The struts would have to extend from a point only a little below the trunnions, otherwise they would be subjected to a bending movement and would have to be made heavy. It would be interesting to see this tripod arrangement worked out for firing a gun from a car on a banked track say eight feet above a New Jersey marsh.

4 The independent drive for railroad cars is in use to some extent on the Pacific Coast. This is one of the good things that come from the West and travel East. It may replace the horse cars in some parts of New York.

ANDREW M. COYLE.

New York, N. Y.

Strength of Boiler Furnaces

TO THE EDITOR:

Referring to Par. 6 of the letter from Mr. John Airey in the July number of THE JOURNAL, I will quote the part of the Board of Trade rules pertaining to pressure allowance on plain circular furnaces, as follows:

$$\text{Plain Furnaces}^1. \quad \text{W. P.} = \frac{C \times T^2}{D(L+1)}$$

TABLE OF VALUES FOR C

Longitudinal Seams of Furnace	Iron		Steel
	Drilled	Punched	Drilled
Single butt straps double-riveted, or double butt straps single-riveted	90 000	85,000	99,000
Single butt straps single-riveted, or lap beveled and double-riveted......	80,000	75,000	88,000
Lap not beveled, double-riveted .	75,000	70,000	82,500
Lap beveled, single-riveted..... ..	70,000	65,000	77.000
Lap not beveled, single-riveted......	65,000	60,000	71,500
Longitudinal seams welded	90.000		99,000

In no case should the working pressure exceed the values found by the following formulæ:

$$\text{W. P.} = \frac{9000\ T}{D} \text{ for iron}$$

$$\text{W. P.} = \frac{9900\ T}{D} \text{ for steel.}$$

From this it will be noted that for a plain circular furnace

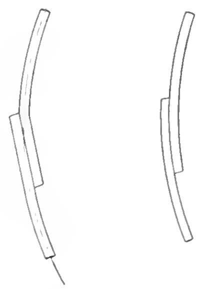


FIG. 1 FIG. 2

FIG. 1 BEVELED LAP SEAM

FIG. 2 ORDINARY LAP SEAM

with a single-riveted lap seam the formula is: $\frac{77{,}000\ T^2}{(L+1)D}$. This gives a pressure of 75 lb. on the furnace of the dimensions given by Mr. Airey, as stated in my communication in the February issue of THE JOURNAL. The constant 77,000 pertains to furnaces in which the single-riveted lap seam is properly formed or "beveled" so that the furnace cross-section is a true circle (Fig. 1).

When such a joint is made as shown in Fig. 2 the constant to be used is 71,500, which would give a pressure of 69 lb. without further deduction for the efficiency of the longitudinal joint.

Comparing the above constants and assuming 100 per cent for the collapsing strength of a flue with a welded seam or one with a double butt-strap joint, which are the easiest to make truly round, we get an efficiency of 71,500/99,000 = 72.2

[1] Copied from quotation of Board of Trade rules in Stromeyer's Marine Boiler Management and Construction.

per cent allowed by the Board of Trade rules for the kind of joint shown in Fig. 2.

While Mr. Airey's mathematical analysis of the efficiency of this joint in compression, which was published in the Journal of the American Society of Naval Engineers, appears a safe approximation, it would not seem that the theoretical result of 27.6 per cent (or about two-fifths of the Board of Trade allowance) he thus obtains need seriously be considered in view of the experience of several decades during which the Board of Trade constants have been operative unchanged in localities where boilers with (riveted) furnace flues always have been proportionally far more numerous than in the United States. It appears quite probable that the failure of the actual flue mentioned by Mr. Airey was due to general out-of-roundness in addition to the fact that the most unfavorable joint was used.

Upon the strength of Mr. Airey's analysis he is not justified in referring in a general way to "the weakness of a lap joint," since a lap joint that is properly formed as in Fig. 1 does not produce the unfavorable feature of making a cylinder out of round, and his analysis pertains only to Fig. 2.

One important point this discussion has brought out is that from the present wording the A.S.M.E. Boiler Code rules may be construed as permitting the use of longitudinal lap joints that are not properly formed for furnace flues, as all lap joints in compression should be, so that true circularity is obtained. It might be well to specifically prescribe this in the various paragraphs of the Code where longitudinal lap joints for flues are mentioned, just as the proper curvature for longitudinal joints of boiler shells now is prescribed.

H. J. Vanderéb.

Hartford, Conn.

WORK OF THE BOILER CODE COMMITTEE

Ten Years of Boiler Standardization

The conception of a standard specification for steam boilers was first advocated, I believe, by Mr. Joseph H. McNeill, who for many years was the very able chief inspector of the State of Massachusetts Boiler Inspection Department, and through the very earnest endeavors of Mr. McNeill and the operating engineers of Massachusetts, most ably sponsored by the late Hon. Curtis Guild, Jr., Governor of Massachusetts and later Ambassador to Russia, the Massachusetts Board of Boiler Rules was created. The writer looks back with pleasure to being one of the members of the original Board, on which he represented boiler-using interests, and which included Joseph H. McNeill, Chairman; Frederic H. Keyes, representing boiler-manufacturing interests; Robert J. Dunkle, representing boiler-insurance interests, and William M. Beck, representing operating engineers.

Upon the retirement of Mr. Frederic H. Keyes, Mr. Bartholomew Scannell, of Lowell, Mass., one of the patriarchs of the boiler industry in this country, was appointed in his place. Upon Mr. Scannell's resignation, Mr. Henry H. Lynch was appointed.

The late Mr. Thomas R. Armstrong was also a member of the Massachusetts Board of Boiler Rules at one time.

The first meeting of the Board was held on July 5, 1907, in a very small and hot room on the fifth floor of the State House at Boston. At this meeting Mr. McNeill stated to the other members of the Board his ideas of a standard specification for all stationary boilers to be used within the Commonwealth of Massachusetts.

We forthwith set to work to formulate a standard which would be first of all safe, and second commercial. We held meetings weekly and oftener for practically the first three years of the service. Incidentally it might be mentioned that the correspondence was very prolific; it came from all known authorities whom we could interest enough to send us any good data they had on boilers which would make the steam boiler of the future reasonably safe, and almost without exception we had prompt and efficient replies from all those well qualified to give advice.

From time to time, as we were in a position to do so, we issued pamphlets of instructions to boiler manufacturers and inspectors, stating how the rules should be applied in the construction of boilers, until we published the Rules of August 5, 1909, which was the last and main issue made by the original members of the Massachusetts Board of Boiler Rules and embodied all that was necessary for the guidance of those manufacturing and inspecting stationary steam boilers for the Commonwealth of Massachusetts for that period.

While this work was going on, the forces in the Inspection Department were augmented, more rigid watch was kept of existing boilers, and more thought, patience and skill put into the manufacture of new boilers; in other words, the educational process was advanced and has advanced ever since Mr. McNeill started this system.

In the meantime, the writer made a trip to Europe and interviewed several of Europe's greatest boiler engineers with special reference to additions or deductions from our Rules, and we were very highly complimented in Europe on the rules formulated.

The present Massachusetts Board of Boiler Rules consists of

Geo. A. Luck, Chairman.

Frederick A. Wallace, Representing Boiler-using Interests.

Henry H. Lynch, Representing Boiler-manufacturing Interests.

Robert J. Dunkle, Representing Boiler-insurance Interests (member of Board since its inception).

Edward D. Mullane, Representing Operating Engineers.

In addition to its boiler-standardization work the Board has formulated very valuable air-tank regulations.

In 1911 the late Col. E. D. Meier, then president of The American Society of Mechanical Engineers, suggested in his wonderful foresight that The American Society of Mechanical Engineers undertake the work of standardization of steam boilers in a more complete manner than was possible with the State of Massachusetts, and the writer was appointed Chairman of the original committee of The American Society of Mechanical Engineers for the purpose of creating a standard for that Society. This committee was called The Committee to Formulate Standard Specifications for the Construction of Steam Boilers and Other Pressure Vessels and for their Care in Service, and originally consisted of

John A. Stevens, Chairman	Chas. L. Huston
Wm. H. Boehm	Edward F. Miller
Rolla C. Carpenter	H. C. Meinholtz (Deceased)
Richard Hammond	E. D. Meier (Deceased)

Upon the death of Mr. Meinholtz, Col. E. D. Meier was appointed in his place.

Colonel Meier took a most active part in the formation of the A.S.M.E. Boiler Code, and up to within a few days of his death had it constantly before him. It is one of the regrets of the members of the Boiler Code Committee that he could not have lived to have seen the fruition of the work he so wisely started.

The A.S.M.E. Committee proceeded on similar lines to those followed by the Massachusetts Board of Boiler Rules in counseling with all qualified authorities, manufacturers and large users of boilers, producing its preliminary report and thereafter issuing at different times other preliminary reports up to the issue given to the public in 1914.

At one stage in the work it was found advisable and necessary to amplify the original Committee by appointing an Advisory Committee composed of some of our most celebrated steam engineers, for it was believed that the great interests of our country should not have "taxation without representation," and it has always been admitted that boilers built to the standard of The American Society of Mechanical Engineers cost more money than boilers built otherwise, and are indeed worth more.

In appointing the Advisory Committee, men were chosen to represent all of the large interests affected, such as railroads, consulting engineers, large manufacturers of different types of boilers and engineering schools. Their keen interest was thus secured in the promulgation of standards among our engineering institutions, steam-heating boiler manufacturers, water-tube-boiler manufacturers, boiler-insurance companies, threshing interests and boiler users.

The members of this Advisory Committee consisted of the following:

F. H. Clark, Railroads.
F. W. Dean, Consulting engineers.
Thos. E. Durban, Boiler Manufacturers' Association, Uniform Specifications Committee, for all types of boilers.
Carl Ferrari, National Tubular Boiler Manufacturers' Association.
Elbert C. Fisher, Scotch marine and other types of boilers.
Arthur M. Greene, Jr., Engineering education.
Chas. E. Gorton, Steel heating boilers.
A. L. Humphrey, Railroads.
D. S. Jacobus, Water-tube boilers.
S. F. Jeter, Boiler insurance.
Wm. F. Kiesel, Jr., Railroads.
W. F. McGregor, National Association of Thresher Manufacturers.
M. F. Moore, Steel heating boilers.
I. E. Moultrop, Boiler users.
Richard D. Reed, National Boiler & Radiator Manufacturers' Association.
H. G. Stott.[1] Boiler users.
H. H. Vaughan, Railroads.
C. W. Obert, Secretary to Committee.

In the appointment of the Advisory Committee, we were most fortunate in selecting men who proved to be real workers, and who moreover were naturally possessed of analytical minds, men not afraid to admit when they were wrong and not afraid to be insistent when they were right.

The writer wishes to mention especially the great assistance given the Committee throughout the early stages of the formulation of the A.S.M.E. Boiler Code by Mr. Henry Hess, Vice-President of the Society, who counseled with and guided us with special reference to our conferring with other large societies interested in standardization work, notably the American Society for Testing Materials, and also other societies which were more or less interested in a boiler standard. He also very wisely advised us not to have anything to do with legislation or politics; had we not heeded this advice we would probably have caused the downfall of the Code early in its life.

Space prevents mentioning the great assistance accorded the Committee by manufacturers of boiler material, irrespective of their own desire to manufacture only one standard material for boilers, also the great help given by the boiler-insuring interests, and that offered by the railroad interests of America, and by the large boiler users.

Throughout the entire formulating period of this work the writer was most ably assisted by his associate-engineer, Mr. Walter Slader, and he wishes here to give this gentleman credit for the very valuable work he did throughout this long and arduous task. In passing, he wishes also to give all due credit to *Power*, *The Boiler Maker*, and several other engineering periodicals which have from time to time issued articles in sympathy with the movement.

The work of the Boiler Code Committee of The American Society of Mechanical Engineers was founded on the standards originated by the Massachusetts Board of Boiler Rules, but it should be noted that the work is a great deal more complete and far-reaching than the Massachusetts Standard. In the first place, the A.S.M.E. Code specifies in detail the chemical and physical properties of all material entering into the construction of boilers, and gives rules, formulæ and tables which have been checked and rechecked by men of national reputation and in many cases verified by testing laboratories; that is to say, in many cases, rules or formulæ were withheld until actual tests in laboratories had been made in order to prove the mathematics.

Therefore, it is with pleasure that we note that the Code has been adopted, or is in the process of adoption, in great states such as New York, New Jersey, Pennsylvania, Ohio, Indiana, Michigan, Wisconsin, Minnesota and California, and such cities as Kansas City, Scranton, Pa., and St. Louis, Mo., and even in the Argentine Republic and the Republic of Paraguay, South America.

This would indicate that the Code has been through a very severe process of trial and has been found to be, as stated, the best in existence for governing the construction and inspection of stationary boilers.

It is also gratifying to the writer to note that, according to Specification No. 2362 for power-plant equipment at the Naval Training Station, Newport, R. I., boilers and accessories used by this department are to be in accordance with the A.S.M.E. Boiler Code.

As the writer has many times stated in public, the Boiler Code of The American Society of Mechanical Engineers is intended for the young engineer. Many of our older engineers know all that is in the Code and more, but in looking forward to the future, the writer, for one, is always especially careful in the endeavor to see to it that our young engineers are started correctly.

It is interesting to the writer to review the enormous amount of money spent directly and indirectly by the engineers having to do with the standardization of boilers in America. It was stated authoritatively in New York at the completion of the A.S.M.E. Boiler Code, Issue of 1914 with Index, that the work, if paid for at ordinary professional rates, would have cost at least a quarter of a million dollars.

[1] Deceased.

Further, it was stated by a member of the Boiler Code Committee in New York recently that by the time the Code is universal in the United States, the cost will approximate a million dollars.

To promulgate the Boiler Code throughout the Union, a group of public-spirited citizens organized what is known as the American Uniform Boiler-Law Society, the officers of which are:

Thomas E. Durban, Chairman Administrative Council.
E. R. Fish, American Boiler Manufacturers' Association.
H. P. Goodling, National Association of Thresher Manufacturers.
F. W. Herendeen, National Boiler and Radiator Manufacturers' Association.
M. F. Moore, Low-Pressure Steel Boiler Manufacturers.
I. Harter, Jr., Water-Tube Boiler Manufacturers.
John H. Wynne, Locomotive Manufacturers.
Walter Plehn, Steam-Shovel Manufacturers.
H. N. Covell, Hoisting-Engine Manufacturers.
Chas. S. Blake, Boiler Insurance Companies.
John Hunter, National Electric Light Association.
D. J. Champion, Boiler Materials.

The Chairman states that this organization has expended on an average $1000 per month since starting on the work of interesting the States to adopt the A.S.M.E. Code. This money is being spent to bring the Code prominently before the people and to explain the advantages accruing from its use.

On December 4 and 5, 1916, the American Boiler Code Congress was held at Washington, D. C., at which the official representatives of twenty-three states were present, and it was unanimously voted to approve the Boiler Code of The American Society of Mechanical Engineers.

We also had a very able sponsor from Toronto, Canada, in Mr. D. M. Medcalf, Chief Boiler Inspector of Ontario, who is fully alive and awake to the advantage of having the same Code in force in the Canadian provinces as in the United States.

The writer would mention that whatever assistance he has given to this work has been given in the spirit of true Americanism: to wit, "for the good of the service"—and incidentally this service has been of great educational value to him. He has made acquaintances everywhere and a great many friends in the pursuit of this work and has had the pleasure of acting as Chairman of The American Society of Mechanical Engineers' Boiler Code Committee since its inception.

For those who do not know, the idea of standardization is strictly American, being an American creation: for instance, the standard fire-hose coupling, the standard berry basket, the standard electric-lamp socket, the standard cement specification, standard structural shapes, standard screw threads, and of late, the standard ship and the standard aeroplane engine; and a standard boiler construction using one standard of boiler materials and accessories would naturally appeal to the highest and broadest type of business men in the spirit of maximum conservation and efficiency.

For the states which have not adopted a standard, the only work that is necessary is of an educational nature: for, when the entire case is fully explained, the Code is usually adopted. To those states which have not adopted the A.S.M.E. Code, the writer would recommend its adoption as being the most complete boiler law of any in existence at the present time.

Further, a permanent committee has been established by The American Society of Mechanical Engineers for adding to and deducting from the A.S.M.E. Code as the art advances, and also to assist in the interpretations of the Code in states and municipalities where the engineers are not conversant with its rulings. In other words, The American Society of Mechanical Engineers very advisedly puts itself in the position of a "clearing house" for boiler engineering.

The writer's thought has always been to have the Code so complete that all that was necessary in ordering boilers was to name the type, amount of heating surface required and the working pressure desired, and where credits and reputations were good, a postal-card order might suffice, since the fact that a boiler had been properly stamped with the symbol of The American Society of Mechanical Engineers would be positive proof that all the purposes of the contract and every detail of the Code requirements were fulfilled.

The A.S.M.E. Code is the result of the combined ideas of several thousand engineers who have assisted the Committee from the start up to the present time in producing the right recommendations.

The Code is now under its first revision and the revised printing will be ready for the public within a few months. The proposed revisions are being published from time to time in The Journal with the idea that all those interested be given an opportunity to discuss them before they are brought to their final form for adoption. The greater part of the revisions will be made to clarify the text but not to change the intent of the original Code.

The writer has often been asked how many boilers there are in America, to which he would answer that as near as he can glean there were about 600,000 power boilers in 1914. He would also state that the boiler business in America is said to amount to $500,000,000 per year.

In closing, let it be said that it is the earnest wish of the writer that all those not conversant with the Code may become so, and may assist in putting it into general service at the earliest opportune time. He also wishes to thank all those who have assisted in any way in the promulgation of the A.S.M.E. Standard.

John A. Stevens.

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee.. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in The Journal, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee in Cases Nos. 158, and 167-172, inclusive, as formulated at the meeting of July 27 and approved by the Council on August 15, 1917. In this report, as previously, the names of inquirers have been omitted.

Case No. 166

Inquiry: Is it permissible under Par. 331 of the A.S.M.E. Boiler Code to omit the stamping from tube heads of boiler drums where they are so flanged and corrugated, as shown in Fig. 1 that the original stamping cannot be preserved, or would it be allowable to stamp the heads with lot numbers as they come off the press so that they may be identified afterward?

Reply: It is the opinion of the Committee that the construction shown is classed with headers and does not require the stamp to be visible after the part is formed.

Case No. 167

Inquiry: Can some allowances be made by the Boiler Code Committee in the specifications for steel castings in the Boiler Code, with regard to the chemical composition of the ladle analysis, to compensate for the difficulty at the present time in obtaining castings low in sulphur and phosphorus?

Reply: The matter of modifications in the specification for steel castings has already been referred to the American Society for Testing Materials, and the question is up for consideration at this time, but no decision has been reached.

Case No. 168

Inquiry: Referring to Case No. 113d, are we to understand that all plates forming any part of a boiler, no matter

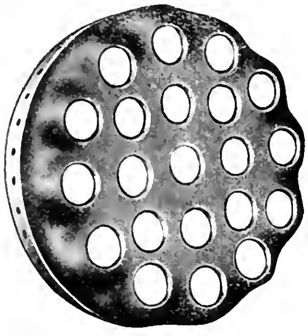


Fig. 1 Flanged and Corrugated Tube Head

whether they are used flat, bent, or flanged, either hot or cold, must be finished on all edges by either planing, milling, or chipping?

Reply: The word "calking" was inadvertently omitted from the reply in Case No. 113*d*, and the inquiry is answered by the reply in that Case which should read as follows:

> *Inquiry: d* Is Par. 257 intended to do away with the bevel shear for finishing the calking edges of plates, and does it mean that the plate edges may only be planed, milled or chipped?
>
> *Reply: d* According to Par. 257 of the Code, in order to eliminate the incipient cracks left by shearing, the *calking* edges of the plates must be finished by planing, milling or chipping, whether they are sheared straight or beveled.

Case No. 169

Inquiry: Can a check valve where a valve stem is provided to permanently close the valve when the stem is screwed down, and thus form a combination stop and check valve, be regarded as both a stop valve and a check valve as required by Par. 317 of the Boiler Code? A device of this character is commonly applied to feed connections on one type of water tube boiler. Is it necessary where this fitting is used on the feed connection of a boiler set in battery to provide such connection with an additional check valve and a globe valve between such check and the source of supply?

Reply: It is the opinion of the Boiler Code Committee that this combination check and stop valve should be classed only as a stop valve.

Case No. 170

Inquiry: Can staybolt iron made from hammered blooms consisting of wrought iron horseshoes, be considered as meeting the requirements of the specification in the Boiler Code for staybolt iron, if the horseshoes are originally made from puddled iron?

Reply: It is the opinion of the Committee that Pars. 139 and 140 in the specifications for staybolt iron require that the material forming the box pile shall consist of bars the full length of the pile. If the horseshoes which are used are first worked into the bars described in Par. 140*b*, then cut to the necessary full length and made into the box pile as described, the material will meet the specifications. It is essential that purchased scrap be eliminated.

Case No. 171

Inquiry: Is it essential that the 10 per cent limit of variation allowed in Par. 285 of the Boiler Code for the springs of A.S.M.E. Standard Safety Valves, be met where it entails serious hardship to obtain springs so close? Certain manufacturers supply only three springs for the entire range from 25 to 250 lb.

Reply: It is the opinion of the Committee that this is a matter to be taken up with the particular valve manufacturer in question, as the variation called for in the Code can be and is being met.

Case No. 172

Inquiry: a Is it to be understood from Par. 296 that ordinary commercial iron or steel pipe may be used from the steam space of a boiler to the upper connection of the water column and that the connection from this pipe to the steam gage may be made of copper pipe?

b Is it permissible under Pars. 320, 321, and 322 of the Boiler Code which require the water connections to water columns to be made of brass and provided with a cross to facilitate cleaning, to connect a drain pipe into one unused opening of the cross and insert a cast iron plug in the other?

c Relative to the arrangement of connections indicated in Inquiry *b*, is it allowable under Pars. 320, 321, and 322 of the Boiler Code to use a malleable iron bushing and a commercial iron or steel pipe to which the drain valve may be connected?

Reply: a This understanding of the requirement of Par. 296 is correct.

b The Boiler Code requires a brass connection from the boiler to the water column including the cross. Any other part can be as described in the inquiry.

c The arrangement described would be considered as in accordance with the Code.

According to *Motorship*, there has been considerable discussion in the last year in regard to the feasibility of concrete ships, and now an experiment is to be made and an ocean-going vessel of large size, in this material, is to be thoroughly tried out. Plans for the ship have been prepared by Leroy Caverly, a marine engineer of San Francisco, and if tests now under way are successful, work on the vessel will shortly be commenced. As planned, this experimental concrete ship is to be 300 ft. over all, 46-ft. beam, with a depth of 24 ft., and be 5000 gross tonnage and powered by steam turbines of 2500 hp. It is claimed that such a craft will have a dead weight no greater than a wooden vessel of the same size, and can be completed in ninety working days at a cost of only $64 a ton. It is not probable that power will be installed at once, but the hull will be towed on a test sea trip.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

THE Secretary is frequently asked what the Society is doing in connection with the war, and he is happy to say that the Society is not only individually rendering a special service, but it is also coöperating with the other societies in most constructive work. It might be well to here review the several activities of the Society which have bearing on the war situation, but before doing so it should be mentioned that the special activity now occupying our attention to the greatest degree is the work of the Engineering Resources Committee, Mr. George J. Foran, Chairman—that of furnishing specialists for the numerous demands of the Government and the industries generally.

Our circular letter to the membership enclosing the Personal Classification Blank has brought in to date over six thousand replies, and upward of four thousand of these have been collated in the most complete manner. To carry out this work of collation the systems employed by the universities in similar work, by the insurance companies, the Census Bureau and the Bureau of Mines, were all carefully studied and all their good features incorporated in our own system of classification.

The Society is now furnishing names literally by the hundred in response to numerous requests for men familiar with munitions work and with researches in the widest variety of war subjects. One recent letter from Washington opens: "Our Bureau has been asked to assist in getting about one hundred of the very highest-class men having business and executive experience. These men are needed to go to France immediately to take charge of organizing ———. Please send the names and experience of any men who satisfy our requirements and who could go." Another letter from an important committee in Washington begins: "We shall consider it a favor if you could give us the names of as many as fifty mechanical engineers who meet the specifications presented in the enclosed bulletin. We should like not only the names but any ratings which you have adopted in your classification."

A further corroboration of the large number of calls being made on the Society for men is furnished by a study of the columns of the Employment Bulletin in this and the last issues of THE JOURNAL. The Positions Available section of the Bulletin last month was the largest we had ever published. This month's Bulletin is even larger than last month's.

To those members who have patriotically offered their services to the Government through the medium of the Society's Engineering Resources Committee, but who have not yet been rewarded by the assigment to duties under the Government, we can only say that their names have invariably been forwarded and that in due time, as the demand for their particular kind of service is created, the Government will undoubtedly take advantage of it.

Passing in review over the steps the Society has taken in connection with the war situation, it is interesting to state: First, the Committee on Engineer Officers' Reserve was directly responsible for the inclusion in the Hay Bill of 1916 of what is known as the Engineer Officers' Reserve Corps.

Second, the Military Engineering Committee of the Engineering Societies participated in the Preparedness Parade, in New York City, in which 10,000 engineers marched; this committee also conducted a series of lectures on Military Tactics by officers assigned by the War Department, and, further, it recruited an entire corps of 1167 men, plus about 160 others, which has already been sent to France. The expense contributed individually by twenty or more members of the Military Engineering Committee was over five thousand dollars.

This Society also took up energetically at the Spring Meeting in Cincinnati, in May last, the matter of Standardization of Gages, and an officer of the Society went to Washington and discussed the case with some of the Bureau heads, and we have reason to believe that this helped in the passing of an act providing for the work now being developed in the Bureau of Standards.

We have also a General Engineering Committee of the Council of National Defense, and the American Engineering Service Committee and War Committee of Technical Societies of the Engineering Council.

In another column the membership will be delighted to read of the prospective meetings in the West which will be attended by the president. It is a noteworthy occasion when an engineering society can obtain a visit from its president. Dr. Hollis is sacrificing both time and strength to make this tour. It is also a source of satisfaction to announce that Mrs. Hollis will accompany him.

CALVIN W. RICE,
Secretary.

Amendments to the Constitution

The following amendments to the Constitution are to be presented at the Annual Meeting, to be held in New York, December 4 to 7, 1917.

Portions in brackets show additions to the present wording of the Constitution, and portions in parentheses show deletions.

These proposed amendments were approved by the Council, presented at the Spring Meeting at Cincinnati, 1917, for discussion, and under the requirements of C57 and C58 will be presented for final vote by letter ballot.

C26 The affairs of the Society shall be managed by a board of directors chosen from among its Members, Associates and Associate-Members, which shall be styled "The Council." The Council shall consist of the President of the Society, who shall be the presiding officer, six Vice-Presidents, nine Managers, the Treasurer, and the five surviving Past-Presidents who have last held office. [The number of persons constituting a quorum of the Council shall be determined by the By-Laws.] The Secretary may take part in the deliberations of the Council, but shall not have a vote therein.

C45 The Standing Committees [of Administration] of the Society (to be appointed by the President) shall be:

(1) Committee on Finance
(2) Committee on Meetings [and Program]

(3) Committee on Publication [and Papers]
(4) Committee on Membership
(5) [Committee on Local Sections]
(6) Committee on Constitution and By-Laws
(Library Committee)[1]
(House Committee)[1]
(Research Committee)[1]
(Public Relations Committee)
(Committee on Standardization)[1]

[The appointment, organization, duties, and terms of service of Standing Committees shall be as the By-Laws provide. The Chairman of each Standing Committee shall have a seat in the Council of the Society but no vote.

There shall be other standing committees of the Society as the By-Laws provide and the Council approves.]

C47 The Annual Committees shall be:
An Executive Committee, appointed by the Council;
A Nominating Committee, appointed by the President;
Tellers, as required by the By-Laws, appointed by the President;

[1] To be designated Standing Committees, in distinction from Standing Committees of Administration, and to be provided for in the By-Laws.

[Such other committees as may be required from time to time.]

C55 The Society shall not be responsible for statements or opinions advanced in papers or in discussions at its meetings. Matters relating to [partisan] politics or purely to trade shall not be discussed at a meeting of the Society, nor be included in the Transactions.

C56 The Society shall not (approve or adopt any standard or formula, or approve any engineering or) [endorse any] commercial enterprise. It shall not allow its imprint or name to be used in any commercial work or business.

C58 The letter-ballot, accompanied by the text of the proposed amendment, shall be mailed by the Secretary to each person entitled to vote, at least thirty days previous to the closure of the voting. The ballots shall be voted, canvassed, and announced as provided in the By-Laws. The adoption of the amendment shall be decided by a majority of the votes cast. An amendment shall take effect on the announcement of its adoption by the Presiding Officer of the Semi-Annual Meeting next following the closure of the vote. [Any changes in the order of consecutive numbering of existing articles of the Constitution, made necessary by such adopted amendment, shall be made under the direction of the Council.]

A LOOK AHEAD

A Review of the Prospective Work of the Society for the Coming Year

HUNDREDS of calls are coming to the engineering societies of the country for help and coöperation in meeting the needs of the war. Highly-trained men are wanted in large numbers, besides technical advice and information on innumerable subjects. In all such work concerted action is necessary and the avoidance of duplication; hence the importance of the Engineering Council and its War Committees, representing collectively the several engineering societies as described by President Hollis, Chairman of the Council, elsewhere in this number.

In a look ahead the greatest promise for effective service to the Government by the Society appears to lie in the part which it will play in this united service by the engineers of the country.

Acting as a separate unit, however, the Society has already done enormous work in this direction largely through its Engineering Resources Committee, George J. Foran, Chairman, which has classified and indexed with respect to their specialties 4000 members and hopes eventually to have similar data for every member to use in supplying the war needs of the country.

DEVELOPMENT OF THE SECTIONS

Last year five new sections were organized at Baltimore, Detroit, Erie, Indianapolis and New Orleans, making a total of 21 sections. The Committee on Sections recognizes that these local organizations emphasize the national scope of the Society and intends to continue this development by the addition of several new sections besides the organization of the Connecticut Section with its five branches, announcement of which has already been made.

This organization of state sections is of more than passing interest. The Minnesota Section was the first and the Atlanta Section has aimed to administer to the requirements of several of the Southeastern group of states, but Connecticut is the first state to have a number of Branches holding meetings in their respective localities, and all contributing in addition to the development of the Society throughout the state. The plan of organization is explained more in detail under another heading.

It is the purpose of the Sections Committee to encourage the sections to identify themselves with local, civic and municipal affairs inasmuch as they relate to engineering projects. An effort will also be made to obtain united action by the several sections on work proposed by the various standing committees of the Society: as for example, if the Research Committee were to outline a series of investigations it is thought that they would be much more successful if the local sections joined in the conduct of the work.

The sections benefit the membership at large by the publication of the section papers in THE JOURNAL. The committee has therefore suggested as a uniform practice that each local section make a special effort this year to contribute technical papers and data, through the establishment of the following organization:

1. The appointment of a committee of three, particularly qualified, to study the local field and determine what papers and data the section is best qualified to contribute; solicit the contributions of papers from local engineers and report to the Committee on Sections. Attention is called to the fact that papers need not be long. In fact, brief, concise statements of valuable information often are of interest and value.
2. Select a committee of two, qualified by broadness of vision, to investigate what researches may be most effectively carried out because of the particular engineering work being done in the locality. Appoint those particularly fitted to organize and conduct these researches and report the findings to the Committee on Sections.

   These researches need not necessarily be in the nature of obtaining original data but may be reports of progress or achievements made in any branch of the profession or consist in the arrangement in convenient form of the best information available on any particular subject. Good technical reports on local engineering developments will also be excellent material.

   There are many well-qualified young men in each locality who will be glad to undertake to accomplish the results if properly encouraged.

It has been suggested that this organization be effected at once in order that one of the first meetings this fall may be given over to the promotion of these results.

In accord with the plan previously announced to have the sections brought into closer contact with the activities of the Society, the Committee on Sections will visit the St. Louis, Milwaukee, Chicago and Detroit Sections this month for the purpose of acquainting those sections with the needs of the Society as outlined in the preceding paragraphs.

In connection with the work of the sections it is pleasing to note that the members at Seattle, Wash., and Portland, Ore., have invited President Hollis to visit them, and for the first time in the history of the Society the members of the Society in those Northwestern cities will come together at a meeting held under its auspices. This will indeed be a momentous occasion and it is fitting that the President of the Society should be the guest of honor. It would not be surprising should the organization of a section in that locality result because of the spirit and enthusiasm which Dr. Hollis brings to all those who have the opportunity of hearing him promulgate his doctrines on the opportunity of the engineering profession to take a leading part in making the world a democracy.

MEMBERSHIP WORK

The work of the sections is closely allied to that of the Committee on Increase of Membership because it is the latter which often makes possible the establishment of a section by securing the strength in numbers to make possible successful meetings. The committee plans to continue during the coming year its established policy of conservatively encouraging the members of the Society to bring within the pale of its influence all mechanical engineers of proven ability and to continue the acquaintanceship work at meetings which it has conducted in the past. The present membership is over 8200.

STANDING COMMITTEES

The Finance Committee has prepared its budget for 1917-18, including a report for the past year, showing that the annual income has passed the $200,000 mark. Next year it is estimated to reach $228,500. In preparing the budget the usual plan is followed of providing for only 90 per cent of the expected income and for half of the initiation fees to be placed in the reserve fund. As a result of this sound policy, the Society holds an enviable position among other organizations as one of unquestioned strength and stability and prepared for any call upon its resources which is likely to arise.

The Committee on Meetings, which has conducted in the past year what are generally considered to have been the two most successful conventions of the Society, has plans well developed for the coming Annual Meeting, elsewhere outlined. Of the sub-committees, the Committee on the Protection of Industrial Workers has now under preparation a number of safety codes including codes for elevators, machine-shop guards and woodworking-machinery guards, which they hope to bring before the Annual Meeting in December.

The Publication Committee has rounded out the year with The Journal covering the mechanical engineering field through its reports of meetings of the Society and reviewing the engineering press more thoroughly than ever before. New departments have been added, the circulation is now considerably above 10,000 and the advertising is constantly increasing. While no radical changes are expected, it is intended to maintain this substantial development and growth; and this applies as well to the annual volume of Transactions and the annual volume of Condensed Catalogues.

The House Committee has completed extensive alterations in the Society's rooms. By the removal of partitions better facilities have been provided, the most modern lighting system has been installed, the acoustics have had most careful attention. The office is now located in two large rooms, one devoted to the publication and engineering work and the other to the business and secretarial departments. Later the reception and reading rooms, the Secretary's office and the Council room will be redecorated.

The Committee on Constitution and By-Laws has had under consideration for some time a number of amendments necessitated by the growing membership of the Society and the larger demands by other societies and the Government upon its facilities. A complete report of these amendments will be found in another part of this issue of The Journal.

TECHNICAL COMMITTEES

The Standardization Committee expects to continue its work in connection with the American Engineering Standards Committee. This committee has drawn up a constitution, and deems this to be only the beginning of what is hoped will eventually fill a very important national and international need. It is expected that with time there will be found to participate in the work of this committee every technical association or society whether of an engineering or other nature, not only in the United States, but abroad. A beginning in this direction has already been made in that the British Engineering Standards Committee has invited this American Engineering Standards Committee to send delegates to London to consider a change in the British standard Whitworth thread to the simpler cross section of the United States screw thread and to consider also the question of metric threads.

The Boiler Code Committee has the following program under consideration for the coming year:

The completion of the first revision of the Boiler Code, in pursuance to a recommendation which was accepted by the Council of the Society and which was as follows:

"Your Committee recommends that you appoint a permanent committee to make such revisions as may be found desirable in these Rules, and to modify them as the state of the art advances, and that such committee should hold meetings at least once in two years at which all interested parties may be heard."

The regular monthly meetings of the committee will be held for the purpose of considering communications relative to the Boiler Code and rendering interpretations thereon.

The Committee on Flanges and Pipe Fittings has the following topics: A 50-lb. low-pressure standard for steam, water and air, etc.; a 600-lb. standard for superheated steam; 800, 1200 and 3000-lb. standard for water, air, gas, etc., with ratings proportionate to shock or no shock conditions. Malleable iron pipe fittings and unions are also scheduled for the Committee's consideration.

The A.S.M.E. and the Manufacturing Standardization Committee have been working jointly in the compilation of drawings, tables and data, most of which should be available for the committee's discussion during the coming years.

The Research Committee has several sub-committees which have investigations or reports in process, outlined in what follows.

Lubrication: Research on cylinder lubrication under both steam and gas engine conditions is expected to be undertaken by Professor Flowers of Ohio State University. This

would call for an appropriation of $600 for the ensuing year to carry it through. The apparatus has been especially built for the purpose and is the only one of its kind in this country.

Cutting Action on Machine Tools: In conjunction with the Bureau of Standards, this committee is to carry out an investigation of the stresses and conditions involved by change of shape and material, cutting speed, etc., on a special planer equipped with a dynamometer at the Bureau of Standards. An investigation is also to be undertaken on the action of the De-Leeuw rotary cutter, which gives a very large increase in cutting capacity over the old type stationary tools, using the same materials. This work should prove very valuable from a production point of view and therefore would appear to be of considerable interest to the Government in connection with its munitions work.

Worm Gearing: This committee has prepared a study of the important American patents on the subject of bearing metals and expects to make a study during the following year of the foreign patents also. It has in view to collect all patent data before reporting; it will take at least a year to do this.

Flow Meters: This committee is preparing what is practically a complete text on the theory, formulae, accuracy, cost and desirability of various types of commercial flow meters now on the market. This is being written in six sections, at least two of which will be ready for publication in December.

The general plan upon which all of the sub-committees are working, is that all previous work upon the particular subjects involved should first be collected by means of a bibliography and written up in a compendium, so that reference outside of the report would not be needed. The principal reason for adopting this plan was to avoid the unnecessary duplication of work which so often occurs in committee activities.

Several of the other committees have standardization work under way upon which it is not possible to announce future plans at the present writing. So extensive has become the professional work of the active committees of the Society, however, that the Secretary has under advisement the organization of a department of the office staff to attend solely to the committe requirements.

THE ENGINEERING COUNCIL

THE formation of an Engineering Council is the outgrowth of a real need for proper consideration of questions of general interest to engineers and to the public, and to provide the means of united action upon questions of common concern. Many such questions have come up in the past and will arise in greater number in the future. This war has brought out very impressively the actual need for united action of some kind. At present the Council is concerned only with four societies because that seemed the most practical way of getting a group of men together to answer the immediate needs, but these societies do not assume to speak for all engineering societies in the country. Criticism that they are exclusive in any way is utterly mistaken. There is the hope that such a Council by proving itself effective may lead to much wider coöperation in a strictly representative body for all engineers, and thus pave the way for a very much larger union in the future.

How can the Council be enlarged? By a union of all societies either as the outgrowth of the present Council or by a congress of engineers leading to united action by all societies. The first method will be the most natural one because many local societies and national societies also have a large membership in the four societies at present concerned. We have three classes of engineers to reach: First, those who are members of local societies and not members of national societies; second, those who are members of national societies and not members of local societies; and third, those who are members of no society. The last-named class constitutes a very large number in our profession.

We engineers are almost as mixed as American citizenship, and we suffer therefrom just as much as America with a population representing every race and every people in Europe. There can be no question of the enormous advantage of union. That union should be completed by strengthening the existing agencies and not by the formation of new societies. The national societies are thoroughly national notwithstanding the occasional complaint that they are run by New York. If they have not been able to express the democratic spirit of our country as fully as might be desired, it is the fault of the members in all the states and not of the city in which the principal offices are located.

The four societies concerned at present are the American Society of Civil Engineers, the American Institute of Mining Engineers, The American Society of Mechanical Engineers and the American Institute of Electrical Engineers. They have come together from time to time in the past for special purposes and there have been general conferences on subjects requiring immediate settlement, but until the Engineering Council was definitely organized in June there was no permanent body to advise all the societies. We have had many fruitful discussions in the past leading to useful action. The Standardization Committee which has been organized to represent five societies has passed upon commercial standards of all kinds. This committee has great possibilities and it should be enlarged enough so that its influence may become very widespread.

Many problems have already been presented before the Council. Its personnel, made up of twenty-four men representing equally the four societies, is well-balanced and judicial. The first duty was necessarily the organization and appointment of standing committees, which have already been reported in the press. They might with advantage be mentioned here:

1 Committee on Public Affairs, comprising Messrs. C. W. Baker, G. F. Swain, S. J. Jennings and E. W. Rice.

2 Committee on Rules, comprising Messrs. J. P. Channing, Clemens Herschel, N. A. Carle and D. S. Jacobus.

3 Committee on Finance, comprising Messrs. B. B. Thayer, I. E. Moultrop, Calvert Townley and Alex. C. Humphreys.

Certain questions relate, however, to the war and the assistance that engineers can render. A committee to be called the American Engineering Service Committee was appointed with instructions to invite the coöperation of all engineering societies. This committee in the first instance consists of A. D. Flinn of the Civil Engineers, A. S. McAllister of the Electrical Engineers, George J. Foran of the Mechanical Engineers, G. C. Stone of the Mining Engineers, and E. B. Sturgis of the Mining and Metallurgical Engineers. Its present duty is the tabulation and listing of the members of the five societies represented, in order that we, as a profession, may be in a position to take a larger part in the industries

after peace is declared. This tabulation has already in part been done, but in a rather unsystematical and unequal way. It is hoped that the new committee by having additions from other societies may make a final and lasting tabulation of all the engineers in the United States. The list is to be kept in the Engineering Building for general use in Government problems and in the industries. At present the committee is devoting its attention to the immediate need of the hour, namely, the procurement of men for special service in the Government. A list of specialists in the societies has already been completed.

There are three methods by which engineers may enter United States service: first, through some organization; second, through individual application to a department of the Government, and third, through selection by the Conscription Law. But this is war service wholly and not civil service, which is the same now as it has always been. As a matter of fact, a great many engineers have already entered through the engineering societies, through colleges and through various special boards in Washington. The importance, however, of a complete list of engineers and their professional specialties cannot be overrated. Such a complete list can be made only with the help of the local as well as the national societies. The committee mentioned above is organized with George J. Foran as chairman and A. S. McAllister as secretary. All societies should respond to the request for coöperation.

Another committee, of which Harold W. Buck is chairman, is called the War Committee of Technical Societies. The members are Messrs. H. W. Buck, A. M. Greene, Jr., R. N. Inglis, C. R. Corning, G. C. Stone, D. W. Brunton, J. M. Boyle, J. V. Davies, Joseph Bijur, A. S. McAllister, W. D. Richardson and Charles Baskerville. It was appointed to assist any organization in Washington, such as, for instance, the Council of National Defense, the National Research Council and the Naval Consulting Board, in any way in which it can bring to the attention of the engineers of the country the necessity for thought and help in the numerous problems that arise.

A Council organized by the enlargement of the present Engineering Council can be very effective in many ways without interfering with the autonomy of any individual society. Every society has some definite purpose of its own and also some which it holds in common with all other societies. One of the latter purposes relates to public service and to coöperation. To the end that all societies may understand fully their opportunity, the committee of which Mr. Foran is chairman has made a complete list of all the societies and their officers, and communications are being sent out inviting coöperation; and it is hoped that the Council may be successful in arousing sufficient interest to bring about a larger and better Council for all engineers.

In organizing the Council, provision was made for the election to membership of other national engineering and technical societies. There is no doubt that rules can be made under which these societies may become members, but this will involve consultation and discussion in the future.

The office of the Council is in the Engineering Societies Building, 29 West 39th Street, New York City.

(Signed) Ira N. Hollis, *Chairman*,
Worcester, Mass.

Calvert Townley, *Secretary*,
115 Broadway, New York City.

THE COMING ANNUAL MEETING

The time is past when engineers, citizens of a country at war, can with equanimity sit in convention to discuss details of engineering practice. Their thoughts are on the great problems of the war and on the service which they can render their country.

With this in mind the Committee on Meetings has planned a program for the Annual Meeting which is designed to be of definite and constructive value for those in the service of the Nation. While a sufficient number of excellent technical papers will be provided on general subjects to uphold the standard of the Society's Transactions for reference purposes, emphasis will be placed on a series of addresses to be given on some of the broad problems that now confront the engineer in his endeavor to give his country the mastery in the great struggle which is to make the "world safe for democracy."

On Tuesday evening will be an address by Hon. Wm. H. Taft, former President of the United States, and conferring of honorary membership on Maj.-Gen. Geo. W. Goethals, events of the greatest interest and satisfaction to every member.

The business meeting on Wednesday morning will be followed by a session in charge of the Committee on Local Sections. The importance which the Sections have assumed in the Society and the possibilities they offer for a broadening influence in the Society's affairs have led to the assignment of this as the opening session, and a very full discussion of the topics to be presented is hoped for.

An intimate account of the engineering achievements of the late Mr. E. D. Leavitt will be presented by Mr. F. W. Dean.

All are agreed that to win the war there must be conservation of resources, including food, fuels and supplies of all kinds; higher efficiency in industry and transportation; unlimited production of munitions and appliances of war; willing coöperation on the part of every citizen, regardless of his status in life; and the greatest possible development of American inventive and productive talent.

The question of the solution of such problems as the foregoing will form the basis of the keynote session on the general subject of Service of the Engineer to the Public. This session will last all day Thursday, December 6, and will be opened by President Hollis who will speak on Universal Public Service in Peace and War. He will be followed by other speakers treating of the topics given below:

The Agricultural Machinery Problem.
Topical Discussion on Machinery of Food Production.
Railroad Transportation.
Motor Transportation.
The Aircraft Problem.
Topical Discussion on Aviation.
Special Education in Time of War.
Engineering Research.
Building a Merchant Marine in a Hurry.

Certain of the foregoing subjects, notably Agricultural Machinery and Aviation, will be discussed in detail, with papers on steam, gas and electric power on the farm, farm transportation and the machinery of canning and preserving. In the case of the aircraft problem there will be discussed the

selection and training of aviators, and problems of aircraft engineering and aircraft production.

At the Cincinnati meeting last spring the three sessions on the principles involved in the manufacture of munitions were among the most enthusiastic and largely attended meetings ever held by the Society, with members in attendance from all sections of the country and Canada. In order to carry this work further a session has been arranged for the Annual Meeting by the Sub-Committee on Machine Shop Practice, upon the subject of inspection. At this session an attempt will be made to present, on the one hand, the requirements of the Government, and on the other, the difficulties encountered by manufacturers in interchangeable manufacture, with the object of defining as far as possible the philosophy of inspection and offering constructive suggestions for carrying out its underlying principles.

Two other sessions by sub-committees have been arranged, one by the Sub-Committee on Textiles and the other by the Sub-Committee on Air Machinery. The former, like the session on the subject of inspection, will deal with broad principles applicable alike to textile manufacture and to other lines of industry, two of the topics being questions of labor turnover and safety in textile mills.

Another timely subject under the present condition of affairs where manufacturers are working under tremendous pressure is that of industrial management and methods of increasing production. There will be a session on management at which one topic, a comparatively new one, will relate to the employment of women in the skilled industries, with special reference to machine-shop and heavy work. Bearing on this also will be addresses on the relation of industrial management to the engineer, to indicate the broadening field of the engineer and the extent to which his efforts must lie in the direction of the management of men, both in respect to efficiency and to social service. It is hoped that arrangements can be made for a luncheon for the membership on one day of the convention at which certain of these matters will be discussed in after-luncheon addresses.

It is expected further that Dr. Brashear will be with his friends of the Society again and deliver the lecture on the Beautiful in Commonplace Things which he was to have given last year, but was prevented from doing by his trip to the Orient. This lecture will be as an oasis in a desert in these war times when we are prone to forget that there are larger, higher and more important things in life than strife among nations.

As for the past two years, there will be a smoker on Wednesday evening for the membership and while the program has not been definitely concluded, several members have expressed the desire that Past-Presidents John R. Freeman, Ambrose Swasey and John A. Brashear may be prevailed upon to tell at that time some of the incidents of their trip to the Orient during the past year. Nothing, surely, could be more pleasing to everyone than this.

WAR CONVENTION OF AMERICAN BUSINESS

Chamber of Commerce of the United States of America, Atlantic City, N. J., September 17-21

THE program of the great convention of American business, just held at Atlantic City, was representative of all walks of life—cabinet officers, captains of industry, engineers, bank and railroad officers. Never has the Secretary attended a meeting from which emanated so impressive and vital a message for the engineers of the country who are holding the pivotal points on the firing line of industry. In some small measure the Secretary desires to pass on the message to every member of the Society.

The earnestness of the speakers and the seriousness of the situation in which the country finds itself at the present time were emphasized throughout the meeting. All the resources of the nation's business were whole-heartedly and unreservedly pledged to help win the war. *This includes us!*

It would be impossible to portray the fervor of the convention, and in the space available in THE JOURNAL no more than an outline can be given of the more important addresses. Those desiring a complete statement may obtain it in the next issue of *The Nation's Business*, published monthly by the Chamber of Commerce.

The addresses covered in the following notes are those of President Rhett, Secretary of War Baker, the Secretary of the Interior, Mr. Lane, and the Russian Ambassador, given Tuesday; those of President Bedford of the Standard Oil Co., Past President Harry A. Wheeler, Mr. Herbert C. Hoover, Mem.A.I.M.E., and Lord Northcliffe on Wednesday; and those of the Secretary of Labor, Mr. Wilson, and Mr. L. A. Osborne, Mem.Am.Soc.M.E., on Thursday.

The chairman of the Munitions Board, Mr. Frank A. Scott, Mem.Am.Soc.M.E., was absent on account of illness.

President Rhett said:

"The Chamber has not only called together the delegates from its own 950 commercial organizations' members, representing over 400,000 individuals, firms, and corporations, and its own individual and associate members numbering over 6000, but it has extended invitations to other commercial organizations of the country not members of the Chamber, to be represented here, and to unite with it in sending out a message from the business men of America which will let the world clearly understand that whatever the cost, whatever the sacrifice, they propose to place every resource at their command behind the Government, and its Allies in their determination to see that liberty, democracy, civilization, and humanity shall not perish.

"There may be those who would sacrifice any national welfare, present or future, to their own ambitions, possibly to their own comforts, but, thank God, in this splendid democracy of ours, they can constitute a very small minority, and in the ranks of business their number is negligible. Let us make this number infinitesimal by such vigorous pronouncements and by such united action both in convention assembled and in business engaged that every impulse to selfish or sordid action may be suppressed and a great wave of enthusiasm may move us on to such achievement in service and in sacrifice as shall constitute a compelling influence for a speedy conclusion to this war—a conclusion that will bring us a real peace—a peace for this generation and generations to come—a peace that will secure for all times to mankind its most precious possessions which in their aggregate we call civilization and humanity."

Secretary of War Baker struck the keynote of the conference when he declared at the morning session:

"American business has been at the right hand of the Government since the moment war was declared. We want every man that can be influenced by you, every woman, and every child enrolled in another great army, the army of American business."

Secretary Baker's speech was intensely human and forceful, and was so clear-cut and compelling that when he had finished he had given the big business men in attendance a clear idea of the reasons why business and the Government had at times been wide apart, and why they were now so closely welded together in a common cause.

Secretary Lane's speech was the feature of the afternoon session on Tuesday, and the audience, estimated at three thousand, cheered him again and again as he recounted the situation. Among other things he said:

"We of America, it is conceded, know how to make money, and we will prove that we know how to make war, wholehearted, resolute war, war that means organization, machinery, science, war that means men by the million and money by the billion, war that means heartbreakings, ruined hopes, a little glory perhaps, a certain self-respect, a world that men can grow in.

"If there is a danger in this country it is not that our men will not be brave, that our guns will not be great, that our troops will have no ammunition and our generals no strategy, but it will be the danger coming from discontent with domestic conditions. The business man can prove his loyalty most surely in fixing prices, in marking down the shoe lace, the loaf of bread, the hatchet, the coat, the beefsteak, all the commonplace things of life, than in any other way. There is not a business man in this hall who does not carry in his hand the future of this war."

The evening session was opened by an address by Charles Edward Russell, who was a member of the Root Commission recently returned from Russia.

He impressed his audience with the seriousness of the situation by emphasizing that

"A thin Russian line of soldiers is all that stands today between the Kaiser and his goal; all that stands between the principle of freedom and the triumph of autocracy. There are upon the Russian line from Rumania to Riga, 153 army divisions. Upon the entire French front there are only 123 German divisions. Let Russia collapse and the German flood will sweep aside anything of resistance that is now there. The Russian people are self governed and they look to us as their brothers. Instead of being bankrupt, they are the richest people on earth, richest in natural resources, richest in character.

"This is our opportunity to save the nation. Let us give freely. Let us show to them that we are really a United States and that we will fight for freedom to the end."

The Russian Ambassador, after a complete statement of conditions, exclaimed:

"What Russia needs most of all is improvement of railway transportation, reorganized agricultural production and a diligently executed possible restitution of supply of general commodities, whether manufactured within the country or imported. Railway materials of all kinds and primarily rolling stock machinery for repair; agricultural implements; machine tools, instruments and raw materials for improving the production within the country; certain commodities of everyday life, that is what Russia needs and needs badly. And, gentlemen, for these requrements to be fulfilled, outside of credits, she needs ships, ships and ships."

President Bedford of the Standard Oil Company urged both economy and increase of production, giving statistics to show the inadequacy of the present supply.

The most eloquent words of the entire convention was the peroration of Past-President Harry A. Wheeler, chairman of the Chamber's Committee on Transportation. He predicted federal control of railroads.

Thursday evening Herbert C. Hoover warned the nation of the penalty of failing to aid the Government, and that inability of business men to realize their responsibilities and coöperate adequately with the Government might result in socialism.

Speaking of Russia, he said:

"Justifiable as this revolution may have been and as great a cause of liberty as it may result, no one can deny that the whole trend of this revolution has been socialistic, and the latest phase is a development into practical socialism. The strain in the revolution, I am convinced from much experience in Russia, was the reaction from failure of the Government and the commercial classes to meet their public duty.

"The other end to be attained is of profound importance. The alternative to failure of our commercial system to maintain its place and at the same time serve public interest is rigid autocratic governmental organization of industry of the German type. Such organization is autocracy itself—it breeds beaurocracy and stifles initiative, and thus democracy, at its birth. We must organize—we must mobilize—our every national energy, if we are to win this war against the organization perfected by autocracy. Either we must organize from the top down or from the bottom up. One is autocracy itself—the other, democracy. If democracy cannot organize to accomplish its economic, as well as its military defense, it is a false faith and need be abandoned."

These are momentous words.

Lord Northcliffe, the head of the British mission, followed with a tribute to the ability and bravery of Mr. Hoover. He further prefaced his remarks by stating that he was engaged in directing one of the largest businesses in America, that of expending $50,000,000 per week.

He went into the exact details of the war as it pertains to us. The following is an example:

"You will require vast refrigerating stores for the preservation of meats and other foods for your armies. At this time six months from now you will probably have between 600,000 and 800,000 men in France. Think of the refrigeration machinery you must establish.

"This war is the greatest business the world ever knew and in our country we are doing nothing else. Let me tell you that you will have to furnish between five and six pairs of shoes a year in the easiest parts of the lines at the front and twelve pairs a year at the hard parts for each of the 600,000 or 800,000 men you will soon have on the front."

Lord Northcliffe pointed out that the average life of a rifle is six weeks as one instance in addition to those already cited of the amount of business organization that must be created in the United States on account of the war.

Thursday morning the third member of the Cabinet to address the meeting, Secretary Wilson, gave a condensed statement of why we were at war, and followed by an exhortation equally to the laboring man and to employers to remember that neither may take this opportunity of the nation's distress to gain advantages that could not be obtained in times of peace, and that the sole idea of all must be to coöperate to win the war.

On Friday the resolutions approved by the Resolution Committee and unanimously adopted by the convention were principally as follows:

"Assembled on the call of the Chamber of Commerce of the United States and representing more than half a million business men and every industry in every state in the Union, this convention promises to our people that business will do all in its power to prevent waste of men and material and will dedicate to the nation every facility it has developed and every financial resource it commands on such terms and under such circumstances as our Government shall determine to be just."

Next to the general pledge to the Government, the most important resolution was the second, which read, in part:

"Be it resolved by the representatives of American Business met in War Convention, that all war buying should be assembled under the control of one board or executive department; and

"Be it further resolved, that this war supply board or department should be given full power to procure war supplies to the best advantage to the Government as to price, quality, and deliv-

[illegible] a way to maintain essential industrial life without disturbing social and economic conditions, including the power to fix prices not only to the Government but to the public on essential products and to distribute output in a manner to promote the national defense and the maintenance of our industrial structure.

This proposal is one which the members of the chamber, particularly those of them who have had occasion to do war business in Washington, feel most strongly is essential to the effective prosecution of the war; and while there is variance of opinion as to the reasons for the present confusion, nearly everybody is agreed that centralization is the obvious remedy.

Another most important development which is only beginning—a very promising start has been made in some industries already—was the recommendation that every industry organize a war committee of its leading men to coöperate directly with the Government in finding a way to meet every demand that the Government makes on industry.

It will then be seen that this Society, "The Society of the Industries," is vitally affected by the decisions of this convention and as executives to carry them to a successful conclusion.

Calvin W. Rice.

Visit by the President

President Hollis will leave Worcester on October 14 for a visit to several Sections and Student Branches of the Society in the far West. His itinerary includes visits to the following cities: St. Louis, El Paso, Los Angeles, San Francisco, Seattle and Portland. Upon the completion of this trip Dr. Hollis will very nearly have accomplished his aim to visit every Section of the Society during his term of office, something which no other President of the Society has been able to do. Wherever Dr. Hollis has spoken, before Student Branches and Sections, he has been uniformly successful in creating unusual enthusiasm.

Including the visits made by the Secretary practically every Student Branch and Section of the Society, numbering 59 in all, will have been visited within the year ending November first.

The following table shows in detail what has been done, H indicating visits by President Hollis and R those made by Secretary Rice:

VISITS OF PRESIDENT AND SECRETARY

SECTIONS

Atlanta	H	1-17-17
Baltimore	R	10-24-16
Birmingham	H	1-15-17
Boston	H	2- 7-17
Boston	R	2- 7-17
Buffalo	H	3- 7-17
Buffalo	R	10-18-16
Chicago	H	1- 5-17
Chicago	R	3-31-17
Cincinnati	R	3-23-17
Cincinnati	H	5-23-17
Detroit	H	1- 3-17
Erie	R	10-19-16
Indianapolis	H	3-12-17
Indianapolis	R	10-20-16
Kansas City	R	10-23-16
Los Angeles	H	10-17
Milwaukee	H	1- 6-17
Milwaukee	R	3-28-17
Minnesota	H	3- 9-17
New Haven	R	10-15-16
New York	H	3-16-17
New Orleans	H	1-13-17
Philadelphia	H	3- 9-17
Providence	H	3-28-17
San Francisco	H	10-17
St. Louis	R	10-24-16
St. Louis	R	4- 8-17

STUDENT BRANCHES

Arkansas, University of	R	4- 9-17
Armour Institute of Technology	R	3-31-17
Bucknell College	R	10-26-16
California, University of	H	10-17
Carnegie Institute of Technology	R	10-16-16
Case School Applied Science	R	10-17-16
Cincinnati, University of	R	3-23-17
Columbia University	R	12-11-16
Georgia School of Technology	H	1-17-17
Illinois, University of	H	1-10-17
Iowa, State University of	R	4- 2-17
Johns Hopkins University	R	10-25-16
Kansas State Agricultural College	R	10-22-16
Kansas, University of	R	4- 3-17
Kentucky, State University of	R	3-24-17
Louisiana State University	H	1-12&13-17
Michigan, University of	H	1- 4-17
Minnesota, University of	H	3-10-17
Missouri, University of	R	4- 6-17
New York University	H	3-16-17
Ohio State University	H	3-13-17
Pennsylvania State College	R	10-27-16
Polytechnic Institute of Brooklyn	H	3-16-17
Purdue University	H	1- 8-17
Rensselaer Polytechnic Institute	H	3- 5-17
Throop College of Technology	H	10-17
Washington University	R	10-24-16
Washington University	R	4- 8-17
Wisconsin, University of	R	3-26-17
Yale University	R	11- 3-16
Massachusetts Institute of Technology	R	2- 7-17

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER NOVEMBER 10, 1917

Below is the list of candidates who have filed applications for membership since the date of the last issue of The Journal. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate or Associate-Member, those in the third class under Associate-Member or Junior, and those in the fourth under Junior grade only. Applications for change of grading are also posted.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by November 10, 1917, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about December 15, 1917.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be somewhat slower than under normal conditions. The first step in the consideration of an application is taken by the Membership Committee, and this committee is composed of busy men, with limited opportunity to meet together in these strenuous times.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

Alabama

APPLEBY, William C., Mechanical Engineer, Southern Wheel Co., Birmingham

JOHNSON, Morris R., Chief Field Engineer, Fairfield Works, Tennessee Coal, Iron & Railroad Co., Fairfield

Connecticut

CLARK, James G., Chief Inspector, Remington Arms Co., Bridgeport

HOGAN, William E., Superintendent Interior Transportation, Remington Arms U.M.C. Co., Bridgeport

LANE, AUGUSTUS H., Engineer,
The Eastern Machinery Co., New Haven
MEAD, RICHARD R., Assistant General Works Manager,
American Graphophone Co., Bridgeport
SPIERS, FREDERICK G., Superintendent,
B. & K. Mfg. Co., New Britain
WELLS, HERBERT E., Division Superintendent,
Remington Arms U.M.C. Co., Bridgeport

District of Columbia
BRIGGS, CLARK A., Associate Physicist,
Bureau of Standards, Washington

Georgia
ELEY, J. N., Consulting Mechanical and Electrical Engineer, Atlanta
HUNTINGTON, WILLIAM S., Designing Engineer, Packing Plants and Cold Storage,
C. L. Brooks Engineering Co., Moultrie
HONIKER, CHARLES D., Textile Manufacturing,
Fulton Bag & Cotton Mills, Atlanta
TITSHAW, ERNEST P., Electrician,
Atlanta Water Works, Atlanta
WIKLE, JAMES T., Mechanical Engineer,
Fulton Bag & Cotton Mills, Atlanta

Illinois
FISKE, CLARENCE W., Assistant Chief Engineer,
Williams, White & Co., Moline
KLINCK, FRED E., Mechanical Engineer,
H. Mueller Mfg. Co., Decatur
McDERMOTT, GEORGE R., Steam Engineer,
Illinois Steel Co., South Chicago
SISSON, VINTON E., Assistant to Vice-President,
The Pressed Steel Mfg. Co., Chicago

Indiana
LONN, EDWARD J., President,
Great Western Mfg. Co., LaPorte

Kentucky
MEEHAN, JAMES L., Manager, Open-Hearth Steel Plant,
Ashland Iron & Mining Co., Ashland

Maryland
ALLISON, ROBERT P., Works Manager,
Poole Engineering & Machine Co., Baltimore

Massachusetts
BOLTON, FRED C., Chief over Gage Makers and Assistant Foremen,
New England Westinghouse Co., Springfield
BRINCKERHOFF, HENRY G., N. E. Representative,
The Engineer Co. of New York, Boston
FISKE, GEORGE L., Engineer,
Choralcelo Co. of Massachusetts, Boston
ISBELL, JOHN A., Chief Engineer,
Wood Newspaper Machinery Corp., Taunton
MORGAN, EARL B., Safety Engineer,
Norton Co., Worcester
PERELSTROUS, ANANY W., Special Russian Representative,
New England Westinghouse Co., Springfield
PERKINS, HENRY F., Assistant Mechanical Engineer,
Worsted Department, Pacific Mills, Lawrence
SHORT, FRED A., Mechanical Designer and Checker,
Stone & Webster Engineering Corp., Boston

Michigan
DENNIS, BASIL W., Assistant Superintendent of Power,
Ford Motor Co., Detroit
GRAVES, WALTER J., Assistant Engineer,
U. S. Engineer Department, Sault Ste. Marie

Montana
BLAKE, HAROLD N., Assistant Superintendent,
Anaconda Copper Mining Co., Anaconda

New Jersey
HAWKINS, WILFORD J., Vice-President,
International Arms & Fuse Co., Inc., Bloomfield
JACOBSON, CONRAD C., Mechanical Engineer and Designer,
The Celluloid Co., Newark
JONES, PAUL, Works Engineer,
Bosch Magneto Co., Plainfield
PATTBERG, GEORGE, Assistant Service Engineer,
United Piece Dye Works, Lodi
ZISCH, GEORGE J., President and General Manager,
Newark Engineering & Refrigerating Co., Newark

New York
DAWLEY, HOWARD H., Safety Supervisor,
Remington Arms U.M.C. Co., Inc., Ilion
JOHNSON, ANDREW F., Designing Engineer,
E. L. Phillips & Co., New York
LAGERHOLM, AXEL F., Assistant Secretary,
J. E. Dockendorff & Co., Inc., New York
NEFF, WILLIAM L., Assistant to New York Manager,
Brown & Sharpe Mfg. Co., New York
PEARCE, CHORTEAU E., Chief Engineer, Heating and Ventilating Department,
Richard D. Kimball Co., New York
ROSSMAN, JAMES G., Financial Manager,
William Hurd Hillyer, Investment Securities, New York
STEARNS, KARL T., Assistant Hydraulic Engineer
St. Lawrence River Power Co., Massena

Ohio
BLUNDELL, EUSTACE E., General Superintendent,
The Cleveland Automatic Machine Co., Cleveland
CALLERY, J. General Manager,
The J. C. Callery Engineering Co., Columbus
KING, WILLIAM L., Construction Foreman,
General Electric Co., Cincinnati

Pennsylvania
FLYNN, JOHN H., Manager,
Blaw-Knox Co., Pittsburgh
HEINRITZ, WALTER J., Construction Engineer,
Counties Gas & Electric Co., Norristown
KANE, WILLIAM, President and General Engineer,
William Kane Mfg. Co., Inc., Philadelphia
KRONFELD, GUSTAVE L. S., Mechanical Engineer
The Haynes Stellite Co., Pittsburgh
McNAUGHER, DAVID W., Partner,
Robert W. Hunt & Co., Pittsburgh
WILHELM, JOHN H., Superintendent of Gauge Department,
Frankford Arsenal, Philadelphia

Texas
HOGUE, WILLIAM H., Manager,
Magnus Co., Inc., Houston

Washington
CARPENTER, HUBERT V., Dean, College of Mechanic Arts and Engineering,
State College of Washington, Pullman

Wisconsin
BAILEY, ATWELL F., Assistant General Superintendent,
The American Appraisal Co., Milwaukee
BROWN, WALTER, Vice-President and General Manager,
The Webster Electric Co., Racine
OLSON, FRED S., General Superintendent,
The American Appraisal Co., Milwaukee
OLSON, LYLE H., General Manager,
The American Appraisal Co., Milwaukee
SMITH, CHARLES R., Appraisal Engineer,
The American Appraisal Co., Milwaukee

Chile, S. A.
HOFFMAN, ALBERT A., Construction Engineer,
Andes Copper Mining Co., Potrerillas

FOR CONSIDERATION AS ASSOCIATE OR ASSOCIATE-MEMBER

California
BEUTER, ARTHUR J., Technical and Sales Representative,
The Baldwin Locomotive Works, San Francisco

District of Columbia
JASPER, GROVER R., Purchasing Inspector,
Emergency Fleet Corp., Washington

Michigan
MERKER, PAUL O., Mechanical Engineer,
The Larrowe Milling Co., Detroit

New York
CASTONGUAY, ARTHUR F., with
Western Electric Co., New York

Ohio
BRIGHTMAN, HOWARD L., Works Manager,
Brightman Mfg. Co., South Columbus

Pennsylvania
STUCKEMAN, HERMAN S., Superintendent of Construction,
American Foundry & Construction Co., Pittsburgh

Cuba
LINTON, EARL B., Assistant Supervisor,
Cuba Can Corp., Pedroso Matanzas

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

Colorado
KRUEGER, GEORGE H., Special Apprentice,
Great Western Sugar Co., Longmont

Connecticut
GORHAM, HOWARD W., Assistant Superintendent,
Raw Material Departments,
Bridgeport Brass Co., Bridgeport

PARKER, Arthur R., Engineer,
Remington Arms U.M.C. Co., Inc., Bridgeport
WILMOT, Russell C., Engineer, Manufacturing Department,
The American Tube & Stamping Co., Bridgeport

Georgia
COWLES, Clifford A., Jr., Chief Engineer,
Atlantic Steel Co., Atlanta

Illinois
GULLEY, Laurence R., Manager and Chief Engineer,
The Burr Co., Champaign
NEWELL, John C., Chief Engineer,
Keystone Steel & Wire Co., Peoria
LUSH, Clarence,
Automobile Construction Work, Chicago
SHUFF, Evans L., Stoker Engineer, Service Department,
Westinghouse Elec. & Mfg. Co., Chicago

Indiana
CLANCY, William C., Inspector Aeroplanes and Aeroplane Engines,
Signal Service at Large, Indianapolis

New Jersey
BOOZER, Douglas G., Mechanical Engineer,
Eclipse Phonograph Co., Newark
BURNS, Herbert A., Superintendent Material Department,
International Arms & Fuze Co., Bloomfield
KOERNER, Theodore H., General Superintendent,
Newark Engineering & Refrigerating Co., Newark
KOHLER, Anthony M., Production Engineer,
The Babcock & Wilcox Co., Bayonne

New York
HAVENSTEIN, Percy W., Engineer,
Viele, Blackwell & Buck, New York
HITE, Hugh D., Works Manager,
Intertype Corp., Brooklyn
ROTH, Sam L., Sales Engineer,
Pawling & Harnischfeger Co., New York

Ohio
BRIGHTMAN, Harrison M., Superintendent,
The Brightman Mfg. Co., Columbus
BROWN, Warren G., Works Engineer,
Modern Foundry Co., Cincinnati

Pennsylvania
GROFF, Howard M., Leading Draftsman, Gauge Division,
Frankford Arsenal, Philadelphia
McDERMET, John R., Industrial Research Engineer,
Mellon Inst., University of Pittsburgh, Pittsburgh
SLAUGHTER, Charles H., Draftsman and Designer,
Jones & Laughlin Steel Co., Woodlawn

Wisconsin
JAHNKE, Charles B., Experimental Engineer, Mfg. Dept.,
Fairbanks, Morse & Co., Beloit
KLECKNER, A. C., Chief Engineer,
The Webster Electric Co., Racine

FOR CONSIDERATION AS JUNIOR

California
KNOX, Garner L., Production Engineer,
Moreland Motor Truck Co., Los Angeles
WIGGERS, John, Chief Engineer,
Moreland Motor Truck Co., Los Angeles

Connecticut
EDWARDS, George C., Foreman of Pull Socket and Assembling Department,
Harvey Hubbell, Inc., Bridgeport
SCHABECT, John G., Tool Designer,
Remington Arms U.M.C. Co., Inc., Bridgeport

Georgia
BLECKLEY, Logan, Jr., Experimental Engineer,
Atlantic Steel Co., Atlanta

Indiana
EDDY, Benjamin S., Heating and Contracting Engineer, Indianapolis
HAMBROCK, Oscar F., Special Apprentice, Office of Assistant Engineer of Motive Power,
Pennsylvania Lines, Ft. Wayne
ROBECHEK, Bert, Machinist,
Inland Steel Co., Indiana Harbor

Louisiana
SPRAGUE, Frank E., Estimator and Designer,
John H. Murphy Iron Works, New Orleans

Maryland
LINCOLN, Joseph B., Mechanical Laboratorian,
U. S. Naval Engineering Experiment Station, Annapolis

Massachusetts
FERRETTI, Alfred John, Assistant,
Mechanical Engrg. Laboratories,
Massachusetts Institute of Tech., Cambridge

New Jersey
SUTTON, Granville G., Time-Keeper,
Brighton Mills, Passaic

New York
EVANS, Lynn B., New York Representative and Associate Engineer,
The Franklin Mfg. Co., New York
HEWARD, Francis S. B., Manager, New York Office,
James Howden & Co., Ltd., New York
HOPKINS, Peter A., Engineer,
Penn Spring Works, Baldwinsville
KINGSBURY, Chester L., First Lieutenant Ordnance Dept., U. S. Reserve, and Assistant Superintendent of Shops,
Watervliet Arsenal, Watervliet
LYNE, Lewis F., Jr., President,
Oil Specialties & Supply Co., New York
SPRECKELS, Charles H., Jr., Assistant Engineer,
New York Refinery of National Sugar Refining Co. of N. J., Long Island City

Pennsylvania
ELLIOTT, George F., Engineer,
Elliott Co., Pittsburgh

Texas
AUSTIN, Paul P., Jr., Engineer of Tests,
Freeport Sulphur Co., Freeport

Vermont
HUBBARD, Guy, Assistant Purchasing Agent,
National Acme Co., Windsor

Canada
O'ROURKE, Francis W., Tour Foreman and Chemist,
St. Maurice Paper Co., Ltd., Cap Madeleine, P. Q.

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

Connecticut
CASHEN, Henry C., Master Mechanic,
The Bradley & Hubbard Mfg. Co., Meriden

PROMOTION FROM ASSOCIATE-MEMBER

CAMPBELL, James A., Mechanical Superintendent,
Renfrew Mfg. Co., Adams

New Jersey
GATES, Grandon D., Assistant Works Superintendent,
The Celluloid Co., Newark

PROMOTION FROM JUNIOR

Michigan
GRIMES, George L., President and Manager,
Midland Machine Co., Detroit

New York
BERRIAN, Henry C.,
Engineering Dept., Federal Shipbuilding Co., New York
CONNETT, Lyndon R.,
L. R. Connett & Co., New York
JOHNSON, David C., Engineer,
Kean, Taylor & Co., Bankers, New York
JONES, Forrest S., Chief Engineer,
Chas. Pfizer & Co., Inc., New York

Pennsylvania
JACOBSON, Franz, Checker,
Pressed Steel Car Co., McKees Rocks
MURPHY, Edward T., Vice-President,
Carrier Engineering Corp., Philadelphia

Texas
EDGAR, Osmer N., Engineer-in-charge, Industrial Department,
Houston Chamber of Commerce, Houston
HOSMER, Fred E., Mechanical Engineer,
Gulf Pipe Line Co., Houston

Canada
BILLINGS, J. H., Lecturer in charge of Machine Design Department, University of Toronto, Toronto

Hawaii
RENTON, James L., Chief Engineer,
Ewa Plantation Co., Ewa

Total number of new applications.................... 114

NECROLOGY

ALFRED J. ORMSTON

Alfred J. Ormston, Jr., was born in Oil City, Pa., on July 6, 1883. He received his early education in the parochial and public schools and the private school of Dr. Samuel Earp, of Oil City.

For several years thereafter he was employed in the office of Alfred Smedley, chief engineer of the National Transit Co., in Oil City, in the capacity of clerk and stenographer, resigning to engage in business for himself in the production of oil.

He later entered Carnegie Institute of Technology, Pittsburgh, from which he was graduated in 1912, having completed the course in mechanical engineering. The following year he taught in the Institute, and later went to Watertown, N. Y., where he was employed by the Massey Machine Co. in the capacity of mechanical engineer. While with this firm he invented and took out letters patent on a small governor for engines. He assigned this patent to the Massey Machine Co., who now manufacture it as their "Type O."

From Watertown Mr. Ormston moved to Woodlawn, Pa., where he was employed by the Jones & Laughlin Steel Co. For a time he occupied the position of assistant master mechanic, and at the time of his death was assistant to Mr. C. L. Dudley, steam engineer.

On the afternoon of July 31 he was scalded by the discharge from a steam siphon at the works and died the following morning. Mr. Ormston became a junior member of the Society in 1913.

EDWIN D. TUCKER

Edwin D. Tucker was born in New York City on October 10, 1865. He was educated in the public schools of the city and in Wilson and Kellogg's private school.

Upon leaving school he served his apprenticeship with the firm of R. Hoe & Co., and later obtained his drawing-room and shop experience with the same firm. He was later promoted to the position of foreman, holding this until 1906.

In the same year Mr. Tucker became associated with Sheppard Knapp & Co. and was treasurer of the firm for five years, when he retired from active business.

He became a member of the Society in 1898. He was also a member of the General Society of Mechanics and Tradesmen, and of The Franklin Institute of Philadelphia. He died on July 9, 1917.

MYRON KNOX RODGERS

Myron K. Rodgers was born in November 1861. He was graduated from Washington and Jefferson College in 1886, taking the first prize in chemistry.

He left immediatey for the West, obtaining a position as rodman on the Montana Central Railroad, then building into Butte. He was rapidly promoted until he was made resident engineer, having charge of several tunnels. When this road was completed he obtained a position as surveyor with the Anaconda Copper Mining Co., and was advanced in a short while to the position of chief engineer, which he held until 1896.

At that time he became associated with Mr. Marcus Daly of New York, who was very much interested in mining. Mr. Rodgers became Mr. Daly's mining expert and traveled all over the world examining mining properties for him. In 1907 he went into the mining business for himself. He opened up the Nickel Plate Mine at Hedley, B. C., and also the Hidden Creek Mine of the Granby Co., taking both of these properties as mere prospects and developing them until they were ready for the reduction works. He designed and built the Hedley Gold Mining Company's mill. In 1912 he became interested in mining property in Mexico, but the revolution stopped any mining operations in that country.

He became a member of the Society in 1894. He died in June 1917.

SYDNEY FRANCIS SAVAGE

Sydney F. Savage was born in 1889 in Cambridge, Mass., and received his early education in that city. He was later graduated from Lowell Institute.

He was employed in an engineering capacity with manufacturing concerns in the vicinity of Boston, including the Blake-Knowles Steam Pump Works and the Hood Rubber Co., until 1914, when he entered the employ of the United Illuminating Co., New Havén, Conn., in the engineering department.

Upon the formation of the firm of Westcott & Mapes, New Haven, he joined the organization as mechanical engineer, later becoming director and assistant secretary and successfully directing many important undertakings.

He became a junior member of the Society in 1914. He died on August 18, 1917.

DWIGHT BOYCE PANGBURN

Dwight B. Pangburn was born in Washington, D. C., on Nov. 27, 1889. Later the family moved to New Haven, Conn., where he was educated in the public schools, being graduated from the high school in 1907. The same year he entered Yale University in the Sheffield Scientific School. He took the regular course in mechanical engineering, and was graduated in the class of 1910. He continued his studies in the same line until 1912, when he received the degree of mechanical engineer. He was then appointed an instructor in the mechanical engineering department in Sheffield and was holding that position at the time of his death.

Mr. Pangburn's shop experience was limited. However, during one summer vacation he acted as consulting engineer for the Hendee Manufacturing Company, and during the following college year he conducted some scientific tests of the Indian motorcycle for the company at Mason Laboratory, Sheffield.

He wrote many scientific articles for various publications, and also a number of short stories for popular magazines. He was a recognized authority on bird life and was a charter member of the New Haven Bird Club.

At the time of his death he was collaborating with Prof. Richard S. Kirby in writing a textbook on descriptive geometry.

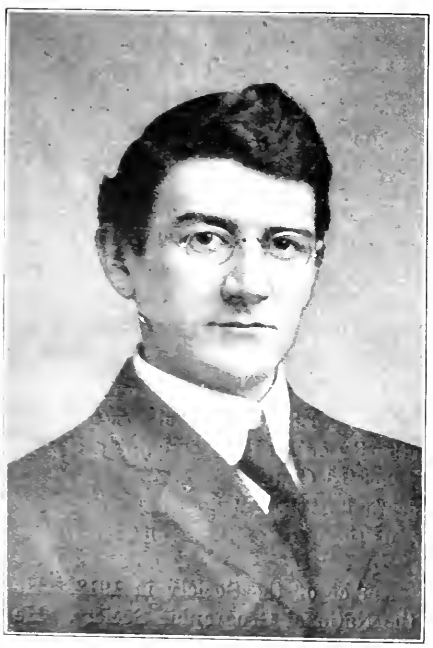
He became a junior member of the Society in 1912. He was also a member of the National Geographic Society. He died on Aug. 24, 1917.

C. R. Richards

EXECUTIVE COMMITTEE OF THE LOCAL SECTIONS OF THE A.S.M.E. 1916-17

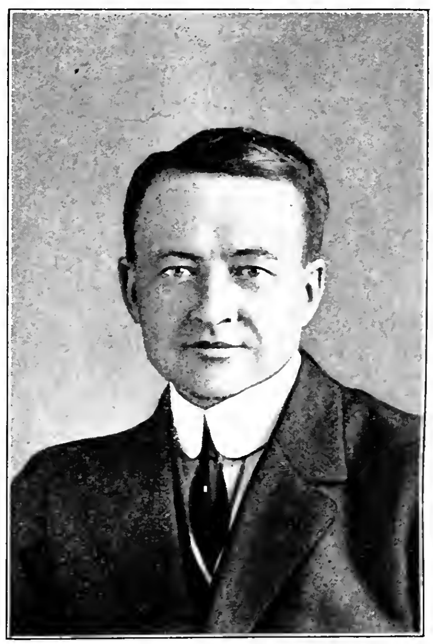
Elliott H. Whitlock

D. Robert Yarnall
Chairman



Walter Rautenstrauch

THE SECTIONS COMMITTEE HAS LAID OUT AN AMBITIOUS PROGRAM FOR THE SEASON. THE COMMITTEE WILL VISIT THE ST. LOUIS, MILWAUKEE, CHICAGO AND DETROIT SECTIONS THIS MONTH



L. C. Marburg

AMONG THE SECTIONS

IN another part of the Society Affairs Section of this issue of THE JOURNAL is given a very comprehensive statement of what the Committee on Sections expects to accomplish during the season just commencing. Of direct interest to the readers of THE JOURNAL is the plan to have each Section present two papers for publishing in these columns.

The President has just completed plans for a Western trip, of which the following is the itinerary: Leave Worcester October 14; St. Louis, October 16; El Paso, October 18; Los Angeles, October 22; San Francisco, October 26; Seattle, October 28 or 29. The Sections at the Coast are looking forward with a great deal of anticipation to this visit, especially as Dr. Hollis will be accompanied by Mrs. Hollis.

The Executive Committees of all the Sections have been actively at work during the summer on their programs, and by the end of this month a few of the Sections will already be holding their initial meetings. In the November issue we hope to be able to publish the programs for the season of all the Society's twenty-two sections.

The Providence Engineering Society, affiliated with our Society, held its opening meeting on September 18. A representative of the A.S.M.E. was present who prepared an account of the meeting which is published elsewhere in this issue.

EXECUTIVE COMMITTEES OF THE SECTIONS

Atlanta

OSCAR ELSAS, *Chairman;* CECIL P. POOLE, *Secretary;* EARL F. SCOTT, ROBERT GREGG, J. N. G. NESBIT.

Baltimore

W. W. VARNEY, *Chairman;* L. B. ROBERTSON, A. G. CHRISTIE, C. C. THOMAS, W. M. CHATARD.

Birmingham

J. H. KLINCK, *Chairman;* W. P. CAINE, *Vice-Chairman;* J. G. HATMAN, *Secy-Treas.;* PAUL WRIGHT, R. E. BRAKEMAN.

Boston

A. C. ASHTON, *Chairman;* W. G. STARKWEATHER, *Secretary;* RICHARD H. RICE, W. W. CROSBY, FRANK L. FAIRBANKS.

Buffalo

Committee to be appointed.

Chicago

ALEX. D. BAILEY, *Chairman;* H. T. BENTLEY, *Vice-Chairman;* A. L. RICE, *Secretary;* P. N. ENGEL, G. R. BRANDON.

Cincinnati

Committee to be appointed.

Detroit

GEORGE W. BISSELL, *Chairman;* S. J. HOEXTER, *Secretary;* T. H. HINCHMAN, E. C. FISHER, RUSSELL HUFF.

Erie

Chairman to be appointed; M. W. SHERWOOD, *Vice-Chairman;* R. CONRADER, *Treasurer;* M. E. SMITH, *Secretary;* N. A. NEWTON.

Indianapolis

W. H. INSLEY, *Chairman;* L. M. WAINWRIGHT, *Vice-Chairman;* B. G. MERING, *Treasurer;* F. C. WAGNER, L. W. WALLACE.

Los Angeles

F. G. PEASE, *Chairman;* T. J. ROYER, *Secretary;* RALPH SPRADO, H. L. DOOLITTLE, H. E. BRETT.

Milwaukee

W. M. WHITE, *Chairman;* FRED H. DORNER, *Secretary;* L. E. STROTHMAN, EDWARD HUTCHENS, M. A. BECK.

Minnesota

H. LEROY BRINK, *Chairman;* J. A. TEACH, *Vice-Chairman;* E. A. WILHELM, *Secy-Treas.;* J. V. MARTENS, C. W. TURBY.

New Haven

H. B. SARGENT, *Chairman;* E. H. LOCKWOOD, *Secretary;* F. L. MACKINTOSH, J. A. NORCROSS, J. W. ROE.

New Orleans

H. L. HUTSON, *Chairman;* E. W. CARR, *Secretary;* W. B. GREGORY, A. M. LOCKETT, R. T. BURWELL.

New York

J. J. SWAN, E. J. PRINDLE, A. D. BLAKE, J. H. NORRIS, W. H. GREUL.

Ontario

R. W. ANGUS, *Chairman;* CHESTER B. HAMILTON, JR., *Secretary;* C. R. BURT, L. H. FLETEMEYER, G. V. AHARA.

Philadelphia

L. F. MOODY, *Chairman;* JOHN P. MUDD, *Secretary;* EMMETT B. CARTER, W. R. JONES, H. B. TAYLOR.

St. Louis

R. L. RADCLIFFE, *Chairman;* E. H. TENNEY, *Secretary;* E. FLAD, W. A. HOFFMAN, H. R. SETZ.

San Francisco

B. F. RABER, *Chairman;* A. C. PAULSMEIER, *Vice-Chairman;* C. H. DELANY, *Secretary;* ELY HUTCHINSON, OMAR DENNY.

Worcester

GEO. I. ROCKWOOD, *Chairman;* R. G. WILLIAMS, *Secretary;* V. E. EDWARDS, H. P. FAIRFIELD, F. W. PARKS.

Providence Engineering Society

ROBERT W. ADAMS, *President;* GEORGE A. CARPENTER, *First Vice-President;* WAYLAND T. ROBERTSON, *Second Vice-President;* JOHN T. FRANKENBERG, *Third Vice-President;* WILLIAM A. KENNEDY, *Secretary;* and ALBERT E. THORNLEY, *Treasurer.*

Providence Engineering Society

The Providence Engineering Society can survey the work accomplished since its organization a year ago with just pride and satisfaction. The slogan of the organization, "Ideas + work = Results," has been productive of a very attractive group of meeting rooms, located on the top floor of the Rhode Island School of Design, conveniently located at 29 Waterman Street, Providence.

The first meeting of the season was held on Tuesday evening, September 18, at which Prof. J. Ansel Brooks, Past President of the P. E. S., gave an illustrated talk on My Trip to Honolulu. Professor Brooks spent about six months in the Hawaiian Islands last winter and spring, and secured a wonderful collection of photographs of the features of the Islands. Mr. John R. Freeman, Past President of the A.S.M.E., who visited the Hawaiian Islands en route to the Orient, was present and gave an interesting supplement to Professor Brooks's address.

The organization of the Providence Engineering Society embraces the following ten sections: Chemical, Dr. R. L. Lyons, Chairman; Designers and Draftsmen, Benjamin F. Waterman, Chairman; Efficiency, Howard D. Wilson, Chairman; Fire Insurance Engineers, Paul A. Colwell, Chairman; Industrial Education, Professor William H. Kenerson, Chairman; Machine Shop, Arthur H. Annan, Chairman; Municipal Engineering, Karl R. Kennison, Chairman; Power, Warren B. Lewis, Chairman; Structural, Eugene B. Whipple, Chairman; and Student, George R. Sturtevant.

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping anyone desiring engineering services. The Society acts only as a clearing house in these matters.

GOVERNMENT REQUESTS

The Society has been asked to make suggestions of men for the following positions with the Government. Further information will be given on request. Non-members of the Society having the qualifications may avail themselves of these notices by enclosing with their reply a personal introduction to the Society.

INSPECTORS OF STEEL HELMETS (under Civil Service Commission)

(A) Steel welding and rolling. Two or three men will be needed. The inspection of processes covers the operation of rolling into sheets and the incidental welding.

(B) Pressing. Six men are needed. This is the ordinary operation of pressed metal work.

(C) Assembling. Four to six men are needed. These men will inspect assembling, including the addition of incidental hardware and the lining, and will be responsible for the finished articles.

(D) In addition, at least six men will be needed to inspect the helmet linings, which are made of felt and leather, sewed by machine. Men of shoe experience to be utilized here. 2174.

RATE SETTER IN ARTILLERY AMMUNITION DEPARTMENT with at least one or two years' experience or more at assembly work, or a man clever with his hands in order that he may jump in and do each operation himself with dispatch, and tabulate his results in a neat manner, thus giving an indication of how many pieces an hour can be done in the various operations of assembling artillery ammunition. The man should not be influenced either by workers or by foremen, and will report results directly to the officer in charge. The work covers a wide range—from small primer work to handling of 6.2 shells. Such a man would be paid at the rate of $0.50 per hour. 2182.

INSPECTORS OF ORDNANCE EQUIPMENT (under Civil Service Commission). Inspectors for hardware and metal equipment, comprising such articles as buckets, rings, fasteners, hand axes, wire cutters, intrenching tools, canteens, cups, meat cans, cutlery and other small articles of brass, iron, steel or aluminum. Men who have had a high-school or equivalent education and in addition have had four years' experience in a manufacturing plant making such articles as those described above will qualify for one class of inspectors. Another class are graduates from a college or university of recognized standing and who have had one year's experience in a manufacturing plant, on the practical end of the work. These men should be over 25 years of age. Duties will consist in the organization and supervision of the inspection work in plants where equipment as described above is being manufactured. Inspectors will also be responsible for the preparation of the necessary reports covering the inspection, shipment and payment for the articles described. 2195.

MECHANICAL DRAFTSMEN who have been called by the selective draft, may, if they desire, serve their country in their chosen profession by being transferred from their respective cantonments into the drafting force of the Ordnance Department as non-commissioned officers. For further particulars, address Gun Division, Ordnance Department 1330 F Street, Washington, D. C. 2223.

MECHANICAL DRAFTSMEN WANTED IMMEDIATELY by the Gun Division, Ordnance Department, Washington, D. C. For further information, communicate at once with the Gun Division, Office of the Chief of Ordnance, 1330 F Street, Washington, D. C. 2224.

For the following positions, Nos. 2171, 2187 and 2217, letters showing qualifications should be sent to the Secretary. Further information cannot be given at this time.

MECHANICAL DRAFTSMEN AND MECHANICAL ENGINEERS. [illegible] to serve as civilians at salaries of from $1400 to $1800 per year. Later to be commissioned as First or Second Lieutenant at from $1800 to $2000 per year. 2171.

INSPECTORS OF INSTRUMENTS, division of Signal Corps. Men not subject to draft and with technical training preferred, especially in physics. Not necessary to have thorough knowledge of aeronautical instruments. Manufacturing experience of value. Salaries from $1200 to $2200 per year. 2187.

TECHNICAL GRADUATES OF ESTABLISHED UNIVERSITIES WITH DEGREE OF M.E.

(A) Some technical and executive experience in operating industrial plants, for commissioned service with salaries ranging from $2500 to $3000.

(B) Men of principally technical and some special experience in designing and coördinating work for the manufacture of products similar to military and naval ordnance, aeronautical supplies, internal-combustion engines, for commissioned service with salaries ranging from $2500 to $3000. 2217.

POSITIONS AVAILABLE

In forwarding applications, stamps should be enclosed for transmittal to advertisers; applications for non-members should be accompanied by a letter of reference or introduction from a member, such reference letter to be filed with the Society. Copy for notices must be in hand by the 15th of the month.

INDUSTRIAL ENGINEER—COST ACCOUNTANT. A well-established firm can offer exceptional opportunities for effective and interesting work to engineering graduates who have had substantial experience with modern industrial accounting, with special preference to manufacturing costs. In reply state age, education, experience, present and expected salary. 431.

ASSISTANT DESIGNER AND WORKS MANAGER. High-grade company with factory located in western Maryland desires services of a man having a technical training in the foregoing capacity. Duties: To assist in designing special machinery and developing ideas; analyze machine operations, prescribe equipment and devise means to effect speedy and economical production; superintend the manufacturing of such machinery. Requires the ability of a thoroughly practical master mechanic with original ideas as to methods, a knowledge of modern shop practice, familiarity with the design and application of time-saving fixtures, executive ability and diplomacy necessary to successfully direct a manufacturing plant. No question of salary if the right man applies. State full particulars and experience from technical degree, with the assurance that such information will be held as confidential and no investigation will be made with present employer prior to conference. 958.

SUPERINTENDENT AND FOREMAN OF POWER PLANT. Man capable of taking complete charge of large smelter plant consisting of steam turbines, large blowing engines, large rotary blowers, Diesel engines, waste-heat and oil-fired boilers, pumping plant, high- and low-tension electrical equipment, etc. Must be familiar with combustion and operating problems and have organizing and executive ability. Salary about $2,500. Location Arizona. 1025.

RESEARCH—TESTS ENGINEER. Man with mechanical and electrical training, from 28-35 years of age, preferably over draft age, for work in the standardization of household equipment. Location New York. 1082.

MACHINE DESIGNER between 25 and 35 years of age, with mechanical and electrical engineering knowledge and sufficient shop experience to enable him to design apparatus so that it can be economically manufactured. Some pneumatic engineering experience preferred, but not absolutely necessary. Work: Improvement of present product in regard to increasing the quality of finished article. Design of new products now in process of development. Salary, $1,200 to $3,600, depending entirely on man. Location Hoboken, N. J. 1155.

SHOP SUPERINTENDENT for machine shop manufacturing planers, lathes, etc., and employing 200 to 300 people. Confidential. 1158.

COMPETENT MAN to take hold of maintenance and machine repairs and general shop economies. Prefer one about 35 years old.

with technical education and enough shop experience to understand the operation of all machine tools, and with a full appreciation of the value of time on an operation without going into any efficiency work. Opportunity for advancement and eventually an executive position. Location Ohio. 1166.

SALESMAN for mechanical apparatus. Salary depends upon the man. Location New York State. 1167.

EXPERIENCED SALES-ENGINEER FOR FRANCE desired by export house. Man who has actually sold machinery in that country. Must be competent to develop efficient sales organization, appoint sub-agents, etc. A substantial profit share will be paid in addition to salary, therefore exceptional opportunity. Address applications in French or English. 1173.

MECHANICAL ENGINEER familiar with general machinery in wood-working and machine shop to take charge of drafting room. At present planning ship ways, and the work for this particular engineer will be the laying out of the wood-working and machine shop, as well as derricks, cranes, etc. Location Pennsylvania. 1175.

PRODUCTION MANAGER. Man 31 to 40 years of age, with machine shop experience and familiar with modern production methods, for a permanent position in charge of planning production department of a large manufacturing concern. In first letter state qualifications fully and initial salary expected. Location New York State. 1176.

INSPECTOR. Energetic, capable young man as inspector in plant manufacturing small machinery and machine parts. Should have had experience as a machinist. State initial salary expected, age, experience and qualifications. Good opportunity for advancement. Location New Jersey. 1183.

STEAM ENGINEER familiar with operation of boiler work, combustion problems, etc., for New York concern. Salary $150. 1184.

SALES ENGINEERS. Men at least 34 years of age, with college education or its equivalent, who have had mechanical training and shop experience, in the sales department of a prominent manufacturer of pneumatic machinery. Good opportunity for the right men. Give references, experience and salary expected. Location New York State. 1187.

DRAFTSMAN with sufficient experience to enable him to take charge of the making and checking of detail drawings in a drawing room employing two or three men. State qualifications and past experience fully. Large part of the work will consist of routine calculations; applicants must be possessed of technical training. Salary about $150 per month. Location New York State. 1189.

FACTORY EXECUTIVE technically trained, about 30-35 years of age, for large textile-machinery manufacturing plant. Knowledge of up-to-date shop methods essential, also successful experience in the handling of mechanics. Applicant would be required to spend from one to two years in shop to become familiar with the various classes of work, after which the position of assistant superintendent with further excellent opportunities for promotion will be open to him. Salary to start, about $2,500. Location Massachusetts. 1191.

CHIEF DRAFTSMAN with executive and engineering ability, competent to direct the work of eight draftsmen and superintend design of output of plant manufacturing large tankage, steel-mill buildings, zinc-smelter equipment and cement-mill work, along engineering lines. Must be competent to operate system now installed in relation to billing, routing and ordering materials. Want man with at least ten years' experience in manufacturing lines. Salary $2,000. Location Kansas. 2013.

HIGH-GRADE TOOL DESIGNER with good experience on heavy automatic-screw-machine tools including Acme, Gridley, Brown & Sharpe and Cleveland automatics, and also capable of handling the problem of standardizing tools and tool records. Salary $25 to $30 per week. Location Ohio. 2037.

TWO TECHNICAL GRADUATES approximately 30 to 38 years of age with experience of sufficient breadth so that they would be posted on problems of manufacture in more than one line. Men who have been steadied by experience, yet ambitious to push ahead and interested in the various problems of manufacture and construction. Location Massachusetts. 2071.

DRAFTSMEN for Watertown plant. Salary $20 weekly. Apply by letter to Employment Dept., Maxim Munitions Corporation. Derby, Conn. 2124.

INSTRUCTOR with technical and actual operating experience to take charge of stationary engineering department where exceptional opportunity along educational lines is offered. Location Pennsylvania. 2126.

CONSULTING ENGINEER in connection with sale and installation of swivel joints. Position would require man to travel quite extensively to call and confer with the master mechanic or engineer and see that our joints are properly installed. Position would be a dignified one and could be made very important, depending upon the results of the efforts put forth. Salary $50 per week and expenses. Location Wisconsin. 2133.

STRUCTURAL DRAFTSMEN (A) For Government work, two timber draftsmen, probably men familiar with trusses and trestles, and one general draftsman for general tracing and drafting. (B) Six structural-steel designing draftsmen and three or four draftsmen familiar with foundation work. Location Maryland. 2136.

METALLURGIST. Large manufacturer of automobile parts operating steel mill and tube mill desires services of a thoroughly competent metallurgist. An exceptionally good opportunity to secure position with firm having a nation-wide reputation for producing a high-quality product. Location Middle West. 2137.

SALESMAN. Young man of some experience to sell or promote patent rights on commission. Only part time will be needed. 2138.

ENGINEER with thorough technical training and not less than five years' experience, capable of designing installations of machinery, tanks, etc., estimating costs and supervising erection. Work in connection with new centrifugal processes. Position permanent. Location Eastern Pennsylvania. 2142.

INSTRUCTORS in mechanical engineering for university in Middle West. Salary $1,300. 2143.

TOOLMAKERS AND TOOL DESIGNERS experienced on jigs, fixtures and gages. Only first-class men need apply. Good salary and best of working conditions. Location Pennsylvania. 2155.

MECHANICAL ENGINEERS. Rapidly growing company has openings for trained and experienced technical men, also for younger men with technical training in mechanical engineering. Apply by letter giving training, experience, and class of work desired, whether operating, efficiency work, or designing. Location Pennsylvania. 2156.

DRAFTSMAN experienced in marine-engine, water-tube boiler and river-steamer work. State age, salary expected and references. Location Charleston, W. Va. 2157.

SUPERINTENDENT for electro-chemical plant. Man with experience and executive ability, capable of handling about 50 employees. Salary entirely dependent upon man. Location Pacific Coast. 2159.

SUPERINTENDENT with not less than five years' experience in factory management, to take charge of a factory employing 600 to 700 people; a man who is leader of men; who has had training as a mechanical engineer and if possible a designer of automatic machinery. Good opening for right kind of high-grade man. Confidential. 2160.

DRAFTSMEN experienced in power-plant work. College graduates preferred. Salary $125-$180, according to individual. Location New York. 2161.

DESIGNER of power-plant work. College graduate preferred. Salary $125-$180, according to man. Location New York. 2162.

MECHANICAL ENGINEER with originality and experience in supervising all details of engineering department. Must be capable and resourceful practical designer. Work of an industrial nature, covering smelting practice and coal- and ore-handling equipment. Large plant located in Eastern Pennsylvania. Salary $250 per month. Apply by letter. 2163.

YOUNG MAN not over 35 and not subject to military draft. Must possess some technical training or experience in mechanical lines, including drafting, be energetic and have executive ability. Salary to start, $1,300 to $1,500. Location New York State. 2166.

PRODUCTION MANAGER with experience in the manufacture of machine tools and specialty appliances. Location New England. Salary depends entirely upon individual. 2170.

SALES ENGINEER. Man competent in handling and selling reinforcing, bar steel, pig iron, coke, etc. Position requires man with some technical knowledge, preferably one with an engineering training and some practical experience in steel construction. Energetic and aggressive salesman of good character desired; one who will be loyal, and while anxious to advance, will not be disposed to fly from job to job. Salary about $4000. Location Pacific Coast. 2172.

DRAFTSMAN preferably one with some experience in general machine design and steel-plate work. Salary $75 to $90 per month. Good opportunity for advancement. Location Pennsylvania. 2173.

EXPERT IN CHECKING UP DRAWINGS to work on special machinery, coke ovens, etc. Salary up to $175 per month, depending upon individual. Location New York. 2175.

DESIGNERS. First-class men experienced on tools, fixtures and gages. State full experience. Location Illinois. 2176.

DESIGNER of regulators and a designer of tools. None but thoroughly experienced man need apply. Good opening with big manufacturing company. Location Middle West. 2177.

PHYSICISTS, CHEMISTS, ENGINEERS, DESIGNERS AND DRAFTSMEN for work of research, development, and design related to problems of telephonic, telegraphic and radio communication, which are matters of public importance. Opportunities for such men in both temporary and permanent positions. Apply by letter. Location New York. 2178.

ENGINEERS FOR STEEL PLANT. Four positions open in modern plant. Mechanical and civil engineering experience desirable. Salaries $125, $150, $175. Location Pennsylvania. 2183A.

MECHANICAL ENGINEER with some knowledge in installing and operating mining and ore-dressing machinery. Must be capable of starting and planning mining enterprises, and must study Russian if he does not already know it, and bring with him certain American agencies in the lines of mining machinery. Location Russia. 2183B.

PROFESSOR OF MACHINE DESIGN in mechanical engineering department of university in Middle West, to teach the subjects usually included under this title, with possibly some laboratory work on the strength and other physical properties of materials. Salary about $2500. 2184(1).

INSTRUCTOR IN MECHANICAL ENGINEERING, at $1400 to $1500, to teach a few hours of class-room work in elementary steam engineering and some elementary laboratory work, including gas-power laboratory. Prefer a man who desires to specialize in gas-power laboratory work. 2184(2).

TWO ASSISTANTS IN MECHANICAL ENGINEERING, at $850 for 9 months' work. One to have charge of the instrument room and the other to be assistant in office; both to do some correction of laboratory reports and class exercises. 2184(3).

SUPERINTENDENT OF AERONAUTICAL LABORATORY and its six or eight instructors in our School of Military Aeronautics. Should be a man of mechanical-engineering training who has specialized and has had considerable experience in the operation and testing of aeronautical engines, a good teacher, with executive ability in supervising and directing the work of the laboratory of 250 to 300 students. Such a man would receive at least $200 per month, 12 months in the year, indefinitely. 2184(4).

UNDERSTUDY to the superintendent of aeronautical laboratory called for in Position No. 2184(4). Would expect to pay from $150 to $175 per month. 2184(5).

DESIGNING DRAFTSMAN, man experienced on water-tube marine and stationary boilers and superheaters only need apply. Good position for competent man. State education and experience in detail, age and salary expected. Location New York. 2185.

YOUNG MEN wanted by manufacturers of mechanical instruments for indicating and reporting pressures, temperature, speed, etc. The position is ultimately that of traveling salesman with attractive pecuniary inducement. The start will be modest, as a course of training must be gone through at home office in New York. 2188.

INSTRUCTOR IN MECHANICAL DRAWING AND MACHINE DESIGN in the extension division of a university in the Middle West. Position consists in taking care of all correspondence study work in the above subjects and also in the revision and preparation of courses along this same line. Salary from $1500 to $1800 per year of 11 months. 2189.

YOUNG ENGINEERS with good technical education and from one to three years' experience along general mechanical-engineering lines. Must be of good personality, energetic, persevering and capable of considerable development; good opportunity for advancement. Address E. I. du Pont de Nemours & Co., Engineering Department, Wilmington, Del. 2192.

DESIGNER AND ASSISTANT OFFICE EXECUTIVE of power plant. Salary $150 to $175 per month. Location New York State. 2194.

AGENT FOR STEAM-BOILER AND FLYWHEEL INSURANCE. Applications will be treated confidentially from men who have demonstrated their ability to produce business in these lines. State fully experience and compensation desired. 2196.

YOUNG SALESMAN for New York City. Applicant should preferably have had experience in connection with building operations and must be a man of good address and pleasing personality. 2197.

TWO TECHNICAL MEN, one to act as a service engineer, the other as a sales engineer. The former need not necessarily be a technical graduate, but should be familiar with die design and hydraulic-press work. For the latter position desire a technical graduate familiar with automobile starting, lighting and ignition apparatus and electrical devices in general. Experience in plastic molding or die design would be advantageous. If applicants are between the ages of 21 and 31 they should show cause for exemption or have numbers near the end of the draft call. Prefer single men, since the positions will require considerable traveling over a wide territory. Product is highly specialized and the first two or three months of employment will be spent in the shop and laboratory. Salary commensurate with experience and ability. 2198.

DETAILER on interchangeable-parts machinery. Salary $25 to $35, depending upon individual. Location New York State. 2199.

CHIEF DRAFTSMAN, experienced on tools, jigs and fixture design, to take charge of a dozen men. Prefer man from 25 to 35 years of age with shop experience in the manufacture of interchangeable parts and with executive ability so that he can assist the superintendent directing the technical work. Salary $200 per month to start. 2200.

ASSISTING MANAGER for large chemical plant. Location New York State. 2203.

OFFICE EXECUTIVE to take charge of correspondence, routing of salesmen, agencies, etc., in connection with an industrial electric-truck manufacturing plant. State experience. Salary to start $2400. Appointment by letter. Location New York State. 2205.

YOUNG MECHANICAL ENGINEER, preferably a recent college graduate, to work up in engineering and steel export department, with probability of eventually taking charge. Location New York State. 2206.

DETAILER on hoisting and conveying. 2208.

YOUNG TECHNICAL GRADUATE as instructor in machine design in the mechanical engineering department of eastern college. Salary $1200. Work begins September 20. 2209.

TOOL DESIGNERS. First-class men for permanent positions. Location New Jersey. 2210.

DRAFTSMEN for power station of railway. Salary $100 to $150 a month. Location Ohio. 2211.

CONSTRUCTION SUPERINTENDENT on brick, iron and combustion. Single man preferred. Salary $175 to $200 a month. Location New York State. 2212.

EXPERIENCED DRAFTSMAN on jigs and fixtures. Good pay and opportunities. Location New York State. 2213.

INSTRUCTOR, with the rank of assistant professor, in engineering mechanics, strength of materials, materials testing laboratory, and hydraulics, for the University of Oklahoma, at Norman, Okla. Salary $1400 for year, with annual increase of $100. The position is for the duration of the war, possibly longer, as the school is growing rapidly. The man will have full charge of the work and be free to use his own methods and text. A teacher of considerable experience in these subjects might be paid more than the above salary. Recent graduates, preferably with some teaching experience, who intend to follow teaching as a profession, will be given careful consideration.

A similar position at the same pay and rank is open in the steam engineering and mechanical laboratory. This position is permanent. 2214.

MAN to assist in the design of laboratory of university in New England, later instructor in night course, to equip motor-vehicle laboratory for the experimental study of the factors entering into the construction and design of motor vehicles, including engine and chassis. 2215.

DETAILERS. Young engineers for work on specifications. Location New York State. 2216.

SUPERINTENDENT, preferably under 50, with enthusiasm and thoroughly conversant with shop routing, cost accounting, and ability for organizing. Position is available at once. Salary between $4000 and $5000 per year. Confidential. 2218.

DETAIL DRAFTSMAN, experienced on jig, fixture and tool designing. Salary $25-$28 per week. Also a man capable of taking charge of

the drafting room at salary depending upon applicant's qualifications. Location Connecticut. 2219.

FACTORY SUPERINTENDENT. Man thoroughly experienced in machine-shop practice and modern centralized planning-control methods; capable of securing large production in the most efficient, economical manner. Factory is divided into divisions of brass and iron foundry, structural steel, machine shop, pattern-making, wood work, polishing and plating. Product is light, generally concerned in the production of cash carriers, pneumatic-transmission tubes and light-duty conveying machinery. Location Massachusetts. 2220

MECHANICAL DRAFTSMEN having such experience in heating and general plant work as would regularly occur in the office practice of the average consulting heating engineer. Location Baltimore. 2221.

INSTRUCTOR IN MECHANICAL ENGINEERING to teach mechanical drawing and descriptive geometry in an engineering college on the Pacific Coast. Salary $1200 to $1400. 2222.

ASSISTANT OR ASSOCIATE PROFESSOR OF MECHANICAL ENGINEERING in charge of department, with salary of $1800 to $2000 for ten months, depending upon qualifications. These should include graduation from a technical school and both teaching and practical experience. Candidates should send without delay late photograph, full record of experience, and credentials. Location Idaho. 2225.

ELECTRICAL ENGINEER, with two or three years' experience developing automatic motor control for heavy machinery. Location near New York. 2226.

YOUNG MECHANICAL OR ELECTRICAL ENGINEER as assistant to executive in New York engineering office. Duties will be largely secretarial. Technical education and combined engineering and business experience are desirable. Salary $2000 to $2500. Apply by letter. 2228.

CHIEF DRAFTSMAN. Permanent position for chief mechanical draftsman with large firm manufacturing a number of heavy standard lines, boilers, engines, sawmill and pulpmill machinery, municipal machinery, etc. Location in city in Central Ontario, Canada. Apply by letter. 2229.

ADVERTISING MANAGER for large industrial corporation in New York City. Familiarity with advertising writing, printing, publishing, etc. 2230

MEN AVAILABLE

Only members of the Society are listed in the published notices in this section. Copy for notices should be in hand by the 15th of the month, and the form of the notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

EXECUTIVE position in the steel business—either in the manufacturing or sales end—desired by an American, technical graduate. Age 36, married. Fifteen years' experience in steel plant, general construction and varied engineering work. At present employed. Will arrange for New York interview. J-320.

CHIEF ENGINEER OR MASTER MECHANIC, now employed. Thorough technical and practical experience, covering the construction, operation and upkeep of steam and hydraulic power plants in connection with industrial works. Specialty: steam and fuel economy. Salary $2500. Available about October 1. J-321.

JUNIOR MEMBER, age 34, with 16 years' general engineering and operating experience, wishes position as malleable foundry engineer or superintendent in connection with engineering concern doing foundry work. Specialized in foundry equipment design, pattern making and mounting for multiple production, furnace operator, core making for agricultural-implement works and malleable pipe fittings. J-322.

SUPERINTENDENT OF POWER of steam-electric and compressor plant, age 31, married, technical graduate. Seven years' experience in design, construction and operation of steam-power plants and electric-transmission lines. At present superintendent of 10,000-hp. power plant for mining company in the Southwest. J-323.

MAINTENANCE ENGINEER OR SUPERINTENDENT OF POWER. Resigned from position as power and maintenance engineer of large industrial plant, and now available for position along similar lines. Have good general education, supplemented by special engineering and business courses of study. Four years of special machine-shop instruction; four years field erection and construction work on large engine, steam-turbine generators, refrigerating and structural machinery. Ten years with large western industrial plant as chief engineer of power plant and power and maintenance engineer. Have originality, training and experience to handle a big job where initiative and hard work will bring recognition and advancement. Non-user of tobacco and alcohol. Refer to former employers as to character and ability. J-324.

MECHANICAL ENGINEER. Technical graduate with experience in time-study, planning, production and inspection work, desires position of responsibility with manufacturing concern. J-325.

MECHANICAL ENGINEER—FACTORY EXECUTIVE. Graduate M.E. with 11 years' practical manufacturing experience. Has held positions as master mechanic, mechanical engineer and factory superintendent with large manufacturing company. Experienced in duplicate manufacture of light and medium-heavy machinery, also in woodworking from standing timber to highly finished cabinet wood. With present employers the past 11 years. Desires position with growing concern with opportunity to obtain financial interest. Middle West preferred. J-326.

MECHANICAL ENGINEER, 37 years old, with 18 years' practical experience with machine tools, steam turbines and engines, boilers and special machinery, exceptional theoretical knowledge, ability in design testing and operation, desires change. Also have had some sales experience. Location anywhere, but Middle West preferred. J-327.

MECHANICAL AND ELECTRICAL ENGINEER, age 34, married, technical graduate, 10 years' experience in power-plant design, appraisal and operation, also consulting and efficiency work in manufacturing. Can design, supervise or organize new work. At present employed, but desires new connections with ample opportunity to produce results. Salary, $3600. J-328.

EXECUTIVE OR WORKS MANAGER, age 34, married, technical, mechanical and electrical engineer with wide experience as executive manager and engineer; specialized in power-plant design and operation. Also experienced in industrial efficiency and appraisal work. Can furnish best of references. Salary $4000. J-329.

FACTORY EXECUTIVE. University graduate in mechanical engineering, 38 years old, wishes to make connections with modern concern manufacturing small mechanical or electrical apparatus in large quantities. Has thorough knowledge and practical experience in modern factory organization, manufacturing methods and employment matters. For several years connected as production manager and assistant factory manager with first-class concern employing 1800 men. J-330.

MECHANICAL ENGINEER OR SUPERINTENDENT. American, with 14 years' practical experience, also theoretical experience. Specialist in valves, fittings and engineering specialties of all descriptions; machines, tools, fixtures and equipment for same, shop maintenance; efficiency and production engineer. Successfully held positions and has references verifying above experience. J-331.

EXECUTIVE, ASSISTANT TO EXECUTIVE OR MECHANICAL ENGINEER. Cornell graduate, age 36, 12 years' experience in positions covering chief executive, office management and works manager, operation and construction and experimental work. Experienced in combustion, steam and gas power. At present employed. J-332.

SELLING ENGINEER, 27 years old, with 10 years' experience in power, gas and chemical equipment design and construction, desires position in sales work; has excellent business training; active worker with initiative and technical ability. J-333.

MECHANICAL ENGINEER OR CHIEF DRAFTSMAN. American, 41, with broad experience in meeting unusual conditions in collieries, smelters, chemical operations, etc. Can supervise work in shop or field. Salary $3000. New York district or foreign. J-334.

MASTER MECHANIC OR SUPERINTENDENT OF CONSTRUCTION. Technical education and 20 years' practical experience. J-335.

INSTRUCTOR in mechanical engineering, with five years' experience in drafting room, shop and laboratory, seeks extra work to be done in his office. Location New York City. J-336.

SALES ENGINEER, OFFICE EXECUTIVE OR DISTRICT MANAGER. Technical graduate, ten years' experience in eastern territory, highly successful in present work as a business getter, seeks larger field where energy and ability to show results are wanted. Nine years in present position. J-337.

PRACTICAL ENGINEER with broad tool-designing and machine-shop experience desires a responsible position where an agreeable personality, ability to handle men, an evening-school technical education, coupled with a capacity to "deliver the goods," will pave the way to a good future. For the past year and a half employed by a large ordnance firm to investigate their machine-shop methods and tools. Age 28, last numbers in draft. Salary $300 per month. J-338.

EXECUTIVE MANAGER. An executive of ability and aggressiveness, a mechanical, technical graduate, at present employed, desires to connect with a manufacturer whose business may need systematizing and building up as to organization and production. Has had a varied experience in different branches of manufacturing, operating industrial plants along lines of scientific management, and is fully conversant with modern methods of manufacturing and marketing product. Only

[illegible] position offering good possibilities for improvement. [illegible]

MECHANICAL ENGINEER [illegible] experience [illegible] with the 2000 [illegible] of elevating con[illegible]. Good organizer [illegible]. Lately re[illegible] country on account [illegible]. Will go anywhere if condition and salary are right. J-340.

CHIEF ENGINEER OF POWER PLANTS OR PLANTS AND SUPERINTENDENT OF GAS WORKS. Age 36, married. Assoc Mem Am Soc M E. [illegible] in present position. Holds Massachusetts [illegible]. Has had extensive experience on both General Electric and Allis-Chalmers turbines and different types of water [illegible] and almost all types of steam boilers at various pressures. [illegible] executive ability. Would consider a position in the [illegible] is preferred. Salary $5000. All correspondence will be treated confidentially. J-341.

TECHNICAL GRADUATE M. E., with two years' practical experience [illegible] engineering. At present employed as assistant to factory engineer of an industrial plant. Has had considerable experience in designing and construction work. Position in the East preferred. J-342.

PURCHASING ENGINEER. At present engaged with large corporation and in touch with production and export organizations; qualified as a [illegible] and [illegible] in machinery, metal products, machine tools, [illegible] equipment and engineering materials. Desires to change, assuming greater responsibilities and expecting commensurate salary. J-343.

DRAFTSMAN. Graduate mechanical engineer, age 24, with 18 months' experience in the design and layout of refrigerating plants and machinery, desires position, preferably in the East. Available on short notice. H-344.

COMBUSTION AND STEAM ENGINEER. Junior member, Cornell graduate, age 28, experienced in fuel and combustion engineering, testing boilers, engines and stokers and also cost distribution and operation, maintenance, construction and supervision of power-plant equipment supplying compressed air, steam, refrigeration and hot water and steam heat. Salary $2000. Location New York. J-345.

EMPLOYMENT MANAGER, at present employed in that capacity, wishes to make a change. Thoroughly competent to hire all classes of help, having had 18 years' practical mechanical experience. Age 37, married. J-346.

FACTORY EXECUTIVE, MASTER MECHANIC OR PLANT SUPERINTENDENT. Age 39. 18 years' experience as production superintendent in the manufacture of engines, condensers, high-vacuum air pumps, centrifugal pumps, etc. General engineering work, both medium and heavy. Has [illegible] extensively in connection with field work on same. [illegible] personality, alert and resourceful [illegible] judgment in all dealings and retaining confidence of organization. J-347.

MECHANICAL ENGINEER. Purdue graduate, age 29, married; experience [illegible] of design, construction, installation, purchasing [illegible] to buildings, machines and department [illegible] employed as supervisor over large drafting room. Salary $2000 to start. J-348.

EQUIPMENT ENGINEER, PRODUCTION MANAGER OR SUPERINTENDENT, with [illegible] knowledge of manufacturing methods and processes [illegible] to apply them to get the maximum production [illegible] men employed. J-349.

MECHANICAL ENGINEER OR ASSISTANT TO EXECUTIVE. [illegible] 25. Two years' experience in the manufacture [illegible]. At present employed. Salary $1800. Location New York City or vicinity. J-350.

ENGINEER OR CHIEF DRAFTSMAN. Technical graduate with 18 [illegible] assistant engineer. [illegible] design of centrifugal and [illegible] conveying machinery, shoe [illegible] making [illegible] power transmission, general factory equipment. [illegible] Salary $2500. Open for engagement Jan. 15. [illegible]

CONSULTING OR ADVISORY ENGINEER. Member with large [illegible] engineering experience on equipment, up[illegible] ways and means and industrial economies [illegible] desires to serve a few reliable manufacturing concerns in [illegible] advisory or designing capacity. J-352.

RAILROAD EQUIPMENT EXPERT. Age 33, college education. Several years' varied experience in designing, construction, estimating, [illegible] shop, office, executive on various types of railroad equipment, including buildings and power plants, foreign and domestic. Speaks foreign languages. Best of references. J-353.

MECHANICAL ENGINEER, EXECUTIVE. Age 31, married. Technical education with two years' commercial experience and six years as designer on steam turbines and power plant. Desires position as works engineer or assistant to executive in manufacturing or engineering firm. Excellent health and habits. J-354.

MECHANICAL ENGINEER. Associate member, age 30. Technical training: three years in civil engineering work, foundation, concrete, steel building and power-house erection; four years' mechanical engineering experience on boilers, engines, special apparatus, hydraulic machinery, shop work, producer-gas engines and generators, industrial plant work; two years in electrical work on a.c. and d.c. generation, transmission and distribution. Good executive. Desires to specialize. J-355.

PLANT ENGINEER OR ASSISTANT TO EXECUTIVE. University graduate, mechanical engineer, not liable for military service under present conscription law. Fourteen years' varied experience in engineering work and design; familiar with modern shop methods and follow-up; thoroughly practical, with executive ability; not afraid of work or responsibility. Desires to communicate with only those who intend to employ a competent assistant for a number of years. J-356.

EXECUTIVE MECHANICAL ENGINEER. Cornell graduate, age 35, married, fourteen years' practical experience in machine-tool use, manufacturing and commercial branches of business; trained in sales engineering and general management. Seeks responsible executive position as general manager or sales manager of progressive machinery manufacturer. J-357.

MECHANICAL ENGINEER with 15 years' experience in designing, estimating and general drafting in excavating machinery, hoisting engines, derricks and miscellaneous machinery, also some experience in machine shop and cast-steel foundry practice, desires a position as chief draftsman or assistant engineer with a concern where there is a good future. Now employed. Middle or Far West preferred. J-358.

ASSISTANT MECHANICAL ENGINEER, ASSISTANT MASTER MECHANIC, ASSISTANT TO MANAGER OR ASSISTANT TO EXPERIMENTAL ENGINEER. Member, born in Norway; age 42, technically educated, married; 21 years' designing and executive experience with large concerns. Has good sound judgment. Anticipates making a change and can go at a week's notice. Location New York or Brooklyn preferred. J-359.

INDUSTRIAL ENGINEER. Junior member, American, age 28, married. Six years' experience in all branches of manufacture of small parts with concern employing 3000 men in time-study work, planning, routing, estimating costs, etc. Experience in detail upon request. At present employed. Good executive ability proved. J-360.

MECHANICAL ENGINEER. Columbia graduate, 1912, with five years' experience in design, construction and inspection work with prominent concerns. Well grounded in machine design, plant layouts, and equipment. Desires position in engineering department, or as assistant to department head. Preference given to opening presenting chance to advance. J-361.

MECHANICAL ENGINEER. Columbia graduate, age 37, married. Fourteen years' service in motive-power department of large western railroad, in testing laboratory, as draftsman, assistant engineer of tests and assistant mechanical engineer. Desires opportunity for advancement and greater responsibility. At present employed. J-362.

TECHNICAL GRADUATE in mechanical engineering desires employment leading to a position in efficiency department. Experience has been mainly with mining machinery and jigs and fixtures. Has had experience in machine shop. J-363.

MECHANICAL ENGINEER. Stevens graduate, age 28, with five years' experience with Diesel engines and auxiliary machinery, desires position with more direct bearing upon the prosecution of the war than present position offers. J-364.

ASSISTANT TO EXECUTIVE. Young technically trained engineering draftsman, exempt from military service, desires a change. Experience covers general steel-mill engineering, construction and machine design. Location Chicago. J-365.

AERONAUTICAL MECHANICAL ENGINEER, age 28, three years' engine experience in aeronautics, also auto-engine experience. At present employed in Buffalo. Desires to enter the production field as production expert or inspector. J-366.

MANUFACTURING EXECUTIVE. Member, age 34, who is a technical graduate and has handled propositions in organization of gas, munitions and artificial silk properties, is now available. Salary $6000-$7200. Location immaterial. J-367.

ENGINEERING SURVEY

A Review of Engineering Progress and Attainment in Mechanical Engineering and Related Fields, Including a Digest of Current Technical Periodicals and a Selected List of Engineering Articles

British Workshops and the War

In a speech delivered in the House of Commons, June 28, 1917, by Christopher Addison, then Minister of Munitions in the British Cabinet, it was stated that the program decided upon by the British Government in 1915, as regarded the production of munitions, required the erection of large additional factories in many lines. As a result of this policy, many products have been manufactured at a price considerably below that which prevailed in the market at the time of the erection of the factories. Thus the present cost of production of one of the basic high explosives, trinitrotoluol, at Queensferry, exclusive of interest and amortization, is 8½d. per lb. When the factory was started the cost in the market was 1s. 9d. per lb.

In connection with the manufacture of explosives and under an arrangement with the Food Production Department, a section of the Explosives Supply Department has been started for the provision of all the artificial fertilizers which are required. The control of the iron and steel industries gives all the basic slag that is wanted, and it is expected that the entire war problem in fertilizers will be met and give more than one million tons of superphosphates, nearly half a million tons of basic slag and a quarter million tons of sulphate of ammonia. Further, through the ingenuity of Mr. Kenneth Chance and his staff, a process has been discovered whereby great quantities of potash may be obtained sufficient to meet the requirements of the optical-glass trade and leave some surplus for the needs of agriculture.

The production of sulphuric acid has also been greatly increased. In particular, that of fuming acid is more than fifteen times greater than it was before the war and costs less to produce.

That the production of gun ammunition and fuses has been increased many times is a well-known fact. It is less well known that a new explosive component has been found and apparently thoroughly tested out.

Many of the filling and shell factories are worked by voluntary boards of management. At present the whole work of filling employs about 100,000 persons, and the cost of filling has been reduced by 40 per cent, as compared with what it was a year ago.

The inspection department has grown tremendously in the last two years, both because of the increasing magnitude of production and because of the greater diversity of the munitions supplied. In July, 1915, the staff of the inspection department consisted of 8761 persons. It now consists of nearly 40,000 persons in the United Kingdom, with an additional staff in the United States of more than 8000. An effort has been made to employ women in every possible way. In March, 1916, they composed 28 per cent of the staff. They now compose 61 per cent, numbering 29,000, and they are employed on almost all operations except those in which special technical experience or physical strength are required.

Notable improvements in design are claimed to have been made. During the Battle of the Somme reports were constantly received that a considerable number of rounds of ammunition either failed to explode or burst prematurely. This has been eliminated to a considerable extent.

As regards the development in gun supply, the demand for guns for anti-aircraft purposes and for the arming of merchant ships has placed a particularly heavy strain upon the country's capacity for producing long-range guns for use in the field. At the same time the output at Enfield has increased tenfold and the weekly capacity for the production of machine guns is more than twenty times greater than it was two years ago. Some months ago the output of small-arms ammunition became so abundant that it was found unnecessary to place any orders outside of the United Kingdom. The arsenal at Woolwich has increased tremendously. In August, 1914, the staff consisted of 10,866 persons. Now it amounts to 73,571. The number of women employed in 1914 was 125. Now it is close to 25,000.

A significant instance of how the war helped allied industries is cited in the case of glass for optical instruments. Before the war England would rely on home sources for only about 10 per cent of the glass used in optical instruments, being dependent mainly on German and Austrian supplies. Since the war, however, difficult formulæ have been worked out, especially by Professor Jackson and his colleagues, and under comprehensive arrangements England not only has adequate supplies for herself, but is able to provide substantial assistance to her allies. In fact, the whole group of industries connected with the glass trade has been placed on a secure foundation.

The great provider of the war industries, the machine-tool department, is the servant of all and has to furnish every variety of machine from the smallest tool, or lathe, to the mightiest crane. The department has a machine-tool clearing house by which idle and insufficiently used machinery is investigated and examined and an attempt made to divert it to better use. During the past seven months (previous to June, 1917), this branch investigated 22,027 applications and succeeded in releasing 42,638 machines roughly valued at more than £3,000,000.

The "tank" made its appearance last autumn. At the close of the year much work was still required to be done in the way of alterations and improvements, but the supplies of new designs are coming forward excellently. The end of the story is not reached and constant improvements are being made.

As regards aeroplanes, it had been found that the mobilization of all resources for the production of internal-combustion engines under a unified scheme of direction was essential. Such a working relation was established. Formerly there were a number of shops which were producing a number of different types of engines. By a continued effort to diminish the number of types and to concentrate on the best, with the policy of maintaining one shop devoted to the production of only a single type of engine, an enormous increase

in production has been obtained apart from the addition either of machinery or labor. The output of aeroplanes is rapidly increasing. The production for May is more than twice that of December and four times greater than that of May 1916. The supply, however, will become much greater still in a few months' time, for the government is working at a vast problem of production and the plans provide for its full realization.

The following statements are made as regards the effect of the submarine campaign on the production of munitions. In overseas supplies alone the Ministry of Munitions is interested in nearly 1,500,000 tons of munitions monthly. Of shell components shipped from North America to supplement home production the total loss since the commencement of the unrestricted submarine campaign, taking the heaviest item of

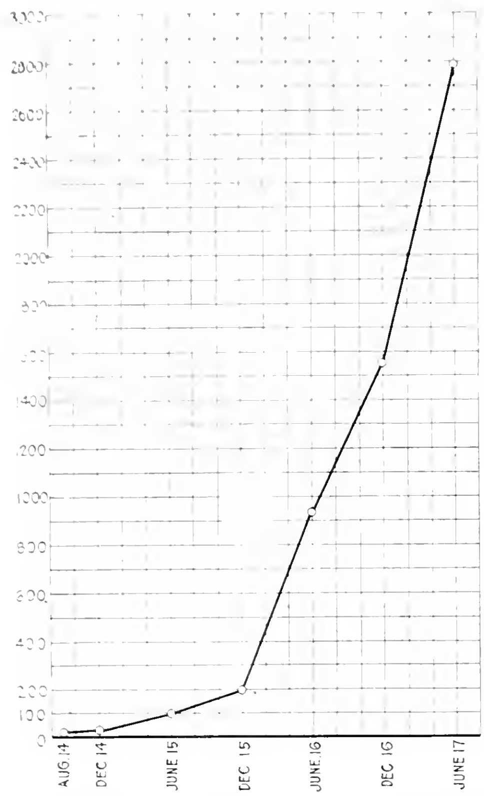


Fig. 1 Increase in Production of British Munitions, by Weight

loss in any single component, is only 5.9 per cent of the amount shipped.

As regards the American and Canadian supplies, it is stated that until recently all purchases were made through J. P. Morgan & Co. Lately, however, Mr. Gordon, the Vice-Chairman of the Imperial Munitions Board of Canada, at the request of the Minister of Munitions, has moved to the United States and has been appointed as the head of all British munitions organizations there and will report to Lord Northcliffe. Negotiations are now (June 1917) proceeding at the suggestion of the United States Government for a further consolidation of interests on both sides.

A vigorous attempt has been made to economize in the use of metals and a part of the program was the institution of scrap collection and distribution. For this purpose an extensive salvage department has been established, which works in coöperation with the armies at the front. The Minister of Munitions proposed to re-form hundreds of thousands of 18-pounder cartridge cases. When it is remembered that the price of a new case is about 7s., that it can be re-formed four times, and that the process of doing it costs 4d. a case, the importance of this branch is obvious. Another committee is charged with the duty of devising ways of economizing in the use of the more expensive metals. In this way a reduction in the amount of copper used in copper bands is secured, amounting to a saving of many thousands of tons of copper in a year, and less expensive metals are now brought into use as constituents of various fuses and other shell compounds.

A large amount of attention is being given to the question of health of munition workers, and principles are being established which will continue to be applied long after the war. More than 600 firms have appointed supervisors whose sole duty is to promote the welfare of their workers, and great benefit has resulted in different directions. Should they be necessary, schemes have been prepared in connection with the feeding of munition workers which have regard to the arduousness of the labor in which they are engaged. Last year the problem arising out of the handling of poisonous explosives (T.N.T. in particular) became somewhat acute, and a special committee was appointed to investigate them and make reports. This resulted in the application of suggestions which have been accompanied by an enormous diminution in the cases of illness. It has been found here, as in many cases before, that the problems of prevention when understood are simpler than those of cure.

The widespread employment of women in munition work has been accomplished with singularly little difficulty. From 60 to 80 per cent of the machine work on shells, fuses and trench-warfare supplies is now being performed by women. They have been trained in aeroplane manufacture, in gun work, and in almost every other branch of ammunition work. Also a large amount of mobile labor, not previously trained, has been utilized. For this purpose training supplementary to that which goes on in the works had to be resorted to. More than sixty technical schools and colleges in Great Britain are used in this work and have trained more than 32,000 workers. There are also five special industrial factories engaged in training. Three other sections of the Ministry of Munitions have been in constant operation to supplement that which is done either by dilution or training. There are 38,000 skilled work people employed away from their homes as war-munition volunteers and also 40,000 soldiers who have been released from the colors and have placed themselves at the disposal of the Ministry.

The Engineering Council has organized a committee known as the War Committee of Technical Societies. This committee is "to act as the intermediary or means of communication, when desired, in matters relating to Science, Research, Invention and Engineering" between the many and varied agencies of the Government and the membership of technical and engineering societies. It is hoped that by this means members of technical societies who as yet have not actively engaged in war work will allow their technical and engineering abilities to be drawn upon.

One of the first activities of the committee was to send to the membership of the technical societies the first bulletin issued by the Naval Consulting Board, under date of July 14, 1917, on The Submarine and Kindred Problems. Each member receiving the bulletin is urged to concentrate his best efforts upon the problem and to transmit any valuable ideas to the Secretary of the Naval Consulting Board.

U. S. BUREAU OF STANDARDS

THE U. S. Bureau of Standards is now doing work of exceptional interest and importance in connection with the war activities of the country. From time to time mention is made in the press of its new great laboratory for testing aircraft engines and of its work for the U. S. Army and Signal Corps. Of course, the greater part of this work is, as it should be, confidential.

But in addition to these special activities, the Bureau of Standards is carrying on many investigations of profound interest to the engineering profession. Thanks to the courtesy of Dr. S. W. Stratton, Director of the Bureau of Standards, and his staff of assistants and investigators, THE JOURNAL is enabled to present to its readers, beginning with the present issue, data on such of the work of the Bureau as is considered suitable for publication.

U. S. BUREAU OF STANDARDS

THE LATENT HEAT OF VAPORIZATION OF AMMONIA, Nathan S. Osborne and Milton S. Van Dusen

The latent heat of vaporization of liquid ammonia has been determined throughout the temperature interval —42 deg. to + 52 deg. cent. by direct measurements, using a calorimeter specially designed for the particular problem. This instrument is of the aneroid or unstirred type, the ammonia being the only liquid in the calorimeter. Heat developed and measured electrically in a coil is transmitted by conduction and convection to the ammonia, and is expended in the evaporation of a determined amount which is withdrawn as superheated vapor. Accessory data from other sources are required only in the computation of small correction terms. The results are expressed by an empirical equation and a table of values given for every degree from —45 deg. cent. to + 55 deg. cent. By combining the data for the heat of vaporization with the data for specific heat of the saturated liquid from a previous investigation, the specific heat of saturated ammonia vapor is obtained and a table of values of this quantity is given in an appendix.

CONSTITUTION OF PORTLAND CEMENT

In order to determine what new constituents are produced in portland cement when the magnesia content is raised considerably above that permitted by present standard specifications, and in order further to determine what effect these new constituents would have upon the physical properties of the material, a number of cements were burned in the rotary kiln of the Bureau. In these the magnesia content varied from 1.7 per cent to 25.5 per cent. In all 18 different cements were produced in two series of nine burnings each. In both series the compositions were those of normal cement, excepting the magnesia content only. But in one case the silica content was somewhat higher and the alumina content somewhat lower than in the other case.

As raw materials, clay, kaolin, feldspar, limestone and dolomite were used. In the one series the cement of lowest magnesia content was made of a raw mix containing limestone, clay and a small amount of feldspar, the latter being added to increase the silica-alumina ratio over that obtainable with clay and limestone alone. The magnesia in the other burns of this series was increased by replacing the limestone with dolomite. In the second series the raw mixes were composed of clay, limestone and a small amount of kaolin, the latter being used to decrease the silica-alumina ratio over that obtainable with the clay alone. In this series also increasing amounts of limestone were replaced with dolomite, until dolomite alone was used.

The deportment of the high-magnesia cements in the kiln was very characteristic. There was a reduction of the clinkering temperature with increasing magnesia content, though to produce satisfactory clinker this was not as marked as expected. But to prevent the dusting of the clinker of the higher-magnesia-content cements, it was necessary to overburn to a very hard vitreous mass. This mass in the kiln was about of the consistency of putty, and as a result there was a decided tendency to form "logs" and "rings." The clinker was also

of a reddish brown color, which gave a decided brownish tinge to the ground cement.

A microscopical examination of the clinker showed that increasing amounts of magnesia produced an increasing size of crystals and granularity. When the magnesia exceeded 8 per cent, a constituent (monticellite) not present in normal cement was noted. When the magnesia was still further increased to an amount exceeding 10 per cent, another constituent—spinel—not present in normal cement, was also noted. It was also noted that those constituents—tricalcium silicate and tricalcium aluminate—which produced quick setting and early strength, were not materially decreased by the appearance of the new constituents; whereas, the orthosilicate of lime which produces the later hardening and modifies the early setting of the other constituents, was decidedly decreased in amount.

The effect of the higher magnesia, when not exceeding 8 per cent, was not very noticeable in any of the physical properties. Higher amounts produced a quick initial set and an apparent slow final set. The strength both in tension and compression of neat and mortar specimens, and of concrete specimens in compression, when 8 per cent was not exceeded, was very comparable with the strengths exhibited by cements of normal magnesia content. Above these amounts the early strengths were less, but show a consistent gain with age.

Specimens are still available for examination and breaking at later periods than those reported in this paper.

Tests of Large Bridge Columns, H. H. Griffith and J. G. Bragg

The investigation gives a comparative analysis of the experimental data found upon eighteen large bridge columns when they were tested in the 10,000,000-lb. testing machine. The action of each column, as a whole, was studied in a range of loadings taken to determine the behavior of lattice bars, pin plates, diaphragms, etc. The causes and effects of initial strain from riveting and fabrication are discussed.

Technologic Paper No. 10 of the Bureau of Standards.

Paints and Varnishes

This publication is intended to give, without unnecessary detail, information which should be of value to those interested in the use of paint and varnish. After a general discussion and classification of paints and varnishes and an explanation of the process of "drying," the raw materials, including oils, driers, thinners, resins, and pigments that enter into the composition of paint or varnish are individually described. The methods of manufacture and of testing varnishes are presented, ready-mixed or prepared paints are discussed, and somewhat detailed instructions on mixing paints and stains, on color blending, and on the application of paint and varnish to various surfaces are given. Specifications in common use for many of the materials treated are included, and a glossary of painters' terms also appears.

Circular No. 69 of the Bureau of Standards.

Materials for the Household

Describes the more common materials used by the household, comprising paint materials, cement, clay products, lime, plasters and stucco, wood, metals, bituminous roofing, inks, and dyes, adhesives, paper, textiles, rubber, leather, cleansers and preservatives, fuels, illuminants and lubricants, and concludes with a chapter on quantity in the purchasing of materials. Each title is treated under the general heads of composition and definition, sources, properties, uses, tests, preservation, hints as to selection and use, and references.

Circular No. 68 of the Bureau of Standards.

Combined Table of Sizes in the Principal Wire Gages

A table combining in one series the sizes in the American (B. & S.), Steel, Birmingham (Stubs'), British Standard, and Metric wire gages, arranges in order of diameters of wires. It gives the diameters of all the gage numbers in these five systems in mils, inches, and millimeters, also the cross-sections in square mils, circular mils, square inches, and square millimeters. The table is specially useful to manufacturers who wish to determine the nearest equivalent in American or British gage sizes of wires specified in millimeters or square millimeters, or vice versa.

Circular No. 67 of the Bureau of Standards.

The Determination of Absolute Viscosity by Short-Tube Viscosimeters, Winslow H. Herschel

The Engler and the Saybolt Universal viscosimeters, which are the instruments usually employed in the oil trade, have such short outlet tubes that the equation for the flow through long capillary tubes is not applicable without correction factors. The literature has been carefully reviewed and further experimental work has been done. The conclusion is reached that water is not a suitable liquid for use in finding the relation between viscosity and time of discharge for short-tube viscosimeters, and that Ubbelohde's equation, and all others based upon it, are seriously in error.

Technologic Paper No. 100 of the Bureau of Standards.

An Investigation of the Axial Aberrations of Lenses

In Scientific Paper No. 311 of the Bureau of Standards, the errors which affect the definition of a lens are discussed, and methods of graphically representing the central errors described. The condition for freedom from coma near the axis is arrived at. The relative importance of the errors in different types of lenses is discussed. Hartman's method is extended, permitting one set of measurements to give all the important central errors—spherical aberration, zonal variation of equivalent focal length, and axial and oblique achromatism. The apparatus and procedure are described, and the accuracy of the adjustments and the measurements discussed. The method is applicable to all systems of relatively short focus and large aperture, such as photographic lenses, projection lenses, and telescope objectives, and also to complete optical systems. The results of the method as applied to a complete telescope are discussed and shown to be independent of the accommodation of the observer. Seventeen sets of curves are given for as many different lenses, and an illustrative discussion of one set of curves, together with a general description of the types of lenses represented by each group of curves.

The Effect of the Size of Grog in Fireclay Bodies

The size of grain has long been known to exert considerable influence upon the properties of mortars, concrete, fireclay

refractories, and other materials. Technologic Paper No. 104 of the Bureau of Standards describes an investigation in which is determined the effect of the size of the calcined portion, or grog, upon the properties of the fireclay bodies within a field of practical sizes. The general plan of procedure consisted of separating grog into a number of sizes, recombining these in arbitrary proportions by calculation from triaxial diagrams, mixing with an equal weight of clay, and molding with water into test pieces for the determination of various properties. Strength in the raw state, as indicated by the modulus of rupture, depended upon a number of factors and did not vary directly with the size of the grog. Proper proportioning of grog sizes gave stronger bodies than single grog sizes. The strength of burned bodies increased directly with decrease of the size of grog, the size being expressed numerically as a surface factor. Bodies containing the larger sizes were more resistant to sudden heating and cooling from 600 deg. cent. and 1000 deg. cent. Volume shrinkage in burning to cone 12 increased approximately with decrease of porosity. No relation was found between strength and porosity in the dry or burned states. Methods are suggested for proper proportioning of grog for glass pots, saggers, and similar bodies.

Wave-Length Measurements in Spectra from 5600 A to 9600 A

Some work in spectroscopic analysis at the Bureau of Standards showed the importance of investigating the red and adjacent infra-red regions of spectra more carefully and extensively. Ordinary photographic plates were stained in a mixture of dicyanin, water, alcohol and ammonia to make them sensitive to the long light waves. These stained plates were used to photograph the arc spectra of twenty of the chemical elements, including the alkali metals, the alkaline earths, and elements commonly found in iron as impurities. The photographs were made in the first-order spectrum with a concave grating of 640 cm. radius, the grating being mounted in parallel light. This spectrograph gives a dispersion of about 10 A per mm. in the first order. With this apparatus exposure times of 30 min. sufficed to record waves longer than 9000 A (A = Angstrom = 0.0000001 mm.) and demonstrated the value of dicyanin as a photographic sensitizer for such spectral investigations. Waves which are 2000 A longer than the longest waves in the visible spectrum were thus detected photographically without difficulty.

Accurate measurements of wave lengths and determinations of the characteristics of the emission lines were obtained from these spectrograms. The second order spectrum of the iron arc was photographed on either side of the first order and the long wave lengths were obtained from the standards in the iron spectrum. In this paper the wave lengths in International Angstroms are given for the arc spectra of the following elements: lithium, sodium, potassium, rubidium, cæsium, copper, calcium, strontium, barium and magnesium.

Frequency differences of doublets in the spectra of sodium, potassium, rubidium, cæsium and copper are shown by these wave-length measurements to be constant in most cases to one part in 100,000 in the number of waves per centimeter.

Comparison of the spectra made it possible to detect many impurities in the elements used for light sources. Still more extensive spectral investigations are required in the region of long wave lengths to identify all lines correctly. (W. F. Meggers, in Scientific Paper No. 309, Bureau of Standards.)

Typical Cases of the Deterioration of Muntz Metal (60-40 Brass) by Selective Corrosion

Brass of the type 60 copper and 40 zinc, which is used commercially in a variety of forms, e.g., wrought bolts, sheathing, condenser tubes, extruded forms, etc., often shows a kind of deterioration by which the metal changes its color to copper-red and becomes very weak and brittle although the shape and size apparently remain unchanged. This change of properties is due to a selective corrosion of the alloy, which has a duplex structure, when exposed to the action of some electrolyte, particularly sea water. This type of corrosion has been recognized by manufacturers and users of brass for some time; the numerous samples illustrating this kind of deterioration which have been submitted to the Bureau of Standards, however, showed the utility of a description of typical cases of such corroded brasses. The study of such types includes bolts, boat sheathing, condenser tubes, and parts which were corroded while under stress.

The examination of the microstructure shows clearly the method of the attack, the zinc-rich constituent being electrolytically "leached out," leaving a skeleton of weak, pulverulent copper in its place so that the piece becomes very weak and brittle. Later the second constituent may be attacked so that the whole specimen is converted into pulverulent "copper," the sample becoming so weak that it can be broken into fragments in the fingers.

Conditions which appear from the examination of corroded samples to accelerate this type of corrosive attack are: The microstructural composition of the alloy, contact with strongly electronegative metals, the effect of certain adhering deposits of basic zinc chloride resulting from the corrosion, the thoroughness of the annealing the sample has previously received, the temperature of the electrolyte, and the stresses to which the specimens are subjected during the corrosive attack. (Technologic Paper No. 103, Bureau of Standards.)

Capital and Labor in England

At the general meeting of shareholders of Messrs. Dorman, Long & Co., held in Middlesbrough, England, on July 31, Mr. A. J. Dorman, dealing with the future relations between Capital and Labor, said that many took a gloomy view of what was likely to happen after the war, but personally he was not one of those. He believed, if they were allowed to manage their own affairs, employer and employed in conference together would arrive at a happy conclusion. To his mind the problem to be solved was to settle the price at which the workmen would give their best labor free from all restrictions. It must be evident to all thinking men that no high wages could be paid except in return for efficiency and increased output. Given that, a settlement would be an easy matter, for the employer did not ask for increased hours and harder work—improved machinery would do the hard work. Under such conditions it is possible to pay higher wages and yet produce at lower cost. British manufacturers could assemble their material at less cost than most nations, and had shipping facilities second to none. They had received little or no encouragement to embark in large commercial undertakings, and their machinery had been allowed to become somewhat antiquated, but a new life was springing up within them, and, if only a fair understanding could be come to between Capital and Labor, he had no doubt that the new industries that had been brought into being would prove to be a source of great prosperity to the country and

enable it to hold its own in the markets of the world. For obvious reasons, there was not likely to be any great alterations in their returns during the continuance of the war, but when peace came it would doubtless bring with it a large demand for shipbuilding and constructional material, for which they would be well prepared.

Sixth Annual Safety Congress

The Sixth Annual Safety Congress of the National Safety Council was held at the Hotel Astor, New York, Sept. 10 to 14. Concurrently with the congress was held an exhibition of safety and sanitation devices at the Grand Central Palace. This exhibition is claimed to be the largest and most complete ever held. The work of the congress was divided into the following groups: Public Safety Division, Public Administrative or Governmental Division, Health Service and Industrial Relations Division, Transportation and Public Service Division, and the Industrial Division. The Transportation Division was subdivided into four sub-sections, viz.: Electric and Street Railways, Marine and Navigation, Public Utilities, and Steam Railroads. The Industrial Division was formed by the following sub-sections: Chemical and Rubber; Logging, Lumbering and Woodworking; Metals and Metallurgy, including Foundries, Iron and Steel Works; Mining and Quarrying; Automobile Manufacturing; Car Builders; Paper and Pulp; and the Textile Trades.

American Chemical Society

The meeting of the American Chemical Society, held in Cambridge and Boston, September 10-13, was, to a large extent, of the nature of a review of the great work done by American chemists since the beginning of the war and of the degree of preparedness for the days of peace, however distant. The meeting was well attended and attracted a considerable amount of attention throughout the country.

Arthur L. Day, Director of the Geophysical Laboratory in Washington, gave an address on the Establishment of Optical Glass Manufacture in America. Up to the time of the war this country was dependent on Germany and France for its optical glass. The details of manufacture could not be obtained by the American Government from the governments of England or France, as the processes were secret and not known to these governments. The problem which was there and then put up to the Geophysical Laboratory was to make a satisfactory glass out of American raw materials and to do it quickly. After careful figuring by the Army and Navy officials it was decided that six was the minimum of different kinds of necessary glasses. In this work the Geophysical Laboratory was assisted by the Bausch & Lomb Co.

The difficulties were many, both in the way of lack of information and securing proper raw materials, but they have all been gradually solved, and it is expected that with the knowledge now available a glass equal to any used in Europe can be made in this country.

William H. Nichols, chairman of the Committee on Chemicals of the Council of National Defense, presented an extensive address on the Work of the Committee on Chemicals. An organization with the view to securing proper chemicals has been taken up by the Washington authorities since the declaration of war. The present organization is, in the opinion of the speaker, temporary. In all, the Chemical Committee with its sub-committees includes some 37 men, practically all of whom are leading men in their respective branches of industry. In general, the manufacturers have responded most cordially to the demands made upon them by the committee, and there are many instances of sacrifices being made for which recognition is not expected and will, probably, not be received. There are exceptions, but every effort is being made to produce satisfactory results without resorting to higher authority.

The one great need of any colossal organization is the complete coördination of all its parts. No one can claim that the organization in Washington has yet reached this stage or even approximated it. Many things are done several times over and many others needed are not done at all.

Dr. M. T. Bogert presented an address on the Work of the Chemistry Committee of the National Research Council, reviewing its activity in the mobilization of research chemists in war work. The most important field of their work is in the production of poisonous gases, gas masks, gas shells, the absorption of hydrogen gas in the submarine battery rooms, and the related U-boat problems.

Among the divisional meetings, one of the most interesting was the conference held by the Industrial Division on the Industrial Chemist in War Time. Dr. L. H. Baekeland, member of the Naval Consulting Board, gave a talk on the Work of the Board. On the whole, there was little encouragement in what he said. The overwhelming majority of the suggested ideas are not worth much, and it has been necessary to issue a pamphlet telling the people what not to do. He said *new* explosives are not what is wanted, but a good supply of those we already know about.

In connection with the meeting a national exposition of chemical industries was held during the week of September 24, an account of which will be given in a later issue of The Journal.

An interesting report on the last meeting of the American Chemical Society will be found in the September 15 issue of *Metallurgical and Chemical Engineering*.

American Association of Port Authorities

Better coördination of terminal facilities back of the docks in American ports bears a close relation not only to reducing the cost of manufacture and the expense of living, but to the economic struggle that is coming after the war. In fact, the elimination of duplicated work and its consequent delays may mean much toward bringing peace in the war now being waged. This preparation for the present fight and the war after the war was emphatically advocated at the convention of American Association of Port Authorities in Cleveland, September 11 to 13.

The enthusiastic reception of this idea showed that the speakers were not alone in placing this interpretation and this emphasis on the resolution calling for increased efficiency of railroad freight terminals connected with ports. The resolution was carried over from last year's convention at Montreal.

The convention was opened Tuesday morning with an address of welcome by E. S. Griffiths, of the Cleveland River and Harbor Commission. This speech was responded to by the president of the association, W. G. Ross, of Montreal. The delegates were entertained at a luncheon reception by the Chamber of Commerce. Officials of the chamber, of the city and of the association made brief talks, and Calvin Tompkins, of New York, former commissioner of docks in that city, was introduced as the principal speaker.

Mr. Tompkins spoke of the way in which the world's shipping is now being administered as a great unit, with an efficiency never before attained. This work shows what can be

done and what probably will be done, at least in a measure, after the war is over.

Papers were read during the day on the following subjects: Establishment of Exact Lines for Port Planning, by Charles W. Staniford, chief engineer of department of docks and ferries, New York City; Administration of New York Canals, by Maurice W. Williams, engineer in charge of mechanical equipment of barge canal terminals; Legal Status of Submerged Land and Littoral Ownership, by Judge Robert M. Morgan, common pleas court, Cleveland. Colonel Lansing H. Beach, United States Engineers, described canal operations in various parts of the country.

How water-borne traffic on the Great Lakes has grown in about half a century from a few small cargoes to one of the greatest tonnages in the world, was interestingly told by Harvey D. Goulder, general counsel of the Lake Carriers' Association. In 1679 the *Griffin,* of about 45 tons, was built just above Niagara Falls. She made one trip and was never heard from again. In the following century a few small vessels appeared. In the forties of the past century a great statesman, in speaking against a land grant for a canal to connect Lake Superior with the lower waters, said one might as well propose to project commerce up into the moon as into the upper lake region. A few years later the state of Michigan made the improvement and the freight movement through the Soo that year was 14,503 tons. In 1916 it was 92 million tons.

The general opening of navigation, Mr. Goulder said, might be fixed as 1855, the date of the opening of the canal. Until after the Civil War the government had spent some \$3,000,000 on lake navigation improvements. Since then it has spent more than \$100,000,000. The great growth of lake freight was accomplished through a gradual growth in size of ships, canals and terminals.

This growth has resulted in cheaper manufactured products not only along the lakes, but in every part of the country, for the cost of carrying grain and ore on the lakes is only about one-tenth the average cost on the railroads.

In the evening an illustrated lecture on the handling of bulk freight on the lakes was given by J. D. Carey, of the Cleveland River and Harbor Commission. He explained with motion pictures how remarkable speed in loading and unloading ships is accomplished through big terminal equipment. By means of grab buckets that pick up in one stroke 15 to 20 tons of ore, a ship of 10,000 tons capacity can be unloaded in 3 hr. 15 min. The same ship can be loaded with ore in 25 min.

The Wednesday session was devoted to the discussion of the resolution adopted at the Montreal convention a year ago, calling on the Interstate Commerce Commission to investigate terminal and port conditions, railroad charges, free wharfage and kindred subjects, and bringing out the need for increased terminal efficiency through pooling and joint use of terminals. This matter had already been taken up with the commission since the previous convention, and is to be considered still further. The investigation probably will be made.

The discussion was opened with a general presentation of the problem of port terminal efficiency in its relation to the economic situation in the Americas and to the preparation for trade expansion when peace comes, by Edward F. McSweeney, of Boston, who first introduced the resolution. Millions of dollars have been spent on docks, he said, but much of it was wasted because there was little vision in planning. Facilities back of the docks were in isolated groups, controlled by separate railroads. Duplication of work and delay and congestion resulted.

In the war after the war—the struggle for foreign trade—the United States must put forth a united effort to win the share of commerce it needs and can supply. The value of this effort will depend largely upon our port arrangements.

The situation in regard to terminal charges and delays was taken up more in detail by Robert Bridges, of Seattle, in a description of that port, where a strong effort is being made to remedy faults. He explained how at several piers it takes 24 hours and costs \$6 to transfer a car from one pier to the next, while with one belt line for the entire port, the same operation could be done in 30 min. for \$2.

Mr. Bridges advocated not only the public ownership or direction of a belt line along the docks and a complete terminal yard, but centralized control of all railroads and the establishment of free ports. Any reduction in the time of handling freight would result in cheaper costs and quicker deliveries, and thus would attract many more factories to the port cities, the natural meeting place of raw materials, Mr. Bridges said.

W. G. Ross, Montreal, was reelected president; William J. Barney, of New York, secretary, and Harry C. Gahn, Cleveland, treasurer.

The next convention will be held in Boston next September.

Wm. J. Nolle.

New England Water Works Association

The Thirty-sixth Annual Convention of the New England Water Works Association was held in Hartford, Conn., September 11 to 15. The choice of Hartford as a place of meeting afforded a splendid opportunity for the study of the extensive new Water Works of that city now nearing completion. An interesting program, including addresses by specialists on problems of water-works design, construction, and management, was carried out.

Hon. Frank A. Hagarty, Mayor of Hartford, extended the greetings of the city, and commented on the extensive provisions for water supply for Hartford. Hon. Charles H. Clark emphasized the economy in water consumptions due to metering of water and made a plea for the treatment of municipal waste before its introduction into public water courses. Hon. Charles E. Goss advocated a dual water supply for cities—one serving domestic and the other industrial needs.

In his presidential address Mr. Caleb M. Saville, Chief Engineer of the Water Department of Hartford, outlined the qualities demanded in water-works executives and emphasized the necessity of broader training in the financial and economic aspect as well as design and construction of water works.

George A. Johnson discussed exhaustively the problems of rapid sand filtration and pointed to the ascendency of the mechanical or rapid sand filter. He called attention to the fact that 74 per cent of the filtered water in this country is supplied by rapid filters. He also pointed out the great diminution in typhoid during the last three decades and ascribed it in large part to water purification.

In the discussion which followed this paper the topics of prevention of tastes in waters treated with sulphate of alumina and the conservation of wash water were discussed by R. S. Hastings, W. C. Hawley, and others.

Robert S. Weston reviewed the development of mechanical filter bottoms and strainer systems and discussed in detail the advantages of the Wheeler strainer, particularly the elimination of metal parts, securing a uniform distribution of wash water and a minimum thickness of gravel. The care and operation of rapid sand filters formed the subject

of a paper by John W. Gatenby, while a paper by F. L. Cady described the slow sand filters in use in Providence, R. I. Delos F. Wilcox described the problems encountered by the city of New York in dealing with the five privately owned companies within its city limits.

Bertram Brewer explained the means employed for reducing water rates in Waltham, Mass.

Papers on water works shop construction were delivered by A. L. Martin and H. W. Hosford. H. R. Turner described the operating problems of a small Water Works Department.

A paper on the control of Microscopic Organisms in Water Supply by William Hame was warmly discussed.

After a general exposition by President Saville of the water system of the city of Hartford, a detailed description of the system was given by the members of the Engineering Staff. Particularly interesting were the descriptions of the construction of the Masonry Dam on Nepaug River, the design of Spillway at Richard's Corner Dam, Grouting of Dam Foundations, and the development and designing by H. W. Griswold, R. E. Wise, J. E. Garrett, W. E. Johnson, Frank Brainard, H. W. Horne, and J. H. Shaughnessy.

In dealing with the subject of Pollution of Streams in Connecticut, J. L. Jackson deplored the failure to restrict the discharge of wastes into streams which might otherwise be excellently adapted for drinking purposes.

S. E. Killam outlined the means by which Boston was enabled to postpone by many years its proposed extension to its water system by reducing its per-capita consumption from 109 to 80 gal. per day, through the installation of service meters.

The papers will be published in full in the Quarterly Journal of the New England Water Works Association.

Gravitation

In the daily papers of September 19 it was stated that a new theory as to gravitation will be announced soon before the St. Louis Academy of Science by Prof. Francis E. Nipher, retired head of the department of physics of Washington University. In a written statement Professor Nipher said:

"It will be shown that gravitational attraction between masses of matter not only has been diminished into zero, but has been converted into a repulsion which is more than twice as great as normal attraction."

Professor Nipher is reported to have made his experiments with bodies suspended horizontally toward each other. By introducing electricity into the atmosphere he converted normal attraction into repulsion.

"If electricity can alter the gravitational attraction of the bodies used in my experiments," he said, "the same force can alter the earth's attraction. If the negative electricity could be drawn from the earth's surface, gravitational attraction suddenly would cease and the coherence of the earth's surface would be disastrously affected."

This Month's Abstracts

A. Leon, in the *Journal of the Society of German Engineers*, discusses the subject of fatigue of machine parts, more particularly the distribution of stresses in machine parts at points where the section of the members concerned becomes wider or narrower.

The variation of temperature in dams of various thicknesses during the period of setting in concrete forms the subject of an investigation by R. A. Monroe. He found that first this variation is different in thin arches from that occurring in thick arches, and second, the temperature of a concrete wall of light thickness (14 in.) follows that of the air with remarkable closeness.

The Bureau of Standards has investigated, with characteristic thoroughness, some unusual structures of wrought iron apparently due to the presence of a high content of phosphorus. One of the remarkable characteristics of the structure investigated is its persistence upon heating, which suggests a possible bearing on the failure of material in which it occurs.

Description of apparatus and processes for testing rails by the quick-bend method as carried out by the Pennsylvania Railroad will be found in the section Engineering Materials. It is stated that this method displaced the drop test formerly used, because the now nearly universal use of open-hearth steel rails has made necessary a method which, in addition to detecting possible brittleness, would also determine the ranges of elasticity and ductility of the steel.

Data on the spark length in various gases and vapors are presented by Robert Wright in a paper in the *Journal of the Chemical Society*. This appears to be the first investigation of this kind of electric ignition carried out under conditions enabling comparable results to be obtained.

Another feature of the design of internal-combustion engines is covered in an interesting manner in an article on bulb experiments in hot-bulb engines published in *The Engineer*. The article discusses the design of the hot bulb and reports experiments with various types of this important auxiliary.

The McEwen high-compression oil engine described in the section Internal Combustion Engineering operates on the Diesel principle. Its interest lies primarily in the fuel valve and method of governing fuel injection, and in the design of a comparatively simple air compressor.

The paper by William Alexander before the Institution of Mechanical Engineers describing the energy diagram for gas mixtures in British units and some of its uses is of considerable interest, and would have been still more valuable had the actual charts been reproduced. As a matter of fact, however, the only chart reproduced is the combined chart of entropy temperature and entropy total heat as found in the abstract in this issue. The writer derives expressions for the various relations affecting the energy derivation in the gas mixture, and in addition gives, by way of illustration of the use of the diagram, some data on the comparison of thermal diagrams for large and small Diesel engines. This part of the paper is of considerable interest in itself, but could not be abstracted here because of lack of space.

Alan E. I. Chorlton's extensive paper on the construction of turbine pumps could be only briefly abstracted. It is particularly interesting because of the careful classification of the various types of turbine pumps under the headings of the various component parts of a pump. It is interesting to note that the writer does not believe that the so-called balanced-type of single-eye wheel of multicellular pumps is actually balanced, and claims that the advantage of being in balance is a purely paper one. Disturbing factors are set up for various influences, and in practice it is necessary to provide additional balancing means of one type or another.

A 120-ton coal car for the Virginian Railway, described in the section Railroad Engineering, is of interest not only because of its huge size, but also because of some features of construction which made the use of such a large unit possible and safe.

REVIEW OF ENGINEERING PERIODICALS

Engineering Materials

Fatigue of Machine Parts. A. Leon

(*Zeits. Vereines Deutsch. Ing.*, vol. 61, pp. 192-196, March 3, and pp. 214-218, March 10, 1917.)

The common assumption that pure tension or compression is distributed uniformly over the whole section, and that the variation of stress is linear in the case of bending, is not justified where the section of the members concerned becomes wider or narrower. There the nature and distribution of stress are complicated, and this is an important factor in machine parts, especially in moving parts of complex form which are subjected to alternating stresses. A notched test bar loaded gradually to the breaking point behaves differently according as the metal is brittle or ductile. In brittle materials the distribution of stress remains uneven until fracture occurs (at lower load than corresponds to the strength of a smooth bar of the material). A ductile material, on the other hand, gives greater strength when notched than when in the plain bar; once the yield point is passed, the extension increases rapidly and the stresses are equalized to an increasing extent. Cross stresses are also set up which reduce the risk of breaking. The author gives curves and formulæ relating to longitudinal and cross stresses, and changes in the corresponding dimensions of a notched rubber rod. A notched rod of ductile material does not contract over the whole breaking section, but only in the immediate neighborhood of the slot bottom. The section after fracture is relatively less contracted than in a smooth rod, hence the greater breaking load. Under repeated, and particularly under alternating, stress, ductile material behaves like brittle material; where the limit of elasticity is exceeded, the material is given a "set" first in one direction, then in the other. As a result it becomes fatigued, small cracks appearing which gradually deepen and extend until failure occurs. Wöhler's tests show the danger of sharp changes in section. St. Venant showed that notching causes local increases in pressure of at least 100 per cent. Failure under alternating load occurs at a point where the stress distribution is affected unfavorably by a hard or soft inclusion, or by complete interruption of the elastic cohesion. Heating of specimens during alternating-stress tests is an indication that the elastic limit is being exceeded, so that inelastic changes in form are occurring and failure will soon take place. In order to tell whether the elastic limit will be exceeded in a constructional part, it is necessary to know the actual distribution of stress. Alternating tensile and compressive stresses up to about 85 per cent of the elastic limit, or 45 per cent of the ultimate tensile strength, do not cause failure of mild steel until the number of load reversals exceeds 1,000,000; the rapidity of reversal of the load also affects the life test. The author mentions Beilby's hypothesis of an amorphous modification of the metal as a possible explanation of fatigue phenomena. Ludwik suggests a loosening of the metallic structure by repeated stressing. Under alternating torsion the change in form is localized more and more until only a single layer of material is "working"; this intensifies local variations in stress and increases the risk of fracture.

Bauschinger's tests on various grades of iron show the ratio of steady tensile strength to initial and to alternating strength to be 1 : 0.56 : 0.49. In other words, the initial strength is only about 14 per cent greater than the alternating strength. The author defines "notch ratio" as the ratio of greatest to smallest width of rod; and the "notch figure" as the ratio of greatest mean stress (referred to the useful section). The reciprocal of the notch figure is the "utilization figure." A circular hole in a plate causes 200 per cent increase in stress at two points on the edge of the hole, i.e., the notch figure is 3, compared with 8/3 for semicircular edge notches. The author cites values for these factors as determined by various investigators, and gives curves for the stress distribution in a perforated rubber rod subjected to tension. Comparison is made between mild steel subjected to small distortion and rubber subjected to great extension. The author gives tables of data from his own tests on rubber rods, and local and average extension. The large deformation in rubber specimens equalizes stress distribution to some extent. For instance, with a notch ratio of 5 the notch figure decreased from 3.15 to 1.98, corresponding to mean extensions of 11 and 37 per cent and maximum local extensions of 36 and 75 per cent. Curves in the original show the distribution of primary and secondary stresses in a perforated stone block subject to compression, and in a rubber specimen with rectangular holes. The secondary (cross) stresses are important. These tests have a bearing on the influence of rivet holes on the strength of parts. Fillets may affect stress distribution unfavorably, and examples in the original show the proportion of various sections which is rendered idle by ribs or fillets. The final section of the paper includes a number of useful notes concerning the effect of various changes in sections, slotting, polished or ground surfaces, and various means of observing these effects and compensating for them. The paper relates rather to the general phenomena and problems of stress distribution than to specific machine parts. (*Science Abstracts,* Section B—Electrical Engineering, vol. 20, part 7, July 30, 1917, no. 235, pp. 225-226, *t*)

How Temperature Varied in Two Dams While Cement Was Setting, R. A. Monroe

In planning the recent 40-ft. height increase of the Lake Spaulding dam of the Pacific Gas and Electric Company in northern California, it was decided to determine how temperatures varied within the concrete. Accordingly, as the work was under way, thermometers in the shape of thermocouples were put in at predetermined locations, so that records could be kept. The same tests were applied to a dam of the multiple-arch type in order that the effect in thin arches might be compared with that observed in a structure of large section.

In the large dam the thermometers were located both at the center and near the surface, while in the thin arches only a central location was used.

The data are presented in the form of tables. From them it is seen that the temperature of the freshly placed concrete was 47 to 48 deg., and in eleven days it rose noticeably across the entire section. At the upstream face the gain was 27 deg.; at the downstream face, 22.5 deg., and at the center 43 deg., or, roughly, twice as much as at the faces. (These data refer to the Spaulding dam.) In two months the temperature of the concrete 1 ft. from the faces of the dam had returned to normal atmospheric temperature, while that of the center of the section was still 20 deg. above normal atmospheric temperature, and falling at the rate of 3 deg. per week. A reading taken over six months from the time of pouring showed the concrete at the center to be 4 deg. above that at the faces, but at practically mean atmospheric temperature for the preceding month.

The results in the case of the thin arch were different. In the design of the arch it was assumed that due to the chemical action of the cement the setting temperature of the concrete in the arch wings would be 10 deg. above the average daily temperatures. Actually, a rise of 17 deg. above the mean was discovered. The results as presented in a table also show that the highest temperature was attained in about 18 hours after pouring, or shortly after the concrete had taken its permanent set, but that this temperature was maintained for only a few hours.

Another interesting thing which was noted was how closely the temperature of a concrete wall of this thickness (14 in.) follows that of the air, and these results indicate clearly that in a structure of this type provision must be made for a temperature variation of approximately the same magnitude as shown by atmospheric records. (*Engineering News-Record*, vol. 79, no. 6, August 9, 1917, pp. 253-254, 3 figs., *e*)

Some Unusual Structures of Wrought Iron, Henry S. Rawdon

Data of an investigation carried out at the U. S. Bureau of Standards in which sections of wrought iron which have failed have been investigated chemically and microscopically, and as a result attention is called to the detection of certain impurities and their possible influence on the physical properties of the metal.

As a rule, in wrought iron no definite orientation of crystals, or grains, is apparent, but the presence of slag in the ferrite matrix is usually revealed by the appearance of streaks.

In some cases, however, the ferrite crystals presented a mottled appearance, particularly after prolonged etching with an acid reagent. This etch pattern was not found over the entire surface of the specimen, but was restricted to certain streaks throughout the metal. Particularly was it found associated with crystals unusually large in size.

By using a copper-chloride etching reagent these patterns may be developed in a striking manner. Crystals of ordinary wrought iron will not exhibit such etch patterns even after very prolonged heating.

The examination of the metal close up to the fracture which occurred during its service shows that the break took place through the crystals and parallel to the markings constituting the mottled etch pattern at that point.

The writer comes to the conclusion that the non-homogeneity of the individual crystals as indicated by the mottled etch pattern is to be attributed to some impurity dissolved in the iron, but not uniformly diffused throughout the crystal.

An examination of several pieces revealed that the unusual microstructure described above is found only in material relatively high in phosphorus, but analysis for phosphorus shows that though such unusual features of structure are invariably associated with irons which are rather high in phosphorus, one cannot predict with certainty their presence from a knowledge of the average phosphorus content alone.

One of the remarkable characteristics of this inter-crystalline structure is its persistence upon heating. After heating a specimen of a wrought iron eyebar for three hours at approximately 600 deg. cent., no appreciable change in structure was found. A second sample heated for about one and a half hours at approximately 725 deg. cent. and furnace-cooled still shows faint traces of the former condition.

The eutectic disappeared, but the non-homogeneity of structure is still apparent from the dendritic pattern. This illustrates the remarkably slow rate of diffusion of phosphorus in the ferrite matrix, and explains why the mottled structure is not wiped out during the processes of heating, rolling and forging constituting the manufacture of wrought iron.

These unusual features of microstructure suggest a possible bearing on the failure of material in which they occur. The brittle character of ferrite containing considerable phosphorus is well known. Crystals which show the heterogeneity caused by high- and low-phosphorus bands in juxtaposition are more apt fatigued by repeated stresses than crystals more uniform in their structure. This applies particularly to bands transverse to the direction of the stresses acting.

Examination of a series of wrought irons showed, however, that such features are not to be regarded as common. Many poor grades of iron may be unsuitable for other reasons. (*The Iron Age*, vol. 100, no. 10, September 6, 1917, pp. 538-540, 7 figs., *t*)

Testing Rails by the Quick-Bend Method

Description of an apparatus recently built by the Pennsylvania Railroad to replace the drop test. The Pennsylvania Railroad introduced the present drop test into its specifications for carbon-steel rails in 1900, at which time the rails were produced by the bessemer process only and brittleness was to be guarded against. Since 1908, however, open-hearth-steel rails have come into general use and at the present time practically all orders for rails on the Pennsylvania Railroad are of this nature.

On the open-hearth rail, however, the drop test gives very little information on the relative merits of rails from different manufacturers. It was therefore thought that a transverse rapid-bending test as an alternative to the standard drop test might give more conclusive information relative to such

physical properties as elasticity, ductility and hardness of the material.

The quick-bend test machine was placed in service about May, 1917. It consists of a hydraulic press and intensifier. The press is of the four-column inverted type, having a clear distance of 3 ft. 4 in. by 12 in. between columns. The main ram, 16 in. in diameter with a 12-in. stroke, is cast solid with the moving platen, which is guided on the four columns. The twin pull-back rams, 6 in. in diameter, are symmetrically located at the sides of the main ram.

The intensifier (Fig. 1) is of the single-pressure type with a total weight of approximately 11,000 lb. The ram which extends from the high-pressure cylinder to the base-pressure cylinder is integral with the base-pressure piston and has a total stroke of 36 in. The diameters of the ram and the base-pressure piston are 9 in. and 26 in. respectively, which gives a step-up ratio of about 8.35 to 1.

The operation of the machine is controlled by a bronze three-way valve having a balanced exhaust. By admitting 450 lb. per sq. in. line pressure to the base cylinder of the intensifier, the pressure in the high-pressure cylinder thereon and consequently in the ram cylinder of the press is raised to approximately 3760 lb. per sq. in., developing a total capacity in the press of about 756,000 lb. The 36-in. stroke of the intensifier ram actuates the entire 12-in. travel of the main ram by intensified pressure alone, thus assuring a smooth, continuous curve of the indicator card.

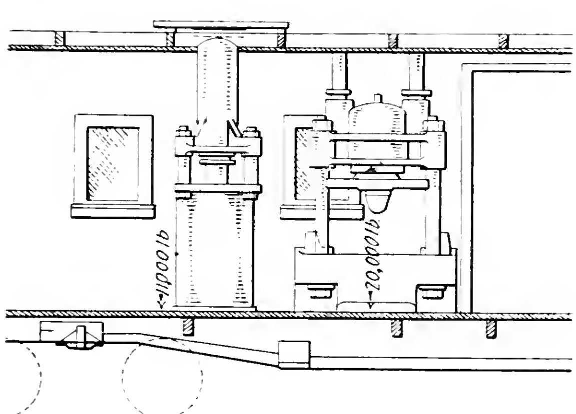


Fig. 1 Pennsylvania Railroad Machine for Testing Rails by Rapid Bending

The hydraulic indicator is used to register the pressure required for a relative deflection of the specimen, the indicator being in direct communication with the main ram chamber.

The rail test specimen is placed on the supports of the press and pressure is applied through the loading head of the ram at the center of the rail until rupture of the specimen occurs. During this action, which requires approximately seven seconds, the indicator card showing increments of deflection and corresponding pressure is taken. In this card the curve is drawn of which the abscissae indicate deflections and the ordinates the loads in thousands of pounds. The elements taken from the card are the deflection and load at the elastic limit and the ultimate strength, while the work required to fracture the specimen may also be obtained.

It has been demonstrated from comparative drop and quick-bend tests that rails which have to meet the drop-test requirements showed undesirable physical properties when subjected to the quick-bend test. The quick-bend test is of particular advantage in the determination of the ranges of elasticity and ductility of the steel. (*Railway Age Gazette*, vol. 63, no. 10, Sept. 7, 1917, pp. 413-415, 3 figs., *d*)

Internal Combustion Engineering

Spark Length in Various Gases and Vapors, Robert Wright

The different factors affecting the phenomenon of electric discharge, in so far as the length and nature of spark, voltage, gas pressure and temperature relations in the spark are affected, have formed the subject of a large number of investigations (compare The Journal for January 1917, p. 86), but the wider chemical relations have been investigated a good deal less.

Natterer, in 1889, published an examination of the spark discharge through a number of gases and vapors at atmospheric pressure. His method of investigation appears to have been, however, quite crude, and the data cannot be relied upon.

As regards the effect of temperature of the gas on the spark, Harris, in 1834, and Cardani, in 1888, both found that the temperature has no effect on the spark, provided that the number of molecules per cubic centimeter of the given gas remains constant. That is to say, if the spark gap be enclosed in a gas-tight vessel, then the voltage required to produce a spark will be quite independent of the temperature: but if the vessel be left open so that the gas can expand at atmospheric pressure, then increase of temperature causes increases of spark length for a given voltage. The effect is exactly the same as if the gas concentration had been reduced by lowering the pressure in the ordinary way, the temperature remaining constant. In the present investigation a 20-mm. gap at 100 deg. cent. was found to correspond with 15 mm. at 18 deg. cent. and 20 mm. at 183 deg. cent. with 5 mm. at 18 deg. cent.

TABLE 1 RELATIVE SPARK LENGTHS IN MILLIMETERS

Substance	Air gap 30 mm.	Air gap 20 mm.	Temperature, deg. cent.
Methane	29	20	100
Methyl chloride	24	16	100
Methylene chloride	9	6	100
Chloroform	5	3.5	100
Carbon tetrachloride	1.5	1	100
Methyl bromide	12	9	100
Methyl iodide	8.5	5.5	100
Ethane	24	18	100
Ethyl chloride	21	16	100
Ethyl bromide	9	6.5	100
Ethyl iodide	6.5	4.5	100
Ethylene	35	27	100
Acetylene	32	26	100
Water	40	36	138
Methyl alcohol	30	26	138
Ethyl alcohol	23	19	138
*iso*Propyl alcohol	18	15	138
*iso*Butyl alcohol	16	13	138
Ethyl formate	14		138
Ethyl acetate	11	..	138
Ethyl propionate	8	..	138
Carbon dioxide	16	11	100
Sulphur dioxide	10	6	100
Carbon disulphide	8	5	100
Hydrogen sulphide	17	12	100

In the present investigation the vapors of a number of simple organic substances were sparked under conditions enabling comparable results to be obtained. Among other things, a fairly constant voltage was arranged for by having an air gap of similar form and definite length coupled in parallel with the vapor gap, both gaps being at the same temperature. In each measurement the length of the vapor gap was adjusted so that on carefully raising the potential it sparked equally with the standard air gap. Thus the measurements may be taken as representing the insulating powers of the various substances relative to that of air at the same temperature and pressure.

It is interesting to note that for various reasons, fully explained in the original article, it was found advisable to abandon measurements made by comparing vapors at their boiling points with air at the same temperature. It was also found that, whether the air gap is heated or not, it is of the first importance that all vapors with which comparative measurements are being made should be at the same temperature.

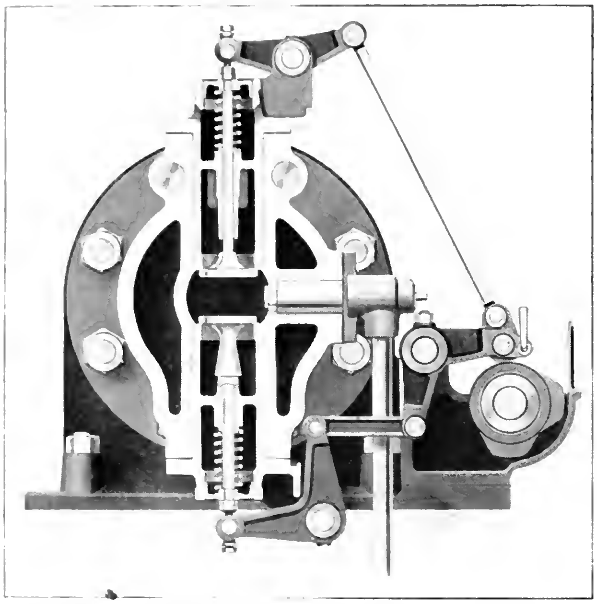


Fig. 2 Suction Through Valve Chamber of McEwen High-Compression Oil Engine

The apparatus used is described in detail. The results given in Table 1 have been obtained, but no claim for great accuracy is put forward, even though each figure is the mean of several readings which never varied among each other by less than 10 per cent. Still, for any series of comparable substances, increase of molecular weight is accompanied by increase of insulating power, but the method is not sufficiently accurate to determine whether the property is a purely additive one or not. In fact, it appears that the curves connecting the potential and length of spark for different gases may intersect one another, and this result was actually obtained in the case of carbon dioxide and air.

An attempt to measure the spark length for several of the substances in the liquid state proved to be a failure. However, we can scarcely expect that any simple agreement could exist in the case of liquids, for, first, the extra factor of surface tension has been introduced, and, second, the relationship between number of molecules and volume which holds for gases no longer exists here. (*Journal of the Chemical Society*, vols. 111 & 112, no. 657, July 1917, pp. 643-649, 2 figs., *e*)

McEwen High-Compression Oil Engine

The McEwen engine is of the four-cycle high-compression type which operates on the Diesel principle and is adapted to burn any kind of heavy crude oil or residue.

As shown in Fig. 2, the inlet and exhaust valves are vertical and the fuel-injection nozzle in the center of the head. The operating camshaft driven by a gear on the crankshaft is supported independently of the cylinder, so that the cam thrust is taken up directly by the engine foundation, thus relieving the frame of stresses from this source. To take off the cylinder head it is necessary only to disconnect the exhaust pipe and fuel line, knock out the pins on the valve levers and remove the nuts from the head bolts.

The piston is in one piece of the truck type and is air-

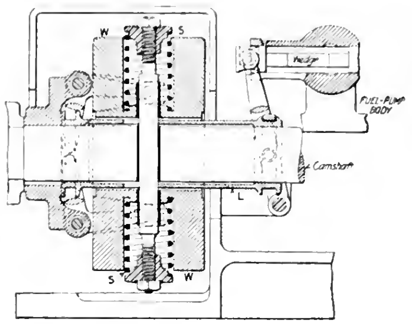


Fig. 3 Governor and Parts of Fuel Valve of the McEwen Engine

cooled. The length of the rod, and thus the compression, may be altered by inserting distance pieces between the rod and the boxes.

In the fuel pump no stuffing box is used, the plunger being

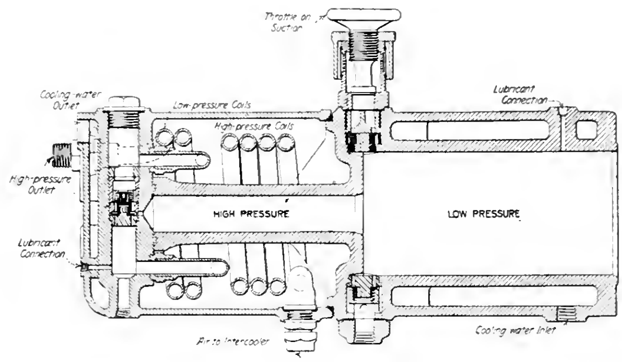


Fig. 4 Air Compressor of the McEwen Engine

case-hardened and ground. This plunger is operated against a spring and the return stroke is controlled by a wedge which is actuated by the governor, Fig. 3.

This governor consists merely of the weights W held by spring S and connected by bell cranks to the sliding sleeve L, which in turn connects with the wedge. As the speed increases the weights fly out, causing the bell cranks to slide the sleeve to the right and shove the wedge in farther. This shortens the return stroke of the pump, decreases the suction, and feeds less fuel to the spray nozzle.

A two-stage air compressor self-contained in a single barrel is driven by a small crank on the end of the main shaft. As shown in Fig. 4, the first- and second-stage cooling coils are

integral with the combined high-pressure head and water jacket.

The high-pressure air goes to the fuel spray line which is provided with a seamless steel-tube receiver to prevent any fluctuation in pressure. The pressure and output of the compressor is controlled by a throttle on the suction line of the low-pressure end, and when it is desired to charge the starting tank this throttle is opened and the charging air taken off between the high- and low-pressure stages. The air starting valve is in the side of the cylinder head (see Fig. 2).

The cooling water first comes to the compressor, then is passed to the engine cylinder jacket and finally to the cylinder head. Neither the piston nor the exhaust valve is cooled. Based on 50 deg. fahr. entering temperature and 140 deg. fahr. exit temperature, the builders estimated a water consumption of approximately 3.5 gal. per hp.-hr. In rating the engine a conservative mean-effective pressure of about 68 lb. is figured on, allowing for 10 per cent overload for two hours. (It is stated that the engine actually carried for a short period as much as 25 per cent overload.) (*Power*, vol. 46, no. 10, September 4, 1917, pp. 321-323, 7 figs. *d.*)

Some Bulb Experiments in Hot-Bulb Engines

With the hot-bulb engine it is always a matter of considerable difficulty to get absolutely complete combustion of the fuel oil. In all engines that inject the oil direct into the cylinder with a pump the oil enters as a jet, and as it is in a more or less solid form, it is extremely difficult to obtain smokeless combustion, owing principally to imperfect pulverization causing the particles of oil to be too large to burn completely during the short period the oil is in the cylinder. Further, if the nozzle is of an imperfect form there is also a danger of the oil carrying over too far and depositing on the sides of the combustion chamber.

With air injection it is possible to obtain greater turbulence and mixing in the combustion space, with the result that cleaner combustion is obtained.

The author [not named] carried out a series of experiments to determine the best form of bulb. Both air- and solid-injection systems were tried, and, while no absolutely uniform conclusions can be drawn from the experiments, forms of bulbs were determined that for certain classes of heavy oils are claimed to be smokeless.

It was also found that when new sizes of engines were built embodying the best results, some of them did not come up to expectations, while others exceeded the best that had been obtained, thus illustrating once more the statement that each size of each type of oil engine is a law unto itself.

Fig. 5 (of which only the top part is reproduced) shows a section of an ordinary crankcase compression two-cycle hot-bulb motor. The cylinder cover was water-cooled and the injection valve was placed horizontally in it, so that it was necessary to deflect the jet up into the bulb by drilling the nozzle hole at an angle.

For the air-injection type the form of bulb shown in Fig. 5 was found to be the best and most durable, and practically all classes of fuel could be smokelessly consumed. In addition, it was possible when the correct compression was found (about 140 to 150 lb. per sq. in.) to run at full speed without the aid of a water-drip to regulate the temperature of the bulb.

The water-cooled cylinder cover possesses an advantage that is very convenient should the supply of water give out. As the air is compressed into the bulb through a water-cooled throat, the temperature of the bulb can be kept within all practical limits, by regulating the temperature of the water around the throat.

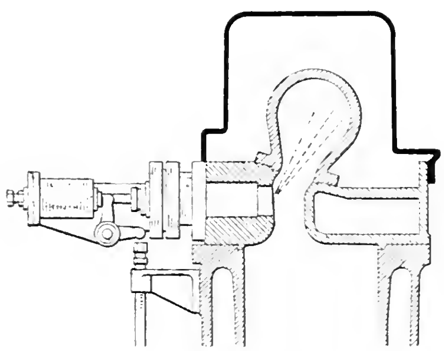


Fig. 5

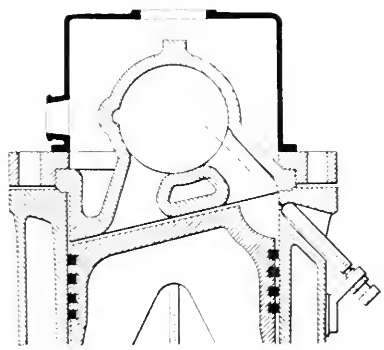


Fig. 6

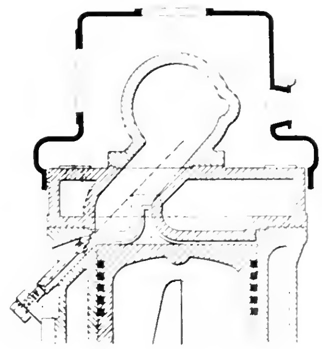


Fig. 7

Figs. 5 to 7 Various Types of Hot-Bulbs Tried Out with Solid and Air Injections

In all designs of hot-bulb motors with water-cooled cylinder covers the bulbs are very small as compared to those (see Fig. 6) in which the bulb and cover are made as one uncooled casting. Bulbs are therefore very cheap to replace, and as the air in the cylinder is kept cooler by the cover, it is denser, and consequently a higher mean pressure can be supported and a more powerful engine obtained, which was proved by the experiments.

As regards the comparative merits of solid and air systems of injection, the writer states that it is safe to estimate an increase of 15 per cent in the power of air-injection over solid-injection engines, which compensates for the complications added by the compressor. On the other hand, it requires a more intelligent driver to operate the engine, and this type should only be installed when good attention can be given. It is also better adapted for the larger sizes of engines and it is the writer's opinion that it should not be fitted to engines giving less than 40 to 50 b.hp. per cylinder.

Practically speaking, any of the six forms of bulb illustrated in the article can be used for air injection with smokeless combustion, and further, it was found that the testing expenses and time required for tuning up was less for a new size of engine of this type than for a new size of the solid-injection type.

For the latter the form of bulb shown in Fig. 6 was tried, but even though it was used with success on a well-known

make of engine, it was found to be rather smoky. Further, the fact that a certain proportion of the air in the passage leading into the bulb furthest away from the jet cannot be directly attacked by the oil jet would, no doubt, tend to keep down the main pressure.

The type shown by Fig. 7 easily gave the best results despite possibly some serious drawbacks. With paraffin, shale oil and gas oil the exhaust was perfectly clean, full power was obtained without assistance of the water-drip, and no overheating of the bulb took place. With the water-drip an increase of 25 per cent in the power was easily maintained for long periods and without the expenditure of any additional fuel oil. The writer believes that this type of bulb keeps cool without the water drip, because the whole of the flange of the bulb is in contact with the water-cooled cover.

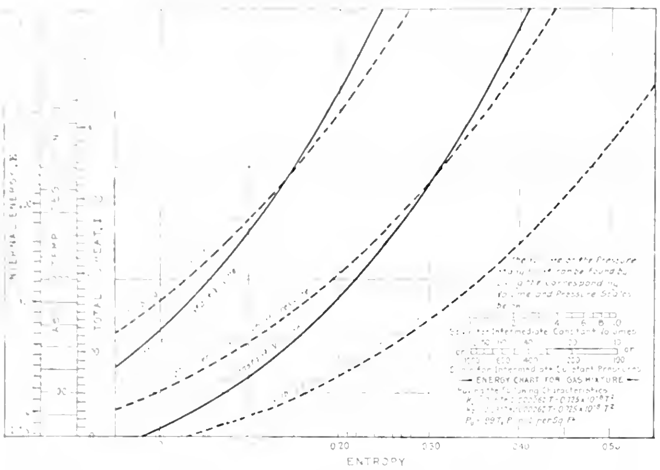


Fig. 8 Combined Chart of Entropy Temperature (ϕT) and Entropy-Total Heat (ϕI)

Should the bulb tend to keep too cool, its temperature can be nicely adjusted by relieving some of the flange, so as to reduce the surface in contact with the water cooling of the cover. The bulb proved to be very durable.

Two modifications of Fig. 7 were tried: one in which the nozzle was placed in the cylinder cover and much nearer to the bulb than in Fig. 7, and another with the bulb having one of the walls practically a prolongation of the throat to the cylinder. Both proved to be failures. Next, the nozzle was put directly in the bulb with no better success. The difference in the design of these types of bulbs is quite slight and is a good illustration of how small the margin is between success and failure in the design of hot-bulb engines. (*The Engineer*, vol. 124, no. 3215, Aug. 10, 1917, pp. 112-113, 6 figs., *d*A)

An Energy Diagram for Gas Mixtures and Some of Its Uses, William Alexander

Charts have been published for the average gas mixture in metric units, namely, by Prof. A. Stodola, but these charts can not be used with British units of pressure and volume. In view of these facts the writer prepared a chart expressed in British units and represented in it all of the six state characteristics of gaseous substances.

In the derivation of the chart and expression of equations on which it is based, the following notation has been used:

P = pressure in lb. per square foot, or

p = pressure in lb. per square inch

v = volume in cubic feet per lb.

T = absolute temperature (centigrade)

ϕ = entropy

E = internal energy

I = total heat, defined by $I = E + \dfrac{Pv}{J} = E + A\,Pv$, where

$J = \dfrac{1}{A}$ = Joule's equivalent = 1,400 ft-lb. per pound-degree centigrade.

The writer derives expressions for the various relations, of which the following are cited here.

Relation between the Entropy and Temperature for the Constant-Volume and the Constant-Pressure Lines. For any constant-volume line, the difference between the entropies at any two temperatures T_2 and T_1, is

$$\phi_2 - \phi_1 = b \log_e \frac{T_2}{T_1} + s(T_2 - T_1) - \frac{u}{2}(T_2^2 - T_1^2)$$

and for constant-pressure lines

$$\phi_2 - \phi_1 = a \log_e \frac{T_2}{T_1} + s(T_2 - T_1) - \frac{u}{2}(T_2^2 - T_1^2)$$

Also, at any given temperature the difference of entropies for the constant-volume lines v_1 and v_2 is

$$\phi_2 - \phi_1 = R \log_e \frac{v_2}{v_1}$$

and for constant-pressure lines P_1 and P_2 is

$$\phi_2 - \phi_1 = -R \log_e \frac{P_2}{P_1}$$

also

$$\phi - \phi(p = 14.7) = 0.0707 (\log_e p + \log_e 14.7)$$

where p is now in lb. per square inch.

On the chart entropy is set off horizontally on an even scale, and an even scale of temperature and uneven scales of total heat and internal energy are set off vertically.

The author discusses in some detail the advantage of representing the six functions of state as a means of simplifying the expressions.

But, besides simplifying the calculation in finding the efficiency of ideal diagrams, the energy chart affords a convenient means of ascertaining, to some extent, the kind of thermal action that goes on in the cylinders of actual gas engines and enables one to obtain a fairly close idea of actual efficiencies.

The writer also shows how the mean pressure can be determined from or checked by means of a practical thermal diagram, which latter gives at once the temperatures at most points of the cycle. In particular, the writer carries through a comparison between a small and large Diesel engine, and finds through a consideration of the compression lines that the larger cylinder and piston are hotter than the smaller. The hot cylinder may account for earlier and better combustion in the larger engine, as the expansion lines on the right (Fig. 9) would indicate. The average temperature of the cylinder and piston surface in the larger engine is seen from the figure to be approximately 750 deg. cent. absolute at the point H, which temperature is near the limit for the best lubricating oils. This indicates the reason for the well-known particular difficulty experienced in keeping cool the piston and internal surface of the cylinder of large Diesel engines.

The nature of the combustion is also well illustrated in Fig. 9. In the larger Diesel engine combustion is nearly complete at 0.4, equivalent to 0.36 of the stroke, and in the small Diesel combustion is almost complete at 0.7 equivalent, to 0.46 of the stroke. The thermal diagram should therefore be of consider-

able service in tuning up engines to give their best indicated results. (*The Journal of the Institution of Mechanical Engineers*, no. 5, July 1917, pp. 333-349, 8 figs., *tA*)

Measuring Apparatus

Theory of the Flexible-Tube Manometer, H. Lorenz

(*Phys. Zeits.*, vol. 18, pp. 117-121, March 15, 1917)

For measuring the pressure of liquids or elastic fluids in industrial processes, the Bourdon flexible-tube manometer plays an important part. The active component of this instrument is a thin-walled metallic tube of oval, i.e., elliptical, cross-section, which is bent into circular shape, the ring, however, not being closed but including an angle of 270 deg. Both ends are closed by soldered covers, and near the fixed extremity the tube carries a support for attachment to the vessel under examination. Pressure causes deformation of the tube, which deformation is communicated to a calibrated recorder fixed to the movable end.

The present paper deals with the theory of this instrument, and first investigates a closed-ring tube possessing a known internal pressure. A previous paper [see Abs. 1335 (1912)] on the bending of curved tubes should be consulted. The distortion produced is found to be directly proportional to the pressure in the flexible tube—a fact which supersedes the previous theory of dependence upon the strength of the tube. Discrepancies between theory and experiment are ascribed to the incomplete elliptical shape of the meridian curve or to the loss of double symmetry of distortion. (*Science Abstracts*, Section A—Physics, vol. 20, part 7, July 30, 1917, no. 235, p. 258, *et*)

Mechanics

Column Tests and Formulæ, Robert S. Foulds

In the *Engineering News-Record* of June 28, 1917, was given a description of column tests made at the Bureau of Standards. The present article is partly of the nature of comments.

The writer expresses the belief that on account of the erratic tests it is idle to expect plotted results of any particular series of one cross-section to give a smooth curve for a column formula. Further, with erratic results eliminated, different sections with ends squared, as in the Bureau of Standards tests, would probably have varying degrees of end fixity, and this would give curves of different slopes.

The general trend of these tests, as a whole, is seen to follow the direction of the formula 36,000-0.386 $(l/r)^2$, tangent to the Euler curve $\frac{28E}{(l/r)^2}$ at $l/r = 216$. Perfect fixity of the ends is not to be expected—that is, a curve tangent to $4\,\frac{\pi^2 E}{(l/r)^2}$. In column tests with pin ends, one would expect a general slope such as is expressed by a curve tangent to $16\frac{E}{(l/r)^2}$, which end conditions it is believed approximate the end conditions in structures. Had the length l between points of inflection in these tests been measured and the results plotted, they would probably have had the general slope of a curve tangent to $\frac{\pi E}{(l/r)^2}$

The writer believes that too few tests have been made to establish any formula, and besides no one formula for a steel of particular chemical combination would exactly express the facts for various sections and for thin and thick material.

He further believes that had the elastic limits been given, it would have probably been found that the ratio of the elastic limit of the columns tested to their ultimate is roughly equal to the ratio of the elastic limit of full-sized tension members to their ultimate.

As regards working stresses, he claims that a curved-line formula is more rational than a straight-line formula, and believes that in time engineers will adopt a curved-line formula something like the J. B. Johnson parabolic formula, or

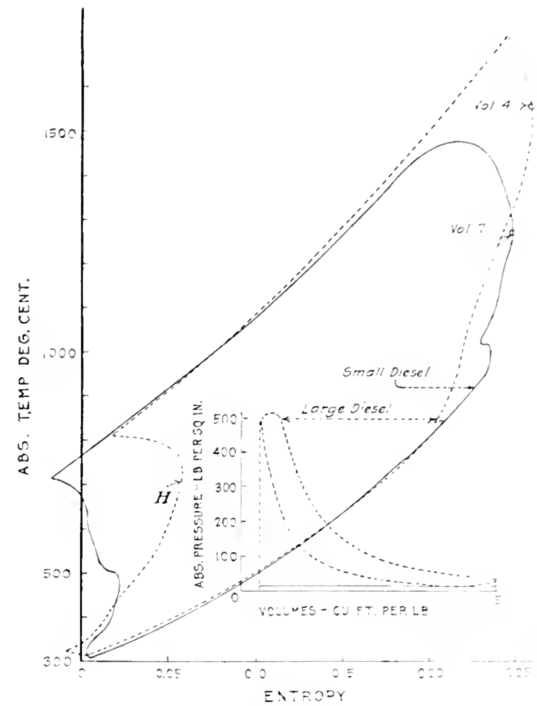


Fig. 9 Comparison of Thermal Diagrams for Large and Small Diesel Engines

36,000—0.7 $(l/r)^2$. (*Engineering News-Record*, vol. 79, no. 6, August 9, 1917, pp. 260-261, *e*)

Standardizing Symbols for Screw-Thread Notation and Formulæ

The Bureau of Standards is considering the symbols given below for use in its work on the standardization of screw-thread gages. In proposing the particular letters given, several points have been in mind, such as the use of symbols which can be found on the ordinary typewriter, and the consistent use of large and small letters.

An attempt has been made to use the large and small letters in a systematic manner which will give the best results. In computations and development formulæ, it is generally most convenient to use the diameter. It has, therefore, seemed desirable to provide symbols for both diameters and radii, and this has been done by using the large letters for the diameters and the corresponding small letters for the radii.

With a few exceptions, the capital letter has been used to indicate the largest quantities and the small, or lower-case, letter the corresponding smaller quantities. This has not been done in the case of the letter "N," as it was thought best to have the upper-case "N" a reciprocal of the upper-case "T," and similarly with the lower-case "n" and "t." The

Bureau will be very glad of constructive criticisms and suggestions from those who are experienced and interested in the subject. The symbols follow:

SYMBOLS FOR SCREW THREAD FORMULÆ

Full, or outside diameter	D
(Corresponding radius)	d
Pitch or effective diameter	E
(Corresponding radius)	e
Core diameter	K
(Corresponding radius)	k
Angle of the thread	A
(For half the angle)	a
Number of turns per inch	N
Number of threads per inch	n
Lead	P = 1/N
Thread interval	p = 1/n
Helix angle	s
Tangent of the helix angle	S
Width of flat at top and bottom	F
Distance from the flat to point that would be formed if sharp V-thread were used	f
Depth or height of sharp V	H
Depth or height of thread	h

REGARDING WIRE MEASUREMENTS

Measurement over wires	M
Diameter of wire	G
(Corresponding radius)	g
Radius of curvature (Whitworth crest and root)	c

(*American Machinist*, vol. 47, no. 8, August 23, 1917, p. 326, *g*)

Pumps

Notes on the Construction of Turbine Pumps, Alan E. L. Chorlton, Mem. Am. Soc.M.E.

Description and discussion of the main elements of construction of turbine pumps. The writer considers the subject under the headings of the various component parts of a pump. These are:

The *stator*, which consists of the casing, or housing, and of the guide vanes, or appliances, for converting velocity energy into pressure energy.

The *impeller*.

The *balancing appliances*, hydraulic or mechanical.

The *rotor* considered as a whole, and including the spindle, with its protecting sleeves, impellers, and, in most cases, the balancing appliances.

The *bed* and other details, bearings, stuffing boxes, etc.

There are two main types of casings: the Osborne-Reynolds, or divided type, sometimes called the ring type, and the Sulzer integral, or one-piece type, sometimes called the cylindrical type. Recent American practice provides a variation of this type with the housing in halves, divided on the horizontal central line.

As regards the guide vane, the writer classifies the various assemblies, or passages, into three groups:

a tangential and radial with return radial
b tangential and spiral
c combinations.

Speaking generally, combination designs are not so efficient as the simple types, owing, probably, to the hydraulic loss through changing the radial direction of the water at high speed.

As regards the finish of guide-passage surfaces, the writer states that for best efficiency, the throat of the passage, at least, if not the entire passage, should be of gun metal or bronze, as iron does not preserve a sufficiently good surface for high-velocity conditions. For best results, a bronze blade should be provided with boxed-in passage, the blade being attached to the guide-vane casting or doweled to the casing.

Impellers are either single-entrant or double-entrant.

Multicellular pumps use a single-eye wheel in three forms: *a*, unbalanced, and equal side areas, one rubbing shoulder; *b*, unbalanced, equal side areas, two rubbing shoulders; and *c*, balanced on paper. Type *c* has the paper advantage of being in balance. Actually it is a poor approximation to a balance. Disturbing factors are set up by differences in side pressure on the impeller due to differences in volume and surface form of the water contained on the two sides of the impeller; by differences of quantitative leakage through the two shoulders, and by high-pressure leakage into one side of the impeller from the stage above and leakage from the other side of the impeller to next low-pressure stage below. Therefore, in practice it is necessary to provide an additional end-balancing device of the hydraulic type, or a mechanically positioning fitting, such as a thrust collar or ball bearing.

The writer discusses in detail the question of how the internal design of all impellers is governed by the two controlling features: the entrance, or inlet angle of vane, and the delivery, or exit angle of the vane.

The balancing appliances are discussed in detail.

As regards the rotor, the question of support is discussed in an interesting manner. The ideal condition is that of a rotor supported in lubricated bearings on a shaft of such sufficient stiffness between supports that the deflection under all possible running conditions is less than the clearance allowed at the neck rings and intermediate bushes, so that no contact takes place between the rotating and the fixed members, this clearance at the neck rings and intermediate bushes being kept down to the smallest possible limits. It is practically impossible to present mathematically the exact conditions with such a number of incalculable factors to take into account.

The supporting effect of the bushes on the shaft in passing through the diaphragm intermediate between the impellers is very difficult to allow for exactly. Intermediate bushes can only, in some cases, be considered as water-lubricated supports, which will act as such so long as a certain low surface pressure on them is not exceeded; but if too great pressure comes on, heating takes place on account of the high-speed of rotation. The author believes that too much use is made of these intermediate supports in turbine-pump design. It is found in practice that an internal bearing to be successful must have the same water pressure at both ends and must be properly lubricated with good grease, and then it gives excellent results. It is, after all, a fact, therefore, that designers are practically dependent on the shaft itself for the necessary strength and stiffness to allow of vane internal clearance, which makes apparent the great importance of a good design which will economically give the minimum deflection of the spindle.

The forms of neck-ring are classified and discussed under the following heads:

a Internal
b External
c Vertical
d Labyrinth

The factors affecting the deflection of a turbine-pump spindle are:

Static
- (*a*) The weight of spindle and distribution of diameter change
- (*b*) The weight and distribution of impellers, balancer, and parts
- (*c*) The number and span of supporting bearings; and

Dynamic
- (*d*) The dynamic condition, other incalculable forces entering into the account, such as centrifugal forces due to the out-of-balance masses, and finally certain hydraulic disturbances.

(*a*) Should be as light as possible consistent with the necessary stiffness, and in common practice spindles are practically parallel the whole length.

(*b*) Impellers and balancer should be grouped together as closely as possible, only allowing sufficient space for the water passages between the stages; also, the entire weight should be brought as close to the supporting bearings as possible.

(*c*) The span of supporting bearings plays such an extremely important part in the durability of the pump; in the possibility and preservation of fine clearances; in the whirling of the shaft and in the determination of the most economical size of spindle, that special notice will be taken of it.

(*d*) A loaded shaft supported horizontally between two bearings will "sag," and when rotated must suffer bending at every revolution. Also, there are bound to be certain out-of-balance masses in the rotor due to keys, heterogeneous composition of material, the unavoidable variation of thickness of castings, etc. In addition, a shaft has vibrational periods due to its length and diameter, the whole question of vibration being intensely complicated by the loading and supports. (*Journal of the Institution of Mechanical Engineers*, No. 5, July 1917, pp. 361-432, 42 fig., *cdA*)

Railroad Engineering

Beach Oil-Electric Car for the Nashville, Chattanooga & St. Louis Railway

Description of an oil-electric car designed to supplant steam-locomotive passenger service in branch-line territory where the slight density of traffic makes such a type preferable. This car is provided with motor-driven trucks, current for which is secured from an oil-engine-driven generator mounted in the forward end of the car. It is stated to be the most powerful self-propelled unit of its kind thus far constructed and is expected to operate at from one-third to one-fifth of the expense required to maintain a corresponding service by steam, in addition to its eliminating smoke, etc.

The power plant consists of a four-cycle eight-cylinder 150-hp. engine direct-connected to a 100-kw. differential-compound-wound 250-volt direct-current generator, running at a constant speed of 1,000 r.p.m.

The engine burns a fixed gas derived from a gas generator which operates on kerosene oil. The gas is supplied directly from the generator into the engine cylinders in the proportion of one part of gas to six parts of air.

The car weighs 113,000 lb. completely equipped, accelerates at a rate of 0.8 miles per hr. per sec. and has a speed of 45 miles per hr. It requires 140 hp. to operate this car at 45 miles per hr. and 340 hp. to accelerate at the above-mentioned rate. As the engine generates 150 hp. and the car when running at 45 miles per hr. consumes only 140 hp., the additional power developed is automatically used to charge the battery.

The car is heated by means of hot water from the engine, which is by-passed when not wanted. The double trucks on which the car is mounted are of the equalized high-speed type with 7 ft. 3-in. wheel base, 33-in. M.C.B. rolled-steel wheels and 5 x 9-in. M.C.B. journals.

The following is believed to be a fair average cost per mile (the cost generally varies with the service required): Wages, \$0.0745; fuel and lubrication, \$0.04; repairs and supplies, \$0.035; depreciation, \$0.0385; total cost, \$0.188. (*Railway Review*, vol. 61, no. 9, September 1, 1917, pp. 259-260, 3 figs., *d*)

A 120-Ton Coal Car for the Virginian Railway. B. W. Kadel

Description of one of four experimental cars built for the Virginian Railway without drop doors to unload in the car dumper.

The car is built for use in bituminous-coal-carrying service and has certain features of construction which make it of particular interest.

The car body is of plate-and-angle construction, with Carnegie cross-tie sections for side stakes and end-plate stiffeners. The principle of design is that the weight of the lading be actually transferred to the sides of the car, the integrity of the center sill as a draft member being maintained. The center sill extends not quite to the bolster at either end of the car. The buffing forces are delivered to the center sill, not through the rivets, but as direct loads upon the ends of the sills, and the center plates are integral parts of the steel castings forming a portion of the radial draft gear.

To prevent the center sill from receiving bending stresses of any moment from the lading, three plate-girder diaphragms are provided to carry the load out to the side plate girders. These have the compression members passing continuously over the center sill, and the bottom, or tension, member passing under the sill.

The sides of the car are carried by the body bolsters, which are of novel construction. They are integral steel castings located above the floor of the car within the coal space, and are shaped not only to give an economic and advantageous disposition of the metal for the various conditions of load application, but, at the same time, to offer no obstruction to the coal in dumper. Wing plates extend upward from the outer ends of the bolsters to stay the sides of the car.

Because of the great weight of the car, it has been found necessary to provide definite jacking points specially designed to take care of this operation. Two jacking blocks are provided at each corner of the car, either of which will support

TABLE 1 STRESS LIMITATIONS OBSERVED IN DESIGN OF VIRGINIAN 120-TON COAL CAR

	Stress, lb. per sq. in.		
	Structural Parts	Steel Castings	Rivets
Tension	13,000	9,000	. . .
Compression	13,000	9,000	. . .
Shear	9,000	8,000	8,000
Bearing	. . .	. . .	16,000

the load of that corner of the car, so that the car can be jacked up at one of these points and stooled at the other. One of these blocks is under the end of, and in reality a part of, a cast steel body bolster, the other being a part of the corner poling pocket. The push-pole pockets also have bracket portions which extend out and engage stops on the cradle of the dumper, should the overhead clamps for any reason fail to hold the car when in inverted position.

It is stated that the aim in the design has been to eliminate, as far as possible, all useless metal, and to this end an especially careful analysis of the known forces and stresses was made. Under the most extreme conditions of loading the extreme combined stresses have not been allowed to exceed those given in Table 1, based on 10 per cent overload in the car. As far as possible, the secondary stresses have been analyzed and allowed for. The article contains a promise of publishing, at a later date, the method of calculation of stresses for the various portions of this car. (*Railway Age Gazette*, vol. 63, no. 7, August 17, 1917, pp. 285-289, 7 figs., *d*)

Steam Engineering

EXCHANGE OF BASES IN PERMUTITE, Miss G. Kornfeld (*Phys. Zeits.*, vol. 18, pp. 113-114, March 1, 1917. Paper read before the Deutsch. Bunsen Gesell., Dec. 1917.)

Together with V. Rothmund, the author investigated the aluminate-silicates, or permutites, of Gans, considering them to consist of two phases, a solution containing two cations and one anion, and a solid phase (permutite) containing the two cations. The author reviews the researches and formulæ of Wiegner and of Gans, and describes experiments in which powdered sodium permutite was mixed with solutions of silver nitrate and sodium nitrate (simultaneously or separately), and shaken for about five minutes; the concentrations varied within very wide limits. A new formula is deduced and tested by experiments with silver permutite and alkali salts. (*Science Abstracts*, Section A—Physics, vol. 20, part 7, July 30, 1917, no. 235, pp. 301-302, *gt*)

SUGDEN'S SUPERHEATER FOR THE STIRLING TYPE OF BOILER

In the usual arrangement of superheater with this type of boiler the former is placed between the first and second bank of tubes. There are, however, certain particular objections to this arrangement, principally because of the very limited space available for cleaning, removing or replacing either boiler or superheater tubes.

If the superheater is arranged with the headers either above or below the two sets of circulating pipes connecting the steam and water space of the drums, there are certain difficulties; if placed below the expanded joints of the tubes and the joints of the handholes affording access to the headers, they are in the path of the flame and heated gases, which is bad practice. In the alternative arrangement the headers are placed outside the superheater pipes, being inserted between the circulating pipes. This is the objectionable feature of placing the superheater tubes in the chamber between the first and second banks of tubes, as this increases the difficulty of taking out and replacing the boiler tubes as well as the superheater tubes.

In the new design, shown in Fig. 10, the superheater is placed in the first chamber, in close contact with the front wall of the boiler and in such a position that access can be readily obtained for cleaning and inspection. It also avoids any complications in removing either boiler or superheater tubes.

Such an arrangement involves the danger of having the superheater projecting too far into the chamber and burning out. In this case this difficulty was overcome by placing the superheater tubes in a single header so arranged that the front and back rows were not more than about four inches apart, which prevents any excessive heat reaching the tube.

The superheater header is divided into three compartments and consists of two double groups of U-tubes, one group being placed immediately alongside the other.

If a superheater tube should fail, it is not necessary to shut the boiler down, as the tube can be plugged in a few minutes. For this purpose a steam stop valve is placed on the inlet side of the superheater, so that it is only necessary to discharge the steam from the superheater to reëxpand or stopper a tube, which can be done in a few minutes without letting the steam out of the boiler.

The following particulars are given of the working of this

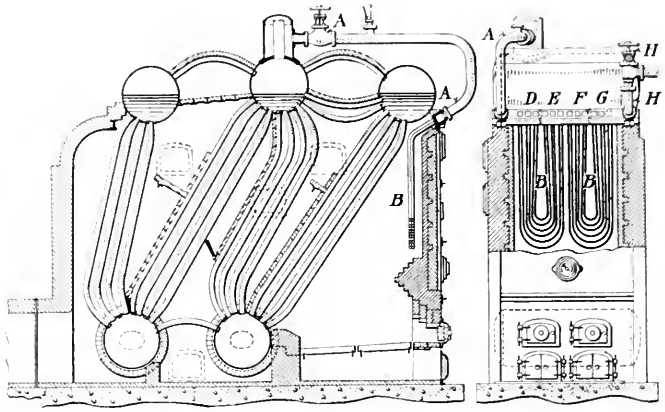


FIG. 10 SUGDEN SUPERHEATER FOR STIRLING TYPE OF BOILER

superheater on a Stirling boiler at the Blaina Colliery. The boiler has a heating surface of 1620 sq. ft. and a grate surface of 32 sq. ft. and is capable of evaporating under normal conditions of working about 6500 lb. of water per hour. The working pressure is 160 lb. per sq. in., giving a temperature of 370 deg. fahr. The superheat added to the steam at this temperature is 180 deg. fahr., making a total steam temperature of 550 deg. fahr. (*Engineering*, vol. 104, no. 2693, Aug. 10, 1917, p. 147, 3 figs., *d*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

The thirty-fifth Annual Convention of the National Association of Stationary Engineers was held at Evansville, Ind., September 10 to 14. The business session included an enlightening paper on How Manual Training Became Vocational Training. This was followed by an appreciative lecture commemorating the one-hundredth anniversary of George Henry Corliss, the inventor of the Corliss engine.

SELECTED TITLES OF ENGINEERING ARTICLES

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PHYSICS OF THE AIR, W. J. Humphreys. Journal of The Franklin Institute, vol. 184, no. 2, August 1917, pp. 137-178, 15 figs., (to be continued)

PHYSICS OF THE AIR, W. J. Humphreys. Journal of The Franklin Institute, vol. 184, no. 3, September 1917, pp. 371-408, 9 figs. (to be continued)

ON THE VALUE AND USE OF THE LARGE AIRPLANE, F. Handley Page. Aviation, vol. III. no. 2, August 15, 1917, pp. 96-100, illustrated.

DISTURBING BODIES ON WING SURFACES, Alexander Klemin. Aviation, vol. III, no. 2, August 15, 1917, pp. 100-101, illustrated.

THEORY OF PRESSURE ON A PLANE SURFACE DUE TO RELATIVE WIND, A. E. Watson. Flight, No. 450 (no. 42, vol. 9), August 9, 1917, pp. 815-816, 1 fig. (to be continued)

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HIGH PRESSURE AIR COMPRESSOR DESIGN AND APPLICATION, Joseph M. Ford, Canadian Machinery, vol. 18, no. 11, September 13, 1917. pp. 293-298, illustrated.

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† BOSTON MEETING OF AMERICAN CHEMICAL SOCIETY. Metallurgical and Chemical Engineering, vol. 17, no. 7, September 15, 1917, pp. 283-286.

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COAL AND ASH CONVEYOR TESTS, L. A. Quayle, Power, vol. 46, no. 10, September 4, 1917, p. 325, 2 figs.

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† TESTING RAILS BY THE QUICK-BEND METHOD. Railway Age Gazette, vol. 63, no. 10, September 7, 1917, pp. 413-415, 4 figs.

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Thermal conductivity of some building materials.

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Method of determining the viscosities of lubricating oil blends.

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GIFT OF PORTLAND CEMENT ASSOCIATION

CONCRETE IN THE COUNTRY.

CONCRETE FACTS ABOUT CONCRETE ROADS.

CONCRETE FENCE POSTS.

CONCRETE SEPTIC TANKS.

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CONCRETE TILE FOR LAND DRAINAGE.

CONCRETING IN COLD WEATHER.

FARMER'S HANDBOOK OF CONCRETE CONSTRUCTION.

PROPORTIONING CONCRETE MIXTURES AND MIXING AND PLACING CONCRETE.

PROTECTING CONCRETE WORK DONE IN WARM WEATHER.

SIMPLE FORMS FOR CONCRETE.

SMALL CONCRETE GARAGES.

TENNIS EVERY DAY ON CONCRETE COURTS.

WHY BUILD FIREPROOF?

GIFT OF NATIONAL ELECTRIC LIGHT ASSOCIATION

One hundred and thirty-six volumes and pamphlets principally on workingmen's compensation and state public service commissioner's reports.

A. S. M. E. Accessions

AIR BRAKE ASSOCIATION. Proceedings of the 24th Annual Convention. *New York, 1917.* Gift of Association.

AN AUTOMATIC STARTER FOR INDUCTION MOTORS. By H. F. Stratton. A paper presented before the Association of Iron and Steel Electrical Engineers, May 26, 1917.

THE CHARACTER OF THE BRITISH EMPIRE. By Ramsay Muir. *London, 1917.* Gift of W. Macnelle Dixon.

NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION. Proceedings 15th semi-annual convention, 1917. Gift of Association.

NEW YORK CITY, BOARD OF ESTIMATE AND APPORTIONMENT. Standard Methods of Testing Rubber Materials. July, 1917. *New York, 1917.* Gift of Board of Estimate and Apportionment.

NEW YORK CITY, BOARD OF WATER SUPPLY. Information for bidders forms of bid, contract, bond and certificates, specifications and drawings for furnishing and delivering a portable steel building and a truck, erecting a brick storage building at 140th Street and Fifth Avenue and doing miscellaneous work. (Contract 181), 1917. Gift of Board of Water Supply.

——. Information for bidders, forms of bid, contract, bonds and certificates, specifications and drawings for furnishing and delivering gate and pressure regulating valves and appurtenances for the City tunnel of the Catskill Aqueduct in the City of New York, 1917. (Contract 188). Gift of Board of Water Supply.

NEW YORK STATE, STATE ENGINEER AND SURVEYOR. Annual Report, Supplement. Vol. II, 1916. *Albany, 1917.* Gift of State Engineer and Surveyor.

NOTES ON THE CONSTRUCTION OF TURBINE PUMPS. By A. E. L. Chorlton. (Excerpt minutes of proceedings of the meeting of the Institution of Mechanical Engineers, May 18, 1917).

PRODUCING THE EVIDENCE IN THE CASE OF THE CHESAPEAKE AND DELAWARE CANAL. Extension of remarks of Hon. J. Hampton Moore of Pennsylvania, June 26, 1917. *Washington, 1917.*

ST. LOUIS PUBLIC LIBRARY. Annual Report, 1916-1917. *St. Louis, 1917.* Gift of Library.

WATTUPPA WATER BOARD. Annual Report to the City Council of the City of Fall River, Mass. 43, 1917. Gift of Wattuppa Water Board.

TRADE CATALOGUES

BOWSER, S. F., & COMPANY. Fort Wayne, Ind. Catalogue of oil filtration devices. Catalogue of oil storage and distribution in the factory.

PERSONALS

IN these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by October 16 in order to appear in the November issue.

CHANGES OF POSITION

M. A. NEELAND has been elected president of the New York Shipbuilding Corporation, Camden, N. J.

G. C. HYDE, formerly engineer with the Kentucky Utilities Company, Louisville, Ky., has entered the service of the Southern Indiana Power Company, Bedford, Ind.

J. CLYDE PARMELY, superintendent of the St. Clair County Gas and [illegible] Company, Belleville, Ill., has become identified with the [illegible] Gas and Electric Company, Plymouth, Pa.

[illegible], until recently connected with the Remington Arms Company, Chester, Pa., as superintendent, has become associated with the [illegible] Manufacturing Company, of New York.

[illegible] M. S[illegible], located at Dozey, N. D., has recently [illegible] with the Sheyenne Valley Light and Power Company, [illegible] Valley City, N. D.

DANIEL E. KEHOE, formerly associated with Kehoe's Iron Works, Savannah, Ga., is now located at the Charleston Navy Yard in the hull division as assistant shop superintendent.

W. L. BEAN, who has been acting as assistant to the president of the N. Y., N. H. and H. R. R. Company, New Haven, Conn., has been appointed assistant to general mechanical superintendent.

GEORGE W. WILDIN, general mechanical superintendent of the N. Y., N. H. and H. R. R. Company, New Haven, Conn., has been appointed general manager of that company, succeeding C. L. Bardo.

GUY C. PITTS, formerly assistant to yard engineer, Sun Shipbuilding Company, Chester, Pa., has entered the service of the Federal Shipbuilding Company, New York, as assistant mechanical engineer.

JOHN E. LOVELY has severed his connection with the Fort Dearborn Manufacturing Company, Sterling, Ill., and has accepted a position with the Vermont Farm Machine Company, of Bellows Falls, Vt.

ARTHUR B. NEWHALL, formerly instructor of applied science at Wentworth Institute, Boston, Mass., has become identified with the Hood Rubber Company, Watertown, Mass.

F. J. RYAN resigned from the Snyder Electric Furnace Company on June 1, to take up the duties of general manager of the Electric Furnace Construction Company, Philadelphia, Pa.

John A. Randall, head of the department of physics at Pratt Institute, Brooklyn, N. Y., has resigned to enter the employ of the Toledo Scale Company in an engineering capacity.

R. Burdette Dale has resigned as chief engineer of the Erie City Iron Works, Erie, Pa., and has accepted a position in the planning department of The Franklin Manufacturing Company, Franklin, Pa.

John J. Harman, assistant chief engineer with the Elliott and Harman Engineering Company, Peoria, Ill., has become affiliated with the Walworth Manufacturing Company, of Kewanee, Ill.

Max M. Shaw has become affiliated with the Merchant Mill of the Bethlehem Steel Company, South Bethlehem, Pa. He was formerly connected with Wentworth Institute, Boston, Mass.

Charles J. Bamford, formerly affiliated with the Agasote Millboard Company, Trenton, N. J., as chief engineer, has become associated with the Buffalo Cold Storage Company, of Buffalo, N. Y.

J. G. Malone has accepted a position as engineer with The Roessler and Hasslacher Chemical Company, Perth Amboy, N. J. He was until recently connected with the Hercules Powder Company, of Parlin, N. J.

Arthur C. Hubbell, formerly machine designer with C. D. Enochs, of Minneapolis, Minn., has become identified with the Purchasing Bureau of Small Arms, New York, in the capacity of United States inspector.

J. B. Freeman has resigned his position as chief engineer of the Webster Engineering Company, Chicago, Ill., and has accepted a similar position with the Du Pere Manufacturing Company, of the same city.

George J. Sturmfelsz, Jr., has resigned the position of boiler house engineer with E. I. duPont de Nemours and Company, City Point, Va., to accept the position of superintendent of boilers with the Bethlehem Steel Company at their Sparrows Point, Md., plant.

Henry Swift has severed his connection with The American Steam Gauge and Valve Manufacturing Company of Boston, Mass., and is now associated with The Cincinnati Ball Crank Company, of Cincinnati, Ohio, as chief engineer.

James P. Calderwood has resigned as associate professor of mechanical engineering in Pennsylvania State College, State College, Pa., and has accepted a position in the technical research department of the Travelers Insurance Company, Hartford, Conn.

James T. Gratiot has severed his connection with Fairbanks, Morse and Company, Denver, Colo., as manager of the machinery department, and has assumed the duties of manager of the Coliseum Garage Company, Casper, Wyo.

Alton A. Richardson, until recently identified with the Castner Electrolytic Alkali Company, Niagara Falls, N. Y., in the capacity of assistant engineer, has accepted the position of engineer with the National Electrolytic Company, Canal Basin, Niagara Falls, N. Y.

Roland F. Hetzel has resigned his position as shop instructor in the Seattle Public Schools, Seattle, Wash., to accept a position in the engineering department of the Ames Shipbuilding and Drydock Company, of the same city.

Clarence P. MacArthur, for the past five and a half years master mechanic of the Bowen Manufacturing Company, of Auburn, N. Y., has resigned to accept the position of general foreman with the Wagner Electric Manufacturing Company, of St. Louis, Mo.

Burton C. Fonda has become affiliated with the New York office of The F. W. Horne Company, of Tokio, Japan. He was formerly connected with the turbine department of the General Electric Company, Schenectady, N. Y.

J. E. Gibson, formerly in the employ of the American Pipe and Construction Company, Philadelphia, Pa., as principal assistant engineer, has assumed the position of manager of the water department of the Charleston Light and Water Company, Charleston, S. C.

W. S. Jones, of Philadelphia, who has been associated with the Midvale Steel Company in its general sales department, has been chosen vice-president of the Vanadium Alloys Company, of Pittsburgh, Pa.

George M. Smith, until recently associated with Walter Rachals and Company, Youngstown, Ohio, as chief engineer, has become connected with the Interstate Iron and Steel Company, Chicago, Ill., in a similar capacity.

Louis M. Zach, formerly mechanical engineer and designer with the Anaconda Copper Company, and International Smelting Company, Tooele, Utah, has accepted a similar position with the Public Works office, Washington Navy Yard, for the period of the war.

Donald C. Wright, formerly production manager of the Remington Arms-Union Metallic Cartridge Company, Ilion, N. Y., in charge of Enfield contracts, has become affiliated with the Dodge Manufacturing Company, Mishawaka, Ind., in the capacity of production manager.

J. N. Helpbringer has resigned from the position of power-plant engineer with the Firestone Tire and Rubber Company, Akron, Ohio, to accept the position of superintendent of power plants with the Kansas Gas and Electric Company, with headquarters at Wichita, Kan.

G. G. Crewson, until recently connected with the Roessler and Hasslacher Chemical Company, Perth Amboy, N. J., as mechanical engineer, has become associated with E. I. du Pont de Nemours and Company, Wilmington, Del., in a similar capacity.

Robert H. Wallace has entered the employ of the Alignum Products Company, South River, N. J., in the capacity of factory manager. He was formerly shop superintendent of the Bailey Meter Company, Cambridge, Mass.

Frank E. Wilder, who has been consulting engineer with the Southwark Machine Company, of Portland, Me., for some time, will remove to Bristol, Conn., where he has taken a position on the engineering staff of the New Departure Manufacturing Company.

Ben. G. Elliott, until recently associate professor of mechanical engineering at the University of Nebraska, Lincoln, Neb., has become affiliated with the University Extension Division of the University of Wisconsin, Madison, Wis.

Edmund Barany, machine designer of the Singer Manufacturing Company, Elizabeth, N. J., has assumed the duties of mechanical engineer and assistant to general superintendent of the Cleveland Twist Drill Company, Cleveland, O.

R. J. S. Pigott, New York district manager for Sanford Riley Stoker Company and B. F. Sturtevant Company, has become identified with the Bridgeport Brass Company, Bridgeport, Conn., as superintendent of the raw-material departments.

Frederick W. Gay, formerly associated with The J. G. White Engineering Corporation, San Francisco, Cal., has assumed the position of general manager of the New York office of the Pelton Water Wheel Company.

Charles L. Fischer has accepted the position of master mechanic with the Willard Storage Battery Company, Cleveland, Ohio, after twelve years of service with the Pennsylvania Lines West of Pittsburgh.

Ernest O. Hickstein, recently identified with the U. S. Indian Service, Pawhuska, Okla., as natural-gas engineer, has again become affiliated with the Empire Gas and Fuel Company, Bartlesville, Okla., in the research department.

Edward R. Feicht, formerly master mechanic of the Federal Dyestuff and Chemical Company, Kingsport, Tenn., has assumed the duties of assistant superintendent of plant of the Bridgeport Brass Company, Bridgeport, Conn.

Charles J. Manuel, formerly chief draftsman of the tool department of the Aeromarine Plane and Motor Company, Keyport, N. J., has become affiliated with the forging department of the American Can Company, Edgewater, N. J., in the capacity of chief draftsman.

Maurice L. Bullard has entered the employ of L. H. Shattuck, Inc., agents for the U. S. Shipping Board, Emergency Fleet Corporation, in the construction of a ship yard and also the building of wooden hulls. Mr. Bullard was recently associated with the W. H. McElwain Company, Manchester, N. H., in the capacity of chief engineer.

Henry C. Berrian, until recently connected with the engineering department, estimating division, of the Newport News Shipbuilding and Dry Dock Company, Newport News, Va., has become affiliated with the Federal Shipbuilding Company, New York.

R. A. Smart, formerly assistant manager of works of the Westinghouse Electric and Manufacturing Company, and later in charge of the American and Canadian plants of the Oliver Chilled Plow Works as works manager, is now associated with the Tacony Steel Company and the Tacony Ordnance Corporation, of Tacony, Philadelphia, Pa.

Harry J. Klotz has obtained a leave of absence from his position as operating engineer for the Decatur Railway and Light Company, Decatur, Ill., and has accepted, for an indefinite period, the position of instructor in the School of Aeronautics which the University of Illinois is conducting for the Government at Champaign.

ANNOUNCEMENTS

[illegible] been commissioned captain in the Engineer Offi[illegible]

[illegible] entered the employ of the Lehigh Navigation Electric Company, Allentown, Pa.

[illegible] has become associated with the Carrier Engineering Corporation, New York.

The partnership between H. K. Beach and Paul C. Phillips, under the name [illegible] and Beach, Philadelphia, Pa., has been dissolved.

[illegible] Merritt has assumed the duties of employment super[illegible] Company, Ltd., Grand Mere, Quebec, Canada.

J. [illegible] Johnson, Jr., of New York, has gone to the Pacific Coast on a professional trip which will require six or seven weeks.

Lawrence E. Webster, secretary of the Western Ohio Railway Company, with headquarters in Cleveland, Ohio, has been commissioned as Captain, Ordnance Department, U. S. A.

Cornelius L. Myers has gone to Washington at the request of Quartermaster General Sharpe to assist in standardization and design of motor trucks to be used by the Army.

Herbert B. Reynolds has become identified with the United Railways and Electric Company, Baltimore, Md., in the capacity of mechanical assistant to the superintendent of motive power.

John B. Price, formerly connected with the Chicago, Ill., office of The Mechanical Appliance Company, of Milwaukee, Wis., as sales engineer, has opened an office for the same company at Cincinnati, Ohio.

W. F. Firth, safety engineer for a number of years with the Midvale Steel Company, Philadelphia, Pa., has resigned to take a well-earned vacation.

E. F. Rich, whose firm, Neiler, Rich and Company, have been selected as supervising engineers in charge of the heating for Camp Custer Cantonment at Battle Creek, Mich., will be located there until the completion of the work.

John A. Stevens, Manager Am.Soc.M.E., engaged in consulting engineering with steam-power plants as a specialty, at Lowell, Mass., has organized a department to cover the design and superintendence of construction of factory buildings.

Harry J. Marks, formerly with the American Engine and Electric Company, New York, which has recently been purchased by the Bound Brook Engine and Manufacturing Company, is now in charge of the New York office of the latter company. Mr. Marks for the past ten years has been instrumental in installing numerous steam plants.

It was erroneously stated in the September Journal that A. R. Dickinson was no longer in the employ of Lockwood, Greene and Company. Mr. Dickinson is still connected with the mill management department of that company, and is temporarily located at the Winnsboro Mills, Winnsboro, S. C.

Captain William T. Taylor has been appointed a permanent captain in the British Army with seniority from June 1, 1916. For the past nine months he has been attached to the Royal Flying Corps. In the early part of 1915 he resigned his position in Bolivia, S. A., to join the British forces. Since 1916 he has been engaged on the French front.

Frank L. Ellis, who was engaged by the Jones and Laughlin Steel Company, Pittsburgh, Pa., to design, build and put into operation a new mill at Woodlawn, Pa., has opened an office as consulting engineer in Pittsburgh. For 12 years Mr. Ellis was chief engineer of the [illegible] Engineering and Foundry Company, Pittsburgh, and later was [illegible] of the Mark Manufacturing Company, of Chicago, [illegible]

APPOINTMENTS

[illegible] Kilpatrick, N. G., N. J., who constructed Camp W[illegible] Major in the regular service, his [illegible] immediately.

[illegible] has been commissioned a Captain of the En[illegible] Corps of the United States Army, and placed [illegible]

Robert G. Bennett, recently assistant engineer of motive power of the central division of the Pennsylvania Railroad Company, Williamsport, Pa., has been appointed master mechanic of the Pennsylvania Railroad Shops at Sunbury, Pa.

Louis T. Klauder has been appointed construction engineer of the Philadelphia Rapid Transit Company, Philadelphia, Pa., superseding William C. Kerr, who has recently become associated with the Republic Railways and Light Company, New York.

Clarence S. Adams has been appointed assistant superintendent of inspection of the Pierce-Arrow Motor Car Company, Buffalo, N. Y. He was formerly connected with the same company in the capacity of engineer.

H. E. Harris and William A. Viall have been appointed members on a committee to act with the National Bureau of Standards in producing gages for the manufacture of munitions and standardized parts for small arms and heavy ordnance.

Walter E. Dunham, until recently connected with the Chicago and North Western Railway Company, Winona, Minn., in the capacity of supervisor of motive power and machinery, has been appointed assistant to the general superintendent of motive power and car departments of the same company, with headquarters in Chicago, Ill.

The following appointments have been announced by The Waltham Watch Company, Waltham, Mass.: Olaf Ohlson, formerly mechanical superintendent, is now general superintendent; E. L. Folson, industrial superintendent, has been appointed assistant to the vice-president and given the title of assistant general manager; Gleason Wood, formerly assistant superintendent, has been appointed assistant general superintendent.

Edgar C. Felton, formerly president of the Pennsylvania Steel Company, has accepted an appointment as Director of the Department of Civilian Service and Labor, under the Committee of the Public Safety, Philadelphia. In addition to being connected with various railroads and steel companies, Mr. Felton is now on the board of managers of the Girard Trust Company, and director of the Franklin National Bank and the Farmers and Mechanics National Bank.

AUTHORS

W. Knight is the author of Stresses in Rotating Discs with a Hole at the Centre, which appears in the August 3 issue of *Engineering*.

L. A. Quayle has contributed an article on Coal and Ash Conveyor Tests to the September 4 issue of *Power*.

C. F. Hirshfeld is the author of an article on Efficiencies of Steam-Turbine Cycles, published in the September 18 issue of *Power*.

C. J. Morrison has contributed an article on Who Pays the Damage? to the September 13 issue of the *American Machinist*.

Christopher H. Bierbaum has contributed a review on Graphite Lubrication to the September 13 issue of *The Iron Age*.

H. D. Church has contributed an article on Design of Motor Trucks for Military Purposes to the September issue of *Western Engineering*.

Charles A. Carpenter has contributed an article on Cost Method of Jobbing Shops to the September number of *Industrial Management*.

R. S. Hawley is the author of an article entitled Heat Losses through Buildings and Building Materials in the September issue of *Western Engineering*.

P. F. Walker is the author of an article on Ethical Tendencies in Modern Industrialism, which appears in the September issue of *Industrial Management*.

J. W. Herbert presented a paper on Safety and the Foreman at the Sixth Annual Safety Congress of the National Safety Council, held in New York, September 11 to 14.

Millard F. Cox is the author of a paper on the Mikado Type Locomotive, Louisville and Nashville Railroad, which appears in the September 8 issue of the *Railway Review*.

Carl W. Weiss is the author of an article on Function of Water in Internal Combustion Engines, published in the September issue of *The Automobile and Automotive Industries*.

L. A. Wilson, Urbana, Ill., contributed an article on Lowering the Grade of Gasoline, which is published in the September number of *The Automobile and Automotive Industries*.

Frederick G. Coburn is the author of an article on The Assistant from the Manager's and His Own Viewpoint, which appears in the September issue of *Industrial Management*.

PREVENTABLE WASTE OF COAL IN THE UNITED STATES

With a Consideration of Alternative Methods of Its Elimination

By DAVID MOFFAT MYERS, NEW YORK, N. Y.

Member of the Society

As a means of far-reaching economy the Government of the United States should at this time apply intelligent and direct-acting efforts to the conservation of fuel at the industrial plants which are responsible for its greatest consumption. It is unnecessary before a body of engineers to show proof that coal is wasted in vast quantities in the boiler furnaces of our plants, to feed which it is mined and distributed at a high and ever-increasing cost of labor and material.

The mining and distribution of coal have been placed under the supervision of the War Coal Board in order more nearly to meet the crying needs in these directions, to use the railroad facilities more efficiently so that the present car shortage may be minimized to the greatest possible extent, and to apportion the coal in quantity and to uses deemed most expedient.

While this organized effort to bring about efficiency in the production and distribution of coal is being made, no parallel measures have been adopted to bring about a normal and practicable efficiency in its use. The hundreds of large plants which are consuming fuel wastefully, in many cases more wastefully and carelessly than ever before, are directly and needlessly causing a large fraction of the existing car shortage. They are overloading the already strained capacity of the railroads: they are rendering slower and more difficult the transportation of food and other vital commodities, and in short they are simply counteracting the measures of efficiency in production and distribution which have elsewhere been established.

Comprehensive abstracts of the papers to be presented and discussed at the thirty-eighth Annual Meeting of The American Society of Mechanical Engineers, to be held in the Engineering Societies Building, New York, December 4 to 7, are continued in this issue and will be concluded in the December number.

The abridgments here presented are supplemental to the complete papers being printed in pamphlet form. They have been prepared with the collaboration of authors and are therefore authoritative presentations of the subject-matter of the papers. In many cases the abstract omits only such sections of the complete paper as mathematical derivation of formulae, minute descriptions of apparatus, logs of tests, etc., which could not very well be curtailed.

As stated, all the Annual-Meeting papers appearing in The Journal are also being printed in unabridged pamphlet size for advance distribution, and members of the Society desiring a complete copy of any particular paper may obtain it upon application to the Secretary.

Contributed discussion of these papers for presentation at the meeting and publication in The Journal and Transactions is invited.

PREVENTABLE WASTE OF FUEL

The preventable waste of fuel in the boiler furnaces of one steel mill amounted to 40,000 tons per year, which at \$5 a ton would cost \$200,000. This was a comparatively modern plant. The efficiency of boilers and furnaces in a 14-day test was 55 per cent. The load factor was unusually favorable to high efficiency and could readily be raised to 70 per cent or over. This is only one example and there are many more extreme cases. In one hand-fired plant the evaporation was raised from 6 to 9 lb. in a few days of instruction, and continuously kept close to this higher mark with the help of coal and water measurements which were inaugurated. The saving was due exclusively to instruction and consequent better operation.

The saving or wasting of one-fourth of the coal consumption of any industrial plant depends entirely upon the efficiency of its operating management. Let me emphasize that this fraction of the consumption relates exclusively to the *boiler* plants, i.e., the production of steam; and does not include the large economies possible in connection with its distribution and use.

For well-known reasons the boiler plant offers the more lucrative field for producing economies, and these with a minimum of alteration in physical equipment.

Under present conditions a plant which carelessly operates at an efficiency of 40 to 50 per cent receives from the Government the same consideration in the delivery of coal as the one whose efficiency is 70 to 75 per cent. This obviously is unfair as well as wasteful.

The Government hands over, say, 200,000 tons of coal a year to a plant owner, but asks for no account as regards its consumption, nor any questions as to the amount of steam it is made to produce. There is nevertheless an equivalent amount of steam this fuel is capable of generating, and it can and should be made to produce that quantity.

CONSERVATION METHODS

The object of this paper is to open a discussion which it is hoped will ultimately lead to the formulation of definite recommendations of means for the reduction of the present great preventable waste of fuel in our industries; to direct such means principally toward the elimination of that portion of the present waste which is due to faulty, careless and uninformed operation of plants; to forward these recommendations to the proper governmental authorities as an official com-

For presentation at the Annual Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York, December 4 to 7, 1917. The paper is here printed in abstract form, and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

ministration of the Society, and to offer to the Government the services of the Society for the organization, furthering, and, as far as possible, the execution of the plan which may as a consequence be adopted.

In general, there are two plans of operation worthy at least of consideration. One might be termed the autocratic method. This would involve the use of authority to compel coal consumers to execute such measures of economy as the proper authorities might prescribe for any given case. Limits to be set as to expense to the user. Such limits might be in terms of a percentage of their present yearly coal bill. Alterations to be directed chiefly, as previously implied, to purely operating improvements. Many objections would probably be made by consumers against this plan, but once in effect the majority would no doubt realize its pecuniary advantage to themselves. But its tendency may be too strongly opposed to democratic principles.

The other plan would be largely an educational one, in which patriotism and efficiency would furnish the motive forces required.

The teaching must be accomplished with the utmost simplicity and directness. Above all it must be in such form as to be readily comprehended and applied. This is a big task, but with the technical and executive ability represented in this Society, these things should be and can be accomplished.

The requisite information must reach the owners and managers of industries, and there must be simple instruction sheets for the engineers and firemen. The vital importance of daily accurate records of coal and water must be taught and information given regarding practical appliances for automatic measurements of both.

Blank forms might be sent in advance to plant owners in order to be advised by them, first, whether they would be willing to coöperate with a governmental organization offering to assist them in reducing their coal consumption, and second, to obtain such data as to size, type, equipment, operation and fuel consumption of the plants as would enable a classification which would permit a Government board of experts to send such instructions as would include the information needed for any one class of plants.

This work would be greatly aided by a staff of experts ready to visit plants when so requested by owners and make investigations and recommendations and keep in touch with the progress of economies. Included in such a staff should be men intimately familiar with practical operating economies whose duties would be the delivering of lectures or talks, which should be planned so as to reach directly not only managers and owners of the industries, but also the chief engineers and firemen of the boiler plants. This feature of the plan, by itself, would undoubtedly result in great savings.

The U. S. Bureau of Mines has for a number of years engaged in obtaining and disseminating scientific information regarding the mining and consumption of coal, and the results of the work have been of great value to technical engineers who are able to use and apply it. It is evident that we now require an extension of the idea of education, but in such form as directly to affect the men who run the boiler plants of our country, for in their hands is the saving or wasting of one-fourth of our fuel supply.

Six hundred million tons of coal were mined in the United States in 1916. If we assume only one-half of this to have been used for our industrial boiler plants, then a quarter of the coal used under boilers amounts to 75,000,000 tons per year. It is worth while to save this fuel by preventing its waste. This quantity of coal represents the use of 1,500,000 fifty-ton freight cars.

PLOTTING BLOWER-TEST CURVES

By A. H. ANDERSON, CHICAGO, ILL.

Member of the Society

To the several methods of plotting blower-test curves another method is here added, whose utility is demonstrated by the solution of problems from graphically recorded test data. Diagrams are given for impellers with blades tilted forward, with blades radial, and with blades tilted backward, the coordinates used being revolutions per minute and static pressure in inches of water. Two series of curves are given, one showing various rates of discharge in cubic feet per second, and the other the volumes discharged per second per horsepower.

SEVERAL ingenious methods of graphically representing centrifugal-fan characteristics are in use, and to these the writer adds another method which, to the best of his knowledge, is new.

To obtain the experimental data the fan is tested at several speeds, the discharge being varied by the use of different sized orifices. Figs. 1, 2 and 3 show the curves for three fans which differ only in the angle of inclination of the blades, the coördinates being static pressure and speed. The curves connect points of equal capacity, and also equal cubic feet per second per horsepower. The use of the charts is best illustrated by the six problems which follow.

PROBLEM 1. Required the input horsepower in Fig. 1 for 1360 r.p.m. and 2.7 in. static pressure.

Solution: The chart shows the fan is delivering 14.5 cu. ft. per sec. per horsepower, with a capacity of 45 cu. ft. per sec. The input horsepower, therefore, is $45/14.5 = 3.1$.

PROBLEM 2. Required the mechanical efficiency in Fig. 1 at 1360 r.p.m. and various static pressures.

Solution: (1) Cubic feet per second: read direct. (2) Velocity pressure: find in Table 1. (3) Dynamic or total pressure: add static and velocity pressure. (4) Output horsepower: take product of cubic feet per second, dynamic pressure, and a constant depending upon temperature and pressure (for usual conditions constant = 0.0093). (5) Input horsepower: divide cubic feet per second by cubic feet per second per horsepower. (6) Mechanical efficiency: divide output horsepower by input horsepower. These successive steps are

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tabulated below. Note that the zone of maximum efficiency is found at the concave part of the series of curves.

Static pressure, in. water	(1) Cu. ft. per sec.	(2) Velocity pressure, in. water	(3) Total pressure, in. water	(4) Output hp	(5) Input hp.	(6) Mech. efficiency, %
2.8	35.0	0.23	3.03	0.95	2.33	40.5
2.4	52.5	0.53	2.93	1.56	3.62	43.0
2.0	62.0	0.74	2.74	1.73	4.07	42.5
1.8	65.0	0.81	2.61	1.72	4.43	41.8

Problem 3. Required the mechanical efficiency in Fig. 2 at 1300 r.p.m. and various static pressures.

Solution: See method used in Problem 2 and the following tabulation.

Static pressure, in. water	(1) Cu. ft. per sec.	(2) Velocity pressure, in. water	(3) Total pressure, in. water	(4) Output hp.	(5) Input hp.	(6) Mech. efficiency, %
2.0	30	0.17	2.17	0.67	1.67	40.0
1.8	42	0.34	2.14	0.92	2.21	41.5
1.4	52	0.52	1.92	1.02	2.56	40.0
1.0	58	0.65	1.65	0.98	2.70	36.0

TABLE 1 VELOCITY PRESSURES IN INCHES OF WATER FOR VARIOUS RATES OF DISCHARGE

Cu. ft. per sec.	Velocity pressure, in.	Cu. ft. per sec.	Velocity pressure, in.	Cu. ft. per sec.	Velocity pressure, in.	Cu. ft. per sec.	Velocity pressure, in.
36	0.250	44	0.375	52	0.520	60	0.700
37	0.264	45	0.390	53	0.540	61	0.720
38	0.280	46	0.410	54	0.562	62	0.740
39	0.294	47	0.425	55	0.585	63	0.760
40	0.310	48	0.445	56	0.605	64	0.790
41	0.325	49	0.463	57	0.628	65	0.810
42	0.340	50	0.483	58	0.650	..	.....
43	0.357	51	0.500	59	0.670	..	.....

Note that the zone of maximum efficiency is found along the 40-cu.-ft.-per-sec. line.

Problem 4. Required the mechanical efficiency in Fig. 3 at 1400 r.p.m. and various static pressures.

Solution: See method used in Problem 2 and the following tabulation.

Static pressure, in. water	(1) Cu. ft. per sec.	(2) Velocity pressure, in. water	(3) Total pressure, in. water	(4) Output hp.	(5) Input hp.	(6) Mech. efficiency, %
1.6	30	0.17	1.77	0.54	1.58	34.0
1.2	40	0.31	1.51	0.61	1.82	33.5
0.8	48	0.44	1.24	0.61	2.08	29.3

Problem 5. Required the r.p.m. and static pressure to change from 1320 r.p.m. and 50 cu. ft. per sec. to 55 cu. ft. per sec. (Fig. 1).

Solution: Follow the 1320-r.p.m. line down to 50 cu. ft. per sec., where the static pressure is found to be 2.29 in. The new static pressure will then be

$$2.29 \times \frac{(55)^2}{(50)^2} = 2.77 \text{ in.}$$

The r.p.m. corresponding to a static pressure of 2.77 in. and 55 cu. ft. per sec. is 1450.

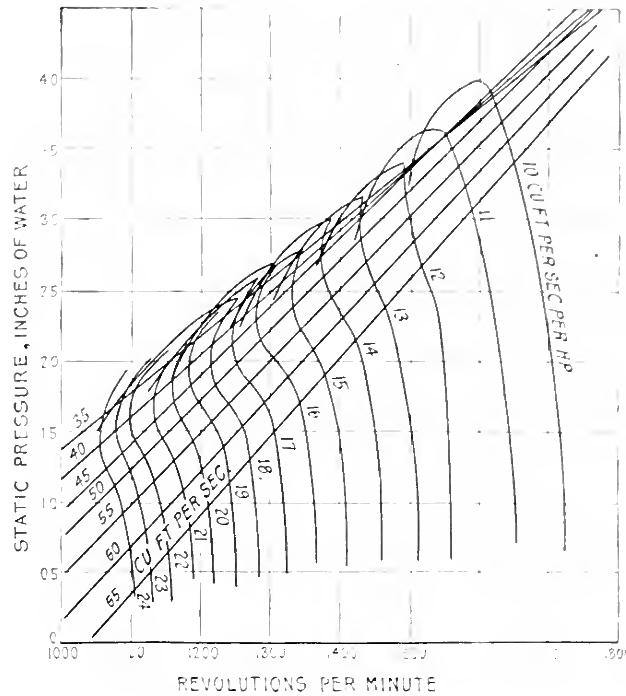

Fig. 1 Characteristic Curves, Blades Tilted Forward

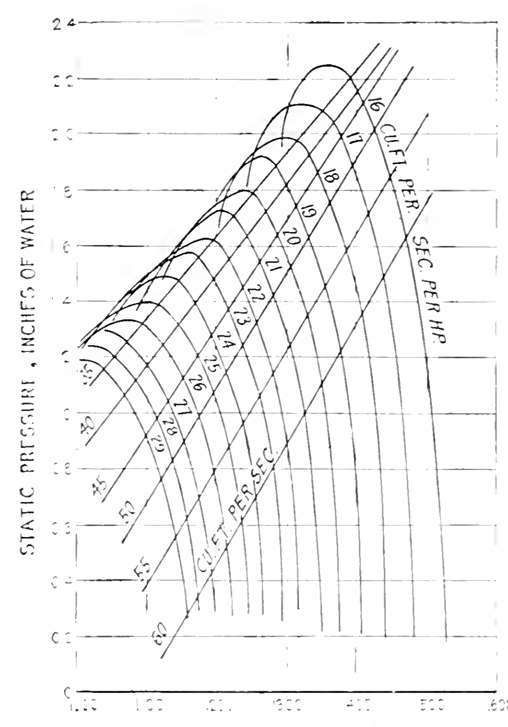

Fig. 2 Characteristic Curves, Blades Radial

Problem 6. The speed of a fan (Fig. 2) is changed from 1160 r.p.m. to 1500 r.p.m. The original static pressure is 1 in. Increase the capacity in the ratio of the speeds, 1500/1160 =

1.3, and determine ratio of new input horsepower to original, and ratio of new static pressure to original.

Solution: The capacity at 1 in. and 1160 r.p.m. is 48 cu. ft. per sec., therefore the new capacity will be $48 \times 1.3 = 62$ cu. ft. per sec. At 1500 r.p.m. and 62 cu. ft. per sec. the static pressure is 1.6 and the ratio is $1.6/1 = 1.6$, or approximately the square of 1.3. The horsepower at 1 in. and 1160 r.p.m. is $48/26.5 = 1.8$, and the horsepower at 1.6 in. and 1500 r.p.m. is $62/15 = 4$, the ratio being $4/1.8 = 2.2$, which is the cube of 1.3. Hence, when the capacity of a fan varies directly with the r.p.m., the static pressure varies directly with the square of the r.p.m., and the horsepower directly with the cube of the r.p.m.

The general arrangement of the apparatus for obtaining the power input is shown in Fig. 4. The fan was directly driven by a Sprague electric dynamometer, and the torque was meas-

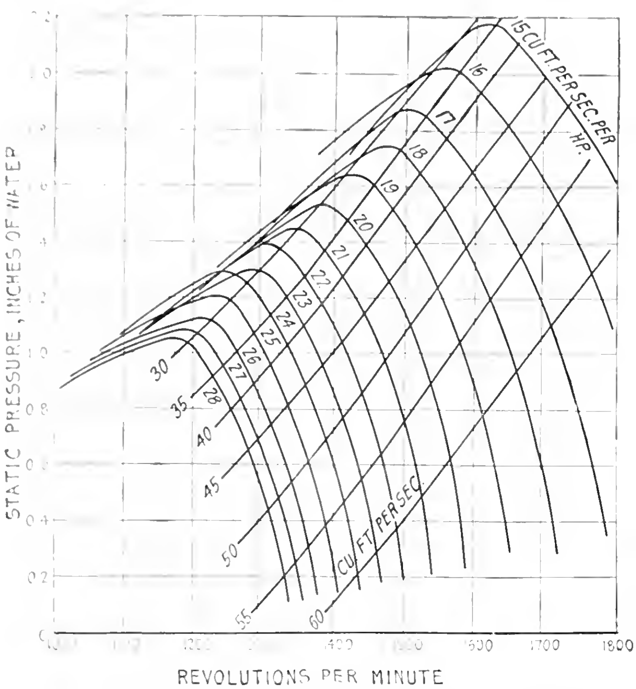

Fig. 3 Characteristic Curves, Blades Tilted Backward

ured by a Kron springless scale. The output apparatus is shown in Fig. 5. Dynamic pressures were obtained by a pitot tube and static pressures by a piezometer ring with four openings through the wall of the pipe. Fig. 6 shows the connections from the pitot tube and piezometer to the differential gages. This view shows also the method of securing the orifice plate to the discharge pipes.

Walter Humphreys, registrar of the Massachusetts Institute of Technology, has compiled registration statistics which indicate the effects of the war on technical education. The total registration is between eight-five and ninety per cent of what it was last year at the same time. The freshman year shows an increase, the percentage in terms of last year's figure being 104, while the second, third and fourth years' classes are, respectively, 93 per cent, 75 per cent and 86 per cent of the number in the school in June.

The graduate students stand at 60 per cent of last year's figure. There is the most shrinkage in the juniors, the sophomores of last year, to whom two years more of schooling has perhaps seemed a long time. The return of eighty-six per cent of the juniors to be seniors is evidence in favor of the junior summer camp. The purpose of this was to give some military

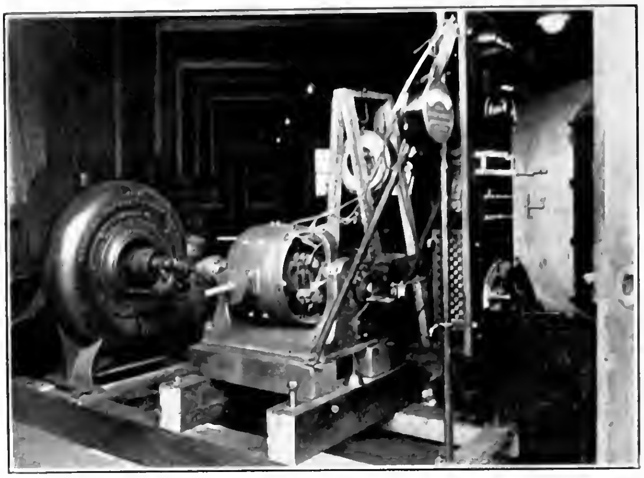

Fig. 4 Apparatus for Obtaining Power Input

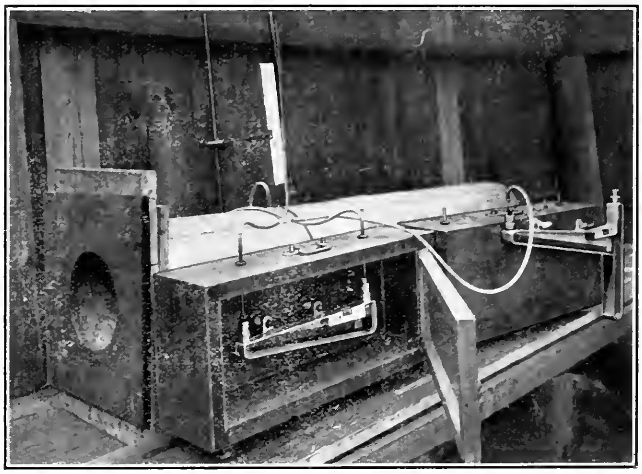

Fig. 5 Apparatus for Obtaining Output

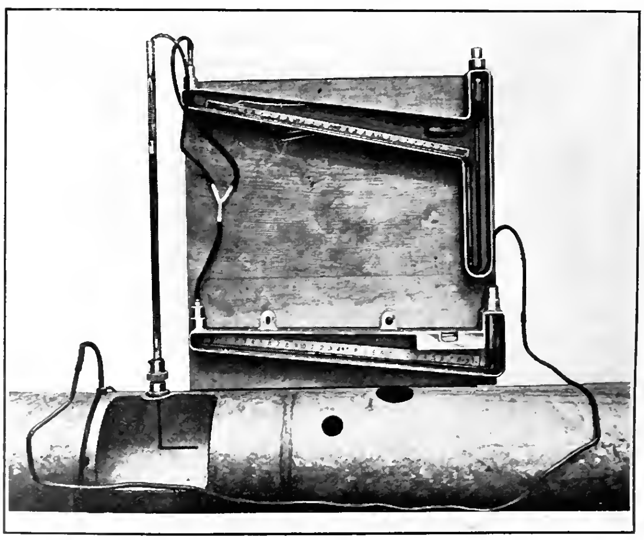

Fig. 6 Connections to Differential Gages

practice and an opportunity to anticipate fourth-year studies, and complete work at an earlier date.

THE MOISTURE CONTENT OF TEXTILES AND SOME OF ITS EFFECTS

By WILLIAM D. HARTSHORNE, METHUEN, MASS.

Member of the Society

THE smoothness and evenness of a thread are dependent upon the relation of its moisture content to the surrounding atmosphere at the time of spinning; and many of the hitherto puzzling defects in a finished fabric are explainable, and the remedy or method of prevention rendered obvious, as soon as the correct relationship of these facts to weaving and fabric-finishing conditions is apprehended. Moreover, the effects of moisture content upon strength and elasticity are not less important, both in manufacturing processes and commercial use.

The most significant effects of moisture content upon textiles may be classified under three general heads:

I Weight
II Dimensions
III Strength and Elasticity

Under these respective heads, among the different textile materials there is great diversity of effect, and as a consequence a great divergency in unverified opinion. The most obvious of these effects is weight, and to this factor the present paper is mainly devoted.

To conditions causing changes in weight much more effective study has been given than to those causing changes in dimensions or strength and elasticity. These latter are complicated by other factors, such as twist or weave, which tend to increase or diminish the ordinary effects of moisture.

EFFECT OF MOISTURE CONTENT ON WEIGHT

In measuring weight, long before any exact causal relationship had been established between the various factors, certain standards of moisture content for the principal textile materials, such as silk, wool, cotton and flax, and their manufactured products, had been established by custom, and to some extent sanctioned by law, in the principal Continental markets and in England, as a basis for purchase and sale.

Variations in weight between different materials due to their individual hygroscopic properties as affected by atmospheric changes alone were thus recognized, and a standard basis for figuring the standard allowances agreed upon was also adopted and with few exceptions has been steadily adhered to. This standard basis was obtained by determining the average loss in moisture of a series of representative samples, from the lot of material in question, by drying them in a proper oven at a temperature of 221 to 230 deg. fahr. until they ceased to lose weight, or the rate of loss had reached a prescribed minimum.

The standard allowances made upon this "standard" dry basis of weight (sometimes called the bone-dry or the absolutely dry basis) are commercially called "regains," a nomenclature liable to misconception and misapplication which it is important at the outset to avoid both in practical use and theoretical study. The hygroscopic capacity and other properties of both wool and cotton, for instance, are well known to be materially affected both by the temperature at which they are dried and the length of exposure to a drying and oxidizing atmosphere.

With materials as valuable as silk, wool and cotton and such of their products as are sold by weight, the actual weighing of the water they may happen to contain at the time of sale is of evident importance to both buyer and seller, when it is once understood what slight changes of circumstances can cause a loss or gain in weight involving thousands of dollars in many everyday transactions.

The standard condition upon which worsted yarn and tops combed without oil have long been bought and sold in England and on the Continent allows 18¼ per cent regain or added weight to the standard dry-weight condition. The standard for silk is 11 per cent and for cotton is 8½ per cent. Until recently no standards except for silk, which is the same the world over, had been generally recognized in the United States.

Theoretically, it makes no difference whether the standard condition of regain be assumed at one figure or another provided that the actual condition is known and that some standard has been agreed upon between buyer and seller. Practically, however, it is desirable that the standard condition be somewhere near the average expected for the country in which the transaction takes place, and that at the time of delivery the material shall in its whole mass be as near as may be in this standard condition.

CORROBORATION OF 15 PER CENT REGAIN FOR WORSTED

The importation of worsted yarns and tops into this country under foreign exporting conditions, owing to the loss of weight sustained upon storage here, had given the impression that there must be at least 2 or 3 per cent difference in weight due to climatic reasons.

It was important, therefore, in developing the new American industry of combing tops for the trade to adopt a standard believed to be safe for this country. This was put at the arbitrary figure of 15 per cent regain, an amount easy to calculate and also within expected limits. It seemed best, however, to determine with some degree of certainty how near this figure was to the average natural condition corresponding to some one locality, such as Lawrence, Mass.

With this object in view, a skein of worsted yarn, 2 42 Australian, combed in oil and spun on the Bradford system, was prepared whose absolute or rather "standard" dry weight was carefully determined by weighing and testing other skeins of the same material under exactly like conditions. This method of using substitute skeins was adopted to avoid the known effects of heat in changing the hygroscopic property of wool and other fibers.

Table 1 shows the variations in weight of this skein, which were remarkable, ranging from a little over 7 per cent to as high as 35 per cent on the calculated dry weight. There were occasional variations of 15 or even 19 per cent in 24 hours.

For presentation at the Annual Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York, December 4 to 7, 1917. The paper is here printed in abstract form and advance copies of the complete paper may be obtained gratis on application. All papers are subject to revision.

The observations recorded in Table 1 gave for outdoor conditions a general average for the year of 17.45 per cent, or something less than the standard allowed abroad; and without attempting at the time to go further into the law of change, it was felt that at least it was demonstrated that a standard of 18 per cent regain for worsted, as had already been assumed, was conservative for this country.

RELATION BETWEEN HUMIDITY, TEMPERATURE AND REGAIN

The determination of the exact relation between the three factors, humidity, temperature and regain, was a problem which the author had had under investigation for some time

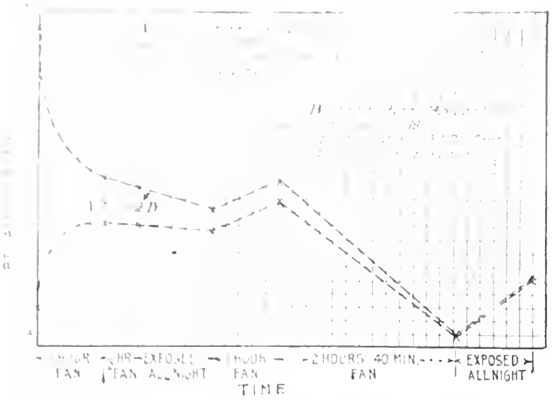

FIG. 1 LAGGING EFFECT IN SKEIN TAKING UP OR PARTING WITH MOISTURE

prior to 1905. That the absorption of moisture by worsted yarn was in some manner dependent upon relative humidity and temperature was abundantly shown by the year of exterior observations recorded, and also by many interior records made subsequently. It seemed possibly true that the atmospheric pressure affected the result, but its effect was so far overshadowed by the element of temperature that, for practical mill purposes, it was evident that the height of the barometer could be neglected. In fact, all observations for either relative humidity or skein regain were made on the assumption of 30 in. barometric pressure.

*TABLE 1 VARIATIONS IN WEIGHT OF SKEIN OF WORSTED FOR ONE YEAR

	Lowest Day		Highest Day		Lowest Observation		Highest Observation		Greatest Difference in 24 Hours	
	Per Cent	Date	Per Cent	Date	Per Cent	Date	Per Cent		Per Cent	Date
May	11^{60}	17	21^{50}	27	9^{7}	17	22^{1}	6 and 27	8^{2}	6 to 7
June	[illegible]	19	25^{92}	29	10^{7}	14	27^{5}	28	10^{0}	5 to 6
July	[illegible]	25	23^{96}	17	12^{9}	3	26^{6}	1	9^{1}	1 to 2
August	[illegible]	9	22^{00}	13	12^{6}	21	22^{9}	13	8^{7}	7 to 8
September	[illegible]	24	[illegible]	11	[illegible]	24	25^{9}	26	12^{1}	26 to 27
October	[illegible]	18	[illegible]	8	[illegible]	18	[illegible]	14	11^{3}	28 to 29
November	[illegible]	22	[illegible]	26	[illegible]	4	35^{1}	26	19^{1}	26 to 27
December	[illegible]	27	[illegible]	2	13^{0}	27	33^{7}	2	16^{1}	2 to 3
January	[illegible]	[illegible]	[illegible]	25	[illegible]	29	34^{9}	25	15^{1}	24 to 25
February	[illegible]	[illegible]	[illegible]	6	[illegible]	25	33^{4}	6	17^{3}	6 to 7
March	[illegible]	[illegible]	[illegible]	[illegible]	10^{2}	27	28^{3}	20	16^{4}	30 to 31
April	[illegible]	[illegible]	[illegible]	2	7^{3}	30	24^{0}	2	12^{2}	1 to 2

General average (by months) for the year, 17^{45} per cent.
Lowest average periods (April), 14^{15}, and (May), 14^{86} per cent.
Highest average periods (November), 22^{02}, and (December), 19^{28} per cent.
Lowest observation (April 30), 7^{3} per cent.
Highest observation (November 26), 35^{1} per cent.

The first efforts toward the solution of the problem of finding the relation were directed to obtaining in a closed room, for as long a period as possible, a uniform state of moisture and temperature. The difficulty of maintaining both these factors uniform for a sufficient length of time to determine more than a very limited range of facts was found to be extremely great, if not impossible, with apparatus then available. So far as these facts were determined, they indicated that the same skein of worsted yarn can always be relied upon to reach the same weight under like conditions, if given sufficient time.

For the purpose of eliminating the effect of hard twist in retarding the absorption of moisture and the effect of oil upon the net result, a quantity of 2/24 soft twist, French spun, fine Australian yarn was prepared and extracted with ether, dried, and extracted again with warm water to which a few drops of ammonia had been added. After allowing it to hang up for some time to come to its natural state, this yarn was made up into groups of skeins of equal lengths and approximately equal weights. The final weight and moisture state of the groups was carefully determined after they had been hung up together again for about two days, by drying out individual skeins of the different groups in the ordinary ventilated Bradford oven at a temperature of from 220 to 230 deg. fahr., until they ceased to lose weight, and also by leaving small two-gram

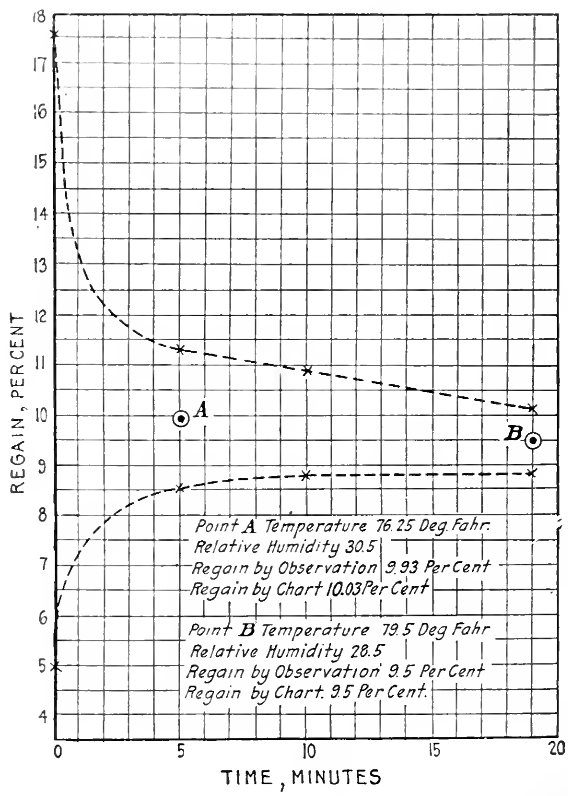

FIG. 2 LAGGING EFFECT IN SKEIN TAKING UP OR PARTING WITH MOISTURE

skeins in weighing bottles under a dessicator containing strong sulphuric acid.

These two methods were used to check each other from time to time during the experiments, to establish the true weight of the skeins being used as moisture indicators.

Attention has already been called to what has been termed the "lagging effect," due to the time required by a skein of yarn to take up or part with moisture. The effect of this is

to show for a given humidity and given temperature a higher result when the skein regain condition has been a falling one, and a lower result when that condition has been a rising one. In undertaking, therefore, a careful series of experiments, it was deemed necessary to make the skeins to be examined of such a size that they could be accurately weighed on a delicate balance, and not be so large that the amount of moisture which might be absorbed or parted with by a given skein would require a great many cubic feet of air to supply or displace it.

Upon comparing the results obtained from two skeins hung together, one of which had been previously exposed to a damp atmosphere, and the other to a comparatively dry atmosphere, it was soon found that while it might require hours or even days to bring the skeins exactly together again, the mean between the two at any time after 15 or 20 min. was practically the same in repeated experiments for the same temperature and relative humidity, and presumptively equal to what a third skein would have shown which had been a long time exposed to identical conditions. It was therefore assumed that this mean could be relied upon to quickly determine the true regain relationship for any not too rapidly changing conditions. It was thus possible to make use of the very lag effect, which had previously rendered individual observations seemingly incompatible, to establish comparatively accurate and true results. Figs. 1 and 2 are intended to illustrate this lagging-behind and coming-together effect and the method of obtaining quick results.

In order to compare the results obtained by this method, a special form of charting was devised, shown in Fig. 3 for worsted and Fig. 4 for cotton, on a scale greatly reduced from the original, where the ordinates represent regain and the abcissæ moisture per cubic foot of space, for the temperatures and relative humidities found and shown in the figures. It will be observed that the lines joining points of the same relative humidity (for example, the 50 per cent line) cross the isothermal lines in a general oblique direction, curved slightly

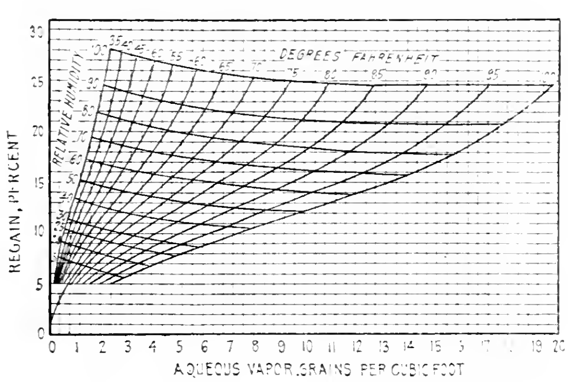

FIG. 3 ISOTHERMAL AND RELATIVE-HUMIDITY LINES FOR WORSTED

convex, on the downward side; that is to say, for a given relative humidity the regain is less at the higher temperature, but not less in a constant ratio.

By the aid of this charting principle, a sufficient number of points were located to trace the isothermal and the relative humidity lines shown, and from these charted results it was found possible to tabulate by interpolation the percentage regain on worsted with a fair degree of accuracy for each percentage of relative humidity from 15 per cent up to near saturation, and for isothermals 5 deg. of temperature apart from 35 deg. fahr. to 100 deg. fahr.

The data for securing the cotton chart were by no means so complete as those used for the worsted chart, and therefore the same degree of accuracy was not expected for it.

It will be seen from Figs. 3 and 4 that the regains for cotton are approximately one-half of those for worsted under like conditions, but the relative-humidity lines are more nearly straight and therefore bear a more nearly constant ratio to the regains.

Another method of comparing results is shown in Fig. 5, in which curves of saturation (100 per cent humidity), 60 per

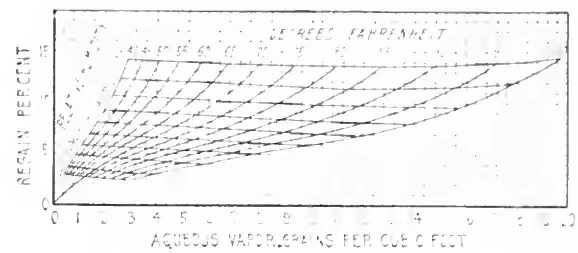

FIG. 4 ISOTHERMAL AND RELATIVE-HUMIDITY LINES FOR COTTON

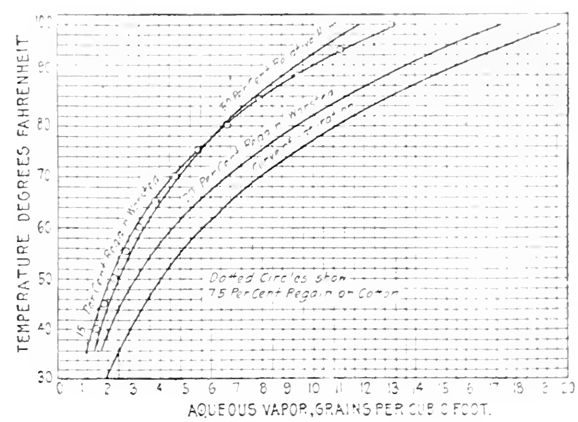

FIG. 5 REGAIN OF COTTON AND WORSTED

cent relative humidity, 15 per cent regain in worsted, and (to avoid confusion) a number of points only on the curve of 7½ per cent regain in cotton, are represented. An additional regain curve for 20 per cent on worsted is also shown.

It will be noticed that at ordinary mill temperatures the 7½ per cent curve for the cotton here used closely coincides with the 15 per cent worsted curve, and within the limits of observation their deviation is not great at either high or low temperatures. In the absence of other considerations, this fact might be taken therefore as reason sufficient for establishing a 7½ per cent regain for cotton for this country, if it be conceded that 15 per cent is the proper standard for worsted.

It is interesting to note also that the 60 per cent humidity curve, Fig. 5, crosses the combined regain curve, just named, at about 77 deg. fahr., a room condition which, according to Sconfietti, is compatible with both good work and comfort in a cotton-spinning room.

Sconfietti gives his own experience, as corroborating that of other men, that the most favorable temperature for manufacturing cotton (and textile fibers in general?) is between 68 and 77 deg. fahr., while the relative humidity for cotton should be:

In carding, between 50 and 55 per cent
In spinning, between 55 and 60 per cent
In weaving, between 65 and 70 per cent.

These figures would indicate a regain condition for cotton, by the 1911 tables:

In carding, from about 6.5 per cent to 7.2 per cent
In spinning, from about 7.2 per cent to 8.0 per cent
In weaving, from about 8.6 per cent to 9.5 per cent.

or, in other words, for cotton the stock should be *gaining* at each step of manufacture.

Whether this be true or not for cotton, it is not true for worsted so far as the Bradford system of spinning is concerned. For the Bradford system of worsted spinning, even though the stock contains oil, there seems to be no doubt that it must be losing moisture during the process of spinning to make a good spin, hence the necessity, if the top contains only 15 per cent regain, for keeping the moisture condition well up during the processes of drawing and roving or else for long aging in a cool, damp cellar before going to the spinning frame. The latter plan used to be thought an absolute necessity, but modern successes in humidification have very largely obviated it.

One of Schloesing's methods involved the use of pure sul-

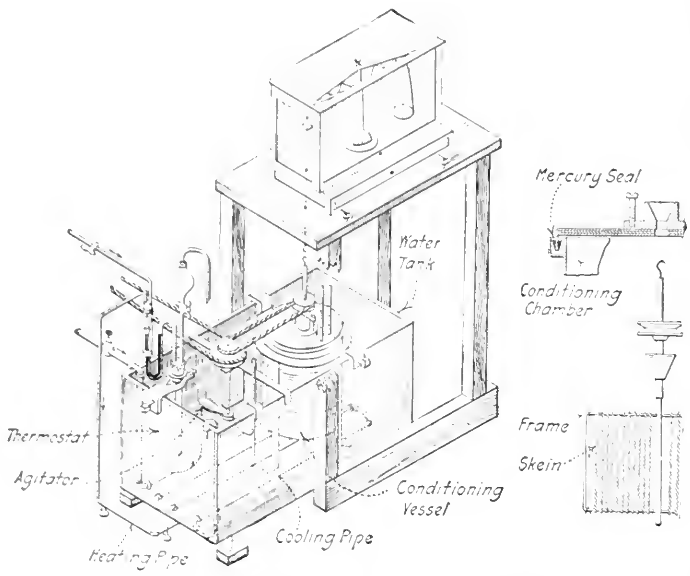

FIG. 6 APPARATUS FOR DETERMINING REGAIN

phuric acid of known strengths in obtaining known and comparatively constant states of relative humidity in a closed vessel or chamber.

Both of his methods, though checking up well with each other, involved the question of control and length of time required to arrive at results—a time so great that to apply them over a wide range of temperatures to make a complete comparison with the writer's figures seemed out of the question. The sulphuric-acid method was the simplest but, though making use of conditions of known humidity in obtaining the facts (not the law) of regain, neglected the phenomenon of lag—one of the time elements in the problem.

To accomplish this, it was necessary to obtain the elimination of the lagging effect by direct observations under conditions of constant temperature and constant humidity [illegible] maintained, or so closely known that the constant [illegible] could be calculated. In attempting this, [illegible] Schloesing's sulphuric-acid method in an apparatus developed after much experimenting, shown in Fig. 6, so that observations could be repeated over and over again under conditions calculably alike upon the same and upon different pairs of skeins to obtain a satisfactory average for a given kind of material at as many points of temperature and humidity as desired.

The principle of operation of the apparatus is: A pair of skeins, one moister and the other drier than the proposed humdity would give, are hung on the two ends of a specially designed metal frame within an enclosed metallic vessel, the cover of which is sealed by mercury. Excepting the top, this vessel is entirely surrounded by water, the temperature of which can be kept constant by a thermostat. In the bottom of this chamber, paraffined for protection, varying known strengths of sulphuric acid are placed and the framework revolved in the air above by a small motor, which also turns an agitator in the outside water. Thermometers pass through the lid of the sealed chamber, one terminating in the air and the other in the liquid below, so that the exact temperature of each is known and therefore the exact equilibrium conditions are calculable. The bearing for the shaft is a copper tube held in a conical plug, making a practically air-tight joint. When it is desired to weigh the combination, the driving band is disengaged, and the hook from the scale above inserted in the hook of the shaft of the framework, just lifting it from its conical bearing, so that the weight can be taken accurately.

It will be noted that: *The original dry weights of the skeins having by calculation, from blank tests on other skeins, been made equal, one-half of the sum of the weights found always represents the average present condition of the skins.*

It was soon found that in about an hour's time an equilibrium was established between the two skeins so that there was neither gain nor loss thereafter, while the temperature remained the same.

It was, however, found on repeating the same experiment on the same pair of skeins, in the same order, that is, the same skein always remaining the drier, that the successive observations gave continually lower results for the average regain; but if the skeins for a repeated experiment were alternated in the exposing condition, that is, if the one which had been drier in the first instance was made the damper in the second, then the results represented a very nearly constant condition of regain, not only for the same pair of skeins, but for duplicate pairs, and in the final accepted results a series of tests on duplicate samples, alternating for the moist and dry state in each, were averaged for each point of regain determined.

By suitable humidities and temperatures, thus predetermined and accurately controlled, points of regain in sufficient number were found not only to confirm the basis for the general law previously propounded in 1905, but to extend its application so as to cover for both worsted and cotton the relationship of humidity and regain at all temperatures within the limits of the apparatus as arranged, giving reliable results not previously found possible.

Having obtained these accurate comparative points, the mathematical considerations as first announced in 1905 and their further application to the more complete conception of the laws of regain as developed in 1911 may be briefly summarized.

SUMMARY OF THE LAWS OF REGAIN

To summarize these laws of regain in cotton and worsted, we can say:

First. The general law for cotton and worsted, and probably for any other textile fiber, may be expressed by the formula

$$K\ R\ T^3 = H \times 5771.44 \times 10^8$$

in which H represents any given relative humidity expressed

decimally; R the regain at any absolute temperature T: K is a variable coefficient depending upon H, R and T in such a way that for $H = 1$ the product of $K\ R\ T^3$ is a constant quantity represented by the number 5771.44×10^6. In this, 5771.44 is the weight in grains of a cubic foot of aqueous vapor at any temperature multiplied by the corresponding absolute temperature in degrees fahrenheit, divided by the maximum elastic force of aqueous vapor at that temperature, expressed in inches of mercury. In this expression, therefore, we are independent of tables for saturated aqueous vapor, either for unit of weight or elastic force.

Second. For any given temperature the relation of values of R to the variable K, for both worsted and cotton, is expressed by a hyperbolic equation, differing for each substance.

Third. For any other temperatures the law for worsted is: *For the same humidity the squares of the regains at different temperatures are to each other inversely as the cubes of the corresponding absolute temperatures.*

Fourth. The law for cotton is: *For the same humidity the first powers of the regains at different temperatures are to each other inversely as the first powers of the corresponding absolute temperatures.*

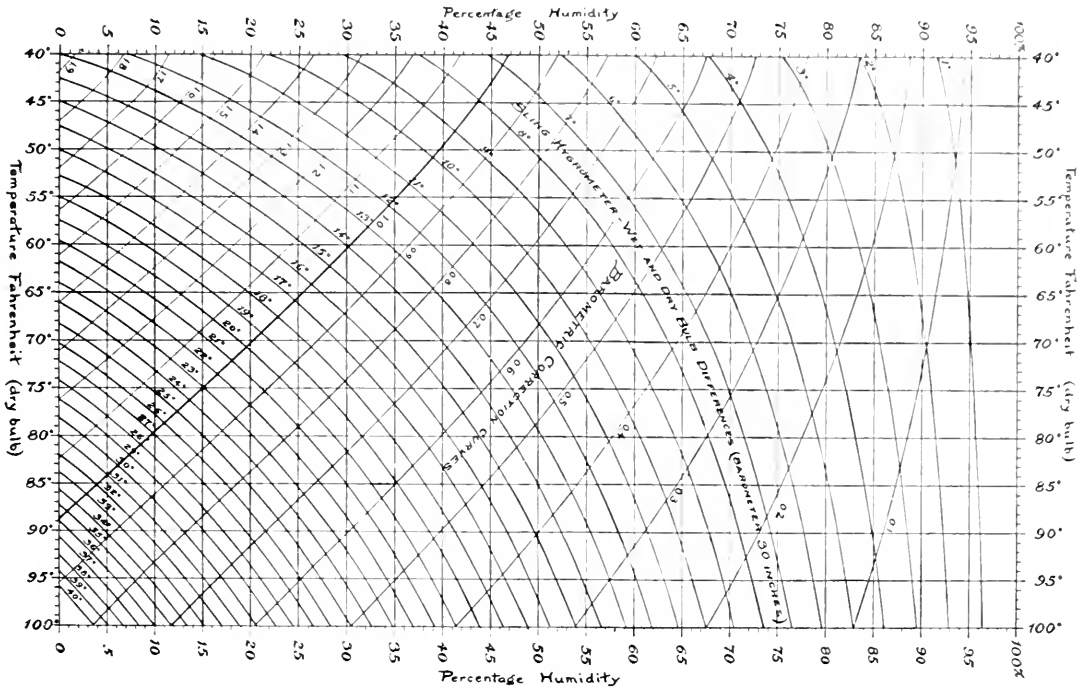

Fig. 7 Barometric-Correction Chart

Note.—Figs 7 to 11, inclusive, are reproduced from the author's original drawings to ensure their accuracy.

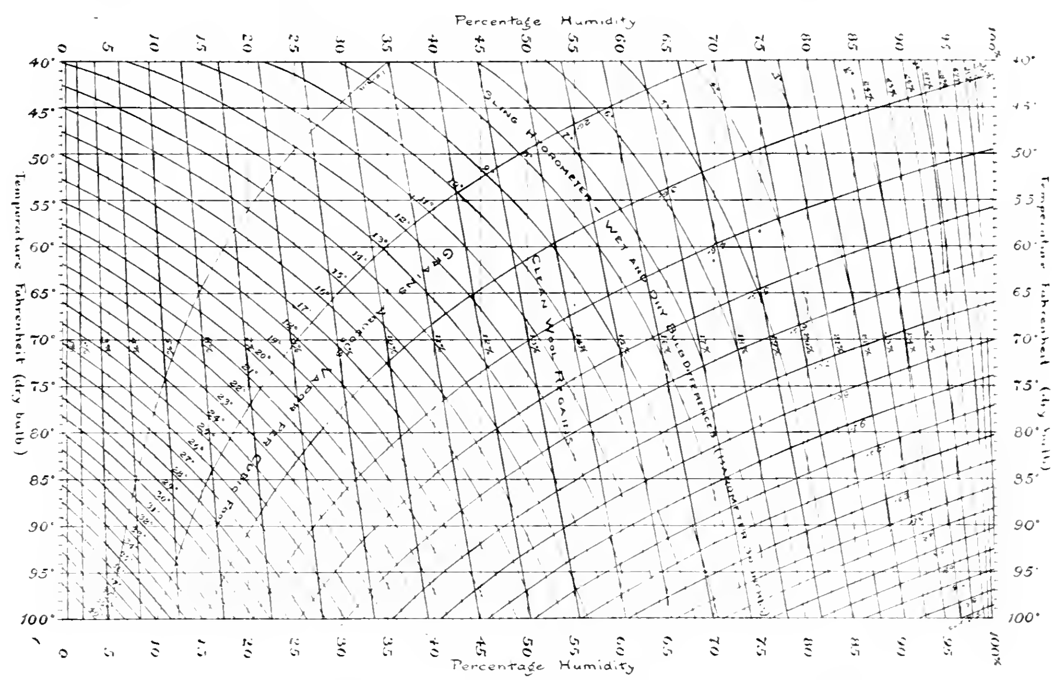

Fig. 8 Absolute- and Relative-Humidity Chart. Wool

No other substances have as yet been compared in this manner by the writer, but for such substances it is quite possible that all these relations, except those of the general formula, may be decidedly different.

points of their construction, nor are they adaptable for everyday use. By properly constructed charts on a unit-system basis, it is possible to avoid the necessity for using any tables in either hygrometric observations as such, or the reading of

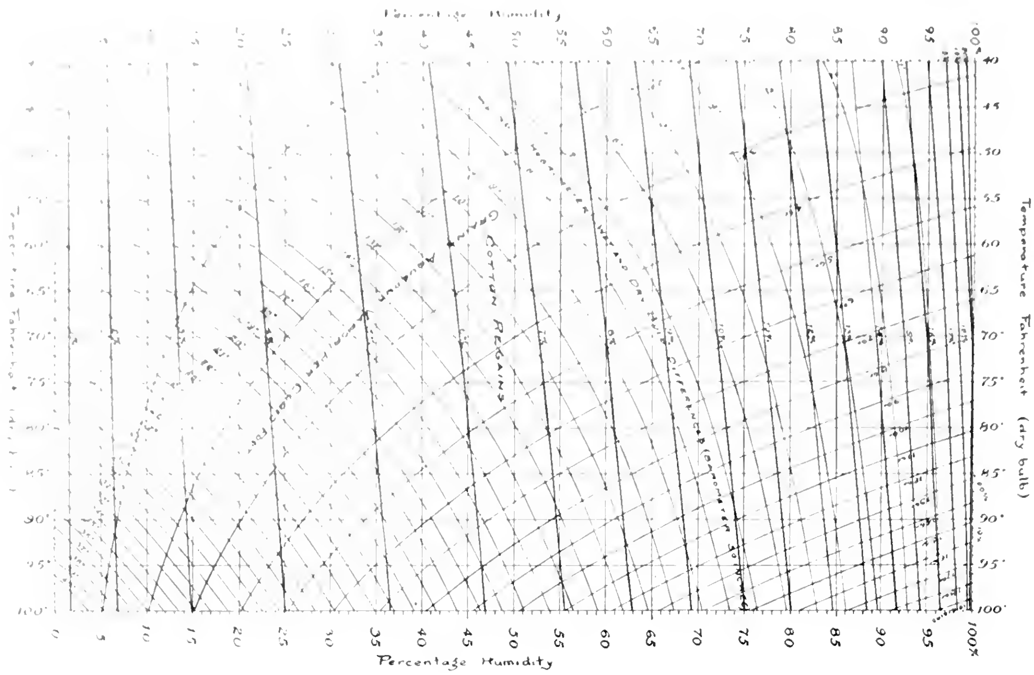

FIG. 9 ABSOLUTE- AND RELATIVE-HUMIDITY CHART, COTTON

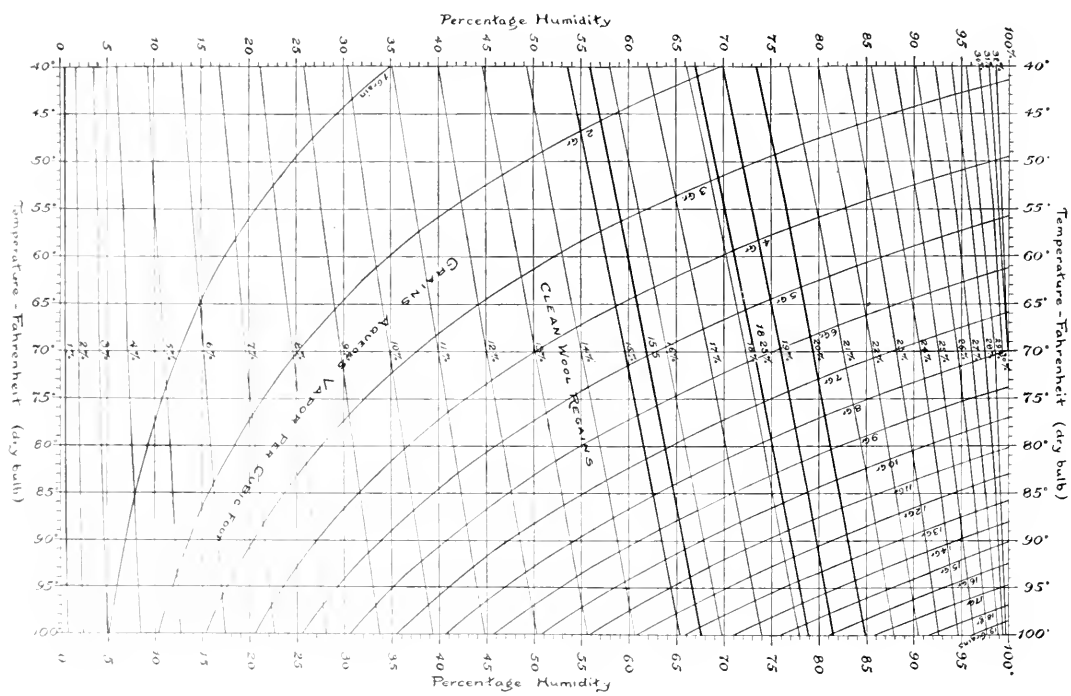

FIG. 10 UNIT-VARIATION REGAIN LINES, WOOL

ANOTHER METHOD OF CHARTING AND FURTHER DEDUCTIONS EXPLAINED

Though graphically expressing the relations and laws referred to, the charts so far shown do not lend themselves readily to accurate portrayal of the established facts at all the corresponding conditions of equilibrium therewith for the several textile materials.

Figs. 7 to 11 were devised for this purpose, so far as commercial and mill uses require, for wool and cotton. On each of them the vertical lines represent (as labeled) 5-deg. inter-

vals of temperature and the horizontal lines 5 per cent intervals in relative humidity. For closer reading, each degree and each per cent are marked off respectively at the top and bottom and on both sides of the charts.

Barometric Corrections. Fig. 7 is needed in ordinary mill use only in a negative sense. It shows the effect of the height of the barometer, by unit variations, in obtaining the correct relative humidity from readings of the sling hygrometer, and can be read as closely as necessary for practical purposes. On respect to the absolute- and relative-humidity lines in whatever manner either may have been determined.

On each of these four figures, the unit-regain curves are nearly straight lines for both clean wool and cotton, running in a general upward direction from left to right, and labeled from 1 to 32 per cent on the wool charts, and from 1 to 20 per cent on the cotton charts.

In Figs. 10 and 11, besides the unit-difference curves, there are three extra lines, two in Fig. 10 and one in Fig. 11,

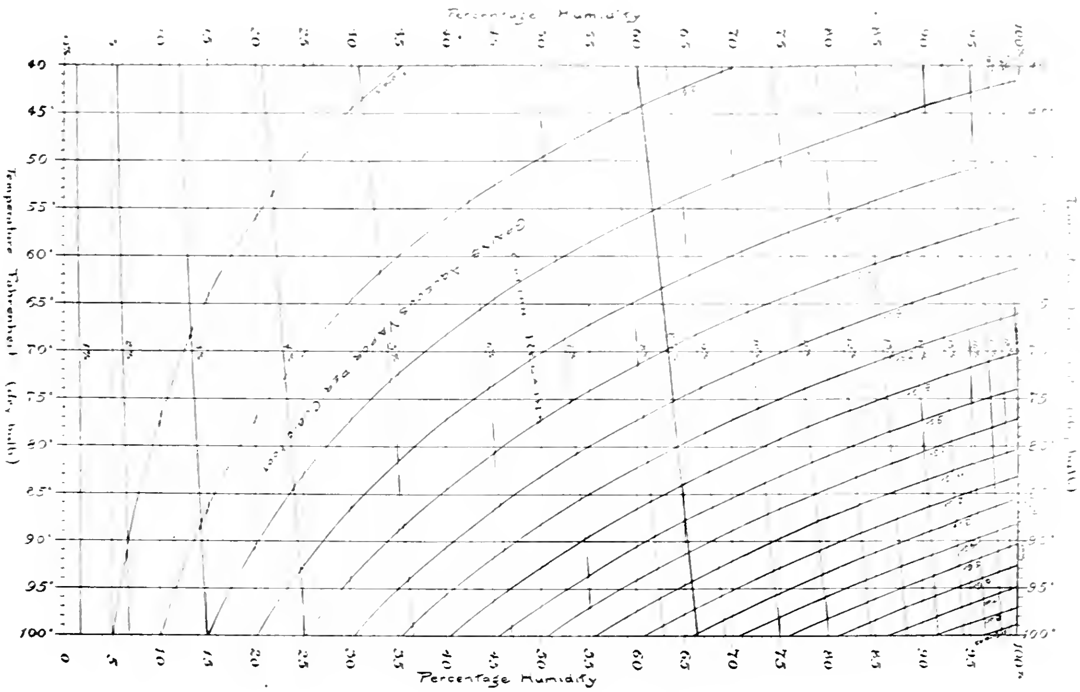

Fig. 11 Unit-Variation Regain Lines, Cotton

it and on Figs. 8 and 9 the curves running in a convex upward direction from left to right and labeled from 1 to 40 deg. downward represent the position of unit differences in the wet-and-dry bulb readings of a sling hygrometer and are plotted from relative humidities, with barometer at 30 in., very carefully calculated to the nearest one-tenth of 1 per cent.

The lines crossing these wet-and-dry-bulb difference curves and running from left to right, concave downward, are designated barometric-correction curves. They are labeled, beginning at the lower left-hand corner, 1.9, 1.8, 1.7, etc., to 1.0, and then continuing 0.9, 0.8, etc. Their significance is this: The correction in per cent to be added to or subtracted from the humidity findings by the chart curves will be one times the drop of the barometer in inches below 30, and one times the rise above 30, respectively, on every reading falling on the line labeled 1.0, and 0.9 times, 0.5 times or 1.1, etc., times such readings falling on the curves so labeled.

For readings *falling between* these lines, a relative estimate can be interpolated by inspection, if need be.

Regain Curves. Figs. 8 and 9 are intended to be used in determining from sling-hygrometer readings both absolute and relative humidities, within the limits of temperature indicated and the corresponding regains, for a state of equilibrium therewith on wool and cotton respectively.

Figs. 10 and 11 show within the same limits of temperature the unit-variation regain lines for wool and cotton with labeled, respectively, 15.5 per cent, 18.25 per cent and 8.5 per cent. These, with the three emphasized lines at 15, 19 and 20 per cent, represent equilibrium conditions for certain commercial standards in wool and cotton, to be more fully described and explained later.

All these lines are plotted from data developed either directly from the writer's original formulæ, or, where admissible, by interpolation from the tables in the Appendix.

Absolute-Humidity Curves. In each of Figs. 8 to 10 are plotted curves running from left to right in a convex direction downward, labeled, respectively, 1 grain, 2 grains, 3 grains, etc., up to 19 grains, which represent weights of aqueous vapor per cubic foot under the temperature and relative humidity conditions indicated at their points of intersection with the temperature and humidity lines. These curves are plotted from data calculated from Professor Marvin's Table 12 in U. S. Weather Bureau Report No. 236.

ILLUSTRATIONS OF THE PRACTICAL USE OF THE CHARTS

Example 1. Assuming a 30-in. barometer, suppose an observation by the sling hygrometer gave a dry-bulb temperature of 65 and wet-bulb 60 deg. Note in Fig. 8 that the 5-deg. difference curve crosses the vertical 65-deg. temperature line just a little below its intersection with the horizontal 75 per cent humidity line; that the curve for 5 grains of aqueous vapor per cu. ft. crosses a little to the left of, and the 19 per

cent regain for clean wool exactly at the same 75 per cent point. The results would be properly recorded:

Temperature, deg.	65
Relative humidity, per cent	75
Absolute humidity, gr. per cu. ft.	5.1
Wool regain, per cent	19
Cotton regain, per cent	10.7 (Fig. 9)

It will be observed that even on the reduced scale of Fig. 9 it would be possible to read the relative humidity closer and call it 74.8 per cent, and the other items correspondingly less; but it would not be worth while to do so for a single observation, because that degree of accuracy would rest upon the assumption that the difference in the wet- and dry-bulb temperature had been taken with an observation error of less than one tenth of a degree—an improbable supposition, except with a very careful observer using very refined instruments. Mill observations are usually taken to the nearest ½ deg., implying a possible error of over 0.2 deg., or as much as 1 per cent in any single record of humidity, under approximately like conditions.

Again, under like circumstances, referring to Fig. 7, it will be seen that the observed point falls approximately on the barometric-correction curve 0.3, which means that it would require a difference of 3 1/3 in. in the barometer, more or less than 30, to make a difference of 1 per cent in the humidity reading; or, in other words, an amount no greater than the possible error of an ordinary mill observation.

Example 2. For dry bulb 77½, wet bulb 61 deg., difference 16½ deg., the point is found at:

Temperature, deg.	77½
Relative humidity, per cent	37½
Absolute humidity, gr. per cu. ft.	3.8
Clean-wool regain, per cent	10.3 (Fig. 8)
Cotton regain, per cent	5.3 (Fig. 9)
Barometric-correction factor	0.65 (Fig. 7)

In this case, to need a correction of as much as 1 per cent in the humidity record, involving 0.2 per cent and 0.1 per cent only in the reading for the regain conditions of wool and cotton, respectively, would require [since $(1.00 \div 0.65) = 1.54$] a drop in the barometer to below 28½ in. or a rise to above 31½ in.

OTHER INTERPRETATIONS AND INFERENCES

As regards barometric corrections in mill practice, the humidity conditions usual either for warehouse storage or manufacturing rooms evidently lie above the barometric-correction curve labeled 1.0; and Figs. 8 and 9 show that it requires, for conditions in the neighborhood of this line, a difference of about 5 per cent in relative humidity for wool and 10 per cent for cotton to make as much as 1 per cent difference in their respective regain conditions. Consequently, the probable maximum effect upon humidity readings of any barometric change likely to occur in our latitude and at elevations not exceeding 1,000 ft. would only be equivalent to about one-half of one per cent in the proper reading for the regain of wool and one quarter of 1 per cent for cotton. The common custom, therefore, of paying no attention to barometer [illegible] for moisture conditions in factories [illegible] is quite justifiable from a practical standpoint.

It cannot at present be said that any definite standard for moisture regain on cotton, manufactures of cotton, raw or scoured wool, worsted yarns, or other manufactures of wool except tops, or other textile materials except silk, is properly recognized in the trade in this country.

The most important reason for not adopting the English and Continental standards for wool here lies in the fact that it is more difficult to maintain indoor atmospheric conditions in our climate corresponding to such standards, and, moreover, tops and yarns actually containing such amounts of moisture, if long stored unprotected from mildew, are likely to become seriously damaged.

In the writer's experience there is little such danger of damage at 15½ per cent on wool (15 per cent on oil stock) or 8½ per cent on cotton. While it is true that for the best conditions of spinning it is better to have in the material an amount of moisture equal to, or possibly even greater than, the Bradford standards, in order to allow for necessary losses by evaporation and still maintain a humidity condition of spinning rooms at a point where electrical action in cold weather would be without material effect, yet this can be taken care of by the spinner himself, and need not involve the danger from mildew by long storage at Bradford standards in our warmer climate. However, with material worth anywhere from 50 cents to \$2.00 per lb. or more, it is easy to see the commercial importance of knowing at what price 100 lb. of bone-dry material is being bought or sold, but it makes little difference, as a commercial transaction, whether the price be fixed on the basis of that 100 lb. weighing 110 lb., 115 lb., or even 120 lb., providing the standard is accepted, condition determined, and corrected weight billed up.

The skin which forms on the surface of some oil paints and varnishes is practically airtight. According to a paragraph in the *Zeitschrift des Vereines Deutscher Ingenieure* of July 21, 1917, such a skin, which is, at any rate, waterproof and dustproof, can be formed on sacks of jute and on bags of cardboard, etc., for the transport of lime, chalk, cement and dextine, as well as for packing greasy and oily materials. The process is described as the Plüss-Stauffer process, and it is stated that the skin is pressed upon the material, which need not be a texture, by special machinery.—*Engineering,* September 28, 1917, p. 340.

Aluminum bronzes can be improved by thermal treatment. When they contain less than 7 per cent of copper, the thermal treatment will not affect the properties much, according to the *Giesserei Zeitung* for June 1, 1917. Higher-grade bronzes can be hardened, however, and by the further addition of iron, silicon and other elements the mechanical properties of the alloys can be much varied. Thus, for instance, bronzes can be prepared having a Brinell hardness of 100 without being brittle. An aluminum bronze, resembling in its mechanical properties a 0.35 carbon Swedish steel, was given hardness values ranging from 100 up to 260 by various thermal treatments; such bronzes will answer as bearing metals even for high speeds. The following figures are given as to the properties of a 10 per cent aluminum bronze containing some titanium, the percentage of which is not stated; the figures refer to the original alloy as cast, to the quenched bronze, and to the bronze after the thermal treatment at different temperatures: Limit of elasticity in kg. per sq. cm., 9.6, 19.8, 27.7 to 19.2; tensile strength in kg. per sq. cm., 51.8, 73.6, 67.7 to 64; elongation in per cent, 19.5, 1.0, 5.5 to 1.4; contraction of area in per cent, 33.7, 0.8, 9 to 18.5; Brinell hardness, 100, 262, 158 to 140.—*Engineering,* September 21, 1917, p. 305.

LABOR-TURNOVER RECORDS AND THE LABOR PROBLEM

By RICHARD B. GREGG,[1] BOSTON, MASS.

Non-Member

The application of rational methods of analysis to the conduct of the operative details of industrial establishments has long been accepted as an effective means of approaching the maximum efficiency of output, and in recent years production problems of all kinds have been studied and solved by such methods. In this paper the author advocates the application of a similar mode of analysis to an increasingly important phase of the labor problem, namely, the labor turnover, or the shifting of workers from one place of employment to another. He considers various causes that have given rise to the problem and suggests other aspects of the subject that still remain to be explored, leaving a discussion of the remedies which have proved successful for future treatment.

THE study of labor turnover is the measurement of the movement of industrial workers in and out of their employment, and the analysis of its causes and results. The value of such study is patent to everyone who has ever handled employment. The difficulty of training a continually shifting force, the low quality and quantity of production obtainable from tramp workers, the lack of team play, low standards, poor tone, discontent and unrest in an establishment where the labor turnover is high—all these are factors that gravely affect both the annual balance and the ease and effectiveness of management.

There is, of course, a certain amount of labor turnover which is unavoidable and normal. The factory will always be losing people from old age, death not caused by industrial accident or occupational disease, marriage, changes of residence or domestic events wholly uninfluenced by the character of work or pay. What this normal amount will be will vary from factory to factory according to local conditions. A careful estimate in one instance placed it at 21 per cent of the total working force. The amount of turnover in excess of this normal, excepting lay-offs due to slackening demand for product, may be considered a kind of barometer of dissatisfaction, either of employer with employee or of employee with position. The quittings are in effect a sort of gradual continuous strike.

Let us imagine a factory where there is a high labor turnover, with all its consequent difficulties. What would it mean to apply scientific methods to this problem, and what would be the probable results? First of all, we must get the facts. How great is the labor turnover? To get this we must examine the payroll or keep a record of the hirings and quittings and discharges from the entire factory for a given period of time—say a year. By comparing the total number of "leavers" for all reasons with the total normal number of workers in the factory we may obtain the turnover in terms of precentage, which is useful for comparisons with other periods or other groups of workers. For purposes of thorough analysis it will be well to obtain the amount and percentage of turnover for each department and each position with the departments. In one factory the annual turnover for the entire concern for several successive years was in the region of 45 per cent. Again, in one department in a cotton mill the turnover last year was over 500 per cent. The turnover in some positions will occasionally run much higher than that.

Having obtained the annual turnover *in toto* and in detail in this fashion, we will get further light on the situation by working out the turnover for each week and for other divisions of the year such as each of the thirteen four-week periods. In this way we learn whether there are any seasonal or periodic fluctuations. In some industries, such as the building trades or the manufacture of clothing, such variations are very marked.

It is obvious that these measurements and analyses tend to make it more possible to learn the causes for the turnover. Once we learn real causes and definitely locate responsibilities we are in a position to begin to control the phenomenon.

Carrying out our analysis and arrangement of facts still further, we can often obtain very valuable indices of the reasons for high labor turover. For instance, grouping the leavers according to their actual earnings will show the significance of the wage factor as a cause for leaving. To illustrate how this works out: A certain cotton mill learned that there was a high labor turnover in its power department. Upon further analysis the turnover was found to be confined almost entirely to the coal handlers. Inquiry showed that these men were receiving fifty cents a week less than the coal handlers at the local railroad station. The wage was raised fifty cents, the turnover ceased, and the management was relieved of its worry about demurrage charges. Usually a large part of the shifting will be found in the low-paid groups. The results of most experiments with this fact seem to show that low wages are much more the cause of the high turnover than any inherent and unchangeable characteristics of that group of workers.

Other groupings that might prove significant are sex, nationality, age, foremen, rooms, heaviness of work, amount of illumination or ventilation of work place, dirtiness of job, method of pay, amount of accident risk, anxiety, amount of other fatigue factors, distance of workers' homes, etc.

A further aid in learning the causes for leaving is making inquiries from the leavers before they go and from the foremen.

As a result of all this recording of facts, measuring, weighing, testing, analysis and classification, we find ourselves able to determine the real causes for the turnover in a large number of cases. Sometimes the causes will be simple, as in the case of a motor company that learned that most of its leavers had resided a considerable distance away from the plant. By giving preference to applicants living nearby the turnover was grad-

[1] 75 State Street.

For presentation at the Annual Meeting of the AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York, December 4 to 7, 1917. The paper is here printed in abstract form, and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

[illegible] greatly reduced. Usually, however, there is a complex of conditions, and the apparent cause merely serves to release discontent that has gradually been accumulating for a number of reasons. With patience and skill we can usually arrive near to the truth. By further measurement and analysis we can determine, or at least approximate, the cost of losing a worker in a particular position and training another. These costs may be roughly divided into overhead costs and operating costs.

Among the overhead costs there are:

1 More rapid depreciation of machinery because of ignorance or lack of skill of new workers
2 Extra floor space and extra machines to provide against idleness of a certain amount of machinery due to shifting labor.

Operating costs may include any or all of the following:

1 Time of increased superintendence or office work:
   - *a* Time spent by foremen or superintendent in discharging a workman where that is the way the vacancy occurred
   - *b* Time spent by foremen or other workers in training the new employee
   - *c* Time spent by clerks on additional payroll or other records.
2 Machine costs, covering
   - *a* Time machinery is idle when a new worker cannot be obtained immediately
   - *b* Idle machinery for temporary stoppages due to ignorance or lack of skill of new worker
   - *c* Repairs to machines or renewals of tools broken for the same reason.
3 Material costs, including
   - *a* Waste or damaged material due to ignorance or lack of skill of new worker
   - *b* Difficulties in subsequent processes due to poor work by new employees in previous processes
   - *c* Lower production while new employee is working up his best skill.
4 Additional accident cost due to higher rate of accidents among new employees.

These two kinds of overhead costs and four groups of operating costs, while not exhaustive, serve to illustrate the method of observation, recording, measurement and analysis which is just as helpful in this aspect of the matter as elsewhere. With knowledge so obtained the factory manager is in a position to estimate more truly the importance of this problem and to judge whether he can afford to take certain steps to reduce this turnover.

As is probably well known, those who have made the most careful studies of this question find that it costs about $10 to replace an ordinary laborer, and as much as $300, and perhaps more, to replace skilled workers. The cost varies, of course, with the nature of the position. The total losses are unquestionably enormous. Mr. Magnus Alexander in his well-known study, it may be remembered, estimated the losses in a group of twelve metal-working factories in a single year at not less than $831,000; and one textile mill, employing about two thousand workers, may be mentioned which is losing at least $20,000 annually from its high labor turnover. Other instances could be multiplied.

It should be remembered, moreover, that none of these estimates includes the losses to the employees or the community. What frequent job shifting means to the employee and his family in terms of frequent house moving, ill-feeling, discouragement, bitterness, decrease of skill, lowering of pride and self-respect, we have no means of measuring.

There are many other aspects of the matter that still remain to be explored. What are the relations between absences and tardiness and labor turnover? Cannot absences and tardiness be studied in the same way as labor turnover? What are to be the relations of labor-turnover control to such problems as trade education, promotion policies, the intellectual life of the industrial community, the mobility of labor, scientific management, women in industry? Will it be wiser to leave the broad problem of control of labor turnover entirely in the hands of employers, or should the state have a voice in the control? These are questions both of the present and of the future. In thinking about them and working over them it is important to bear in mind the value of scientific method. The discovery of a unit of measurement, a method of measurement, analysis and classification, has made possible great advances in this one small part of the labor problem.

Let us get the facts in the labor situation,—all of them. Just as Darwin always recorded all facts which tended to contradict his hypotheses, because he knew that unless he did so he would be apt to overlook those facts in order to make his hypotheses triumph, let us also recognize the presence of personal and business interests and bias in ourselves as well as in others. Let us never dodge or shirk the facts. Let us record them so that we and others can study them at any time. Let us measure when means of measurement are obtainable. Let us analyze, weigh, test, and fearlessly experiment. Let us invoke our finest constructive imagination in making our hypotheses. Let us not be dogmatic but humble with our theories, ready to throw them away when new facts are recognized.

Let us last of all never overlook the human instincts. They lie at the heart of our problem. Because of much past neglect in the handling of this question they require the greater emphasis.

It is unquestionably a trait that every person wants to have some sort of control of the circumstances and direction of his own life and of his work as a part of his life. For this reason I believe not only in scientific method and spirit, but I also believe that science must join hands with democracy in order to reach any sound solution of the greatest of all our problems. To find the methods and forms of organization through which such a solution may be obtained is the task that lies ahead of us.

Like the farmer, the engineer is an indispensable factor in the well-being of the nation. He has to deal not with whim and fancy, but with the forces and elements of nature. At bottom his problems involve the utilization and conservation of the natural resources of the nation—the patrimony, as it were, of nature to man. With progress social life becomes increasingly complex. With division of labor comes the efficiency and expertness of the specialist, but also the interdependence of individuals and communities. Only the uncivilized who live upon the gifts of nature are today self-sufficient and independent as regards the necessities of existence. A large city, on the other hand, is always within hailing distance of starvation. The engineer is a product of this interdependent life, and his sway has increased as civilization has grown in complexity. His function has become so specialized that it cannot be dispensed with, and none can substitute in his place. Light, heat, power, sanitation, irrigation, construction, intercommunication—these are vital elements in modern progress.—*Power,* October 23, 1917.

ACCIDENT PREVENTION IN THE TEXTILE INDUSTRY

By DAVID S. BEYER,[1] BOSTON, MASS.

Non-Member

Mechanical accidents form a large percentage of all those occurring in the textile industry. Contributory factors to this condition are (1) an exceptionally large mechanical exposure—the exposure points run into the thousands or tens of thousands for a single plant and it is an extensive problem to guard completely all the belts and gears, (2) female and child labor—a large percentage of the employees are women and youths, and (3) an ever-present temptation to clean machines in motion—there is a natural tendency on the part of the operator to be constantly cleaning or picking the "fly" out of a machine.

There is probably no other industry where so great a weight should be given to mechanical guarding, or where effective guards will produce such important results.

This paper describes the various methods and forms of mechanical protection which are desirable for textile machinery, discusses effective steps toward overcoming difficulties encountered in providing complete safeguards, and codifies definite standards for use in specifying guards for textile machinery.

THE manager of the steel mill handling several hundred tons of molten metal every day, might think that in comparison with his difficulties the mechanical problem involved in turning out a spool of thread or a bale of cloth would be very simple. A study of conditions in the textile industry, however, would soon convince him that the man in charge of a modern textile plant has some problems which are all his own. Many of these problems come from conditions which have a very direct bearing on accident prevention, notably the following:

Mechanical Exposure. In the majority of manufacturing industries the number of machines is less than the number of employees. For example, the combined insurance records from a number of states show the following average conditions:

Earthenware manufacturing, 17 machines per hundred employees.
Furniture manufacturing, 40 machines per hundred employees.
Rubber goods manufacturing, 60 machines per hundred employees.
Printing, 67 machines per hundred employees.

In the textile industry, on the other hand, the number of machines usually exceeds, by several times, the number of employees. Sixty-one characteristic cotton mills contained 33,393 employees and 119,078 machines, or,

Cotton mills....................357 machines per hundred employees

The average cotton mill in Massachusetts has nearly a thousand employees and several thousand machines. These machines are usually belt-driven, and some of them have auxiliary belts in addition to the main driving belt. Most of them have gears at several points on each machine. The exposure points run into the thousands or tens of thousands for a single plant, and it is an extensive problem to guard completely all the belts and gears.

District	Males 16 years and over		Females 16 years and over		Children under 16 years	
	Number	Per cent	Number	Per cent	Number	Per cent
New England States....	76,483	49.0	70,113	45.0	9,385	6.0
Middle States..........	13,852	43.7	15,116	47.6	2,765	8.7
Southern States.........	54,577	45.5	37,885	31.6	27,538	22.9
Indiana and Other States	806	29.4	1,597	58.3	341	12.3
Total..............	145,718	46.9	124,711	40.2	40.029	12.9

Kind of Employees. Another feature of the textile industry that adds to the accident hazard is the fact that such a large percentage of the employees are women and youths, as shown by the data in the preceding table from one of the U. S. Government publications.[1]

These figures were for 1905, and it is probable that the number of young persons employed in the cotton mills has been reduced by child-labor laws enacted since that date. It is undoubtedly safe to assume, however, that at least half of the employees in cotton mills are women and children.

Women are naturally less mechanically inclined than men and are not so likely to appreciate the danger of power-driven machinery. Their clothing and hair are much more likely to become entangled in machinery, thus making the hazard inherently greater for women than for men. The youthful employee is also more likely to be injured through carelessness and as the result of chance-taking or horseplay.

A large percentage of cotton-mill employees are foreigners, to whom it is difficult to explain fully the hazards of their work. Figures from the government report mentioned show that less than 10 per cent of the employees are American or American-born.

Cleaning Machinery. Another condition contributing to the accident hazard in the textile industry is the fine lint or fluff which results from many operations, and which tends to collect in the form of "fly" over the machinery and gets into the gears and moving parts. While this is not likely to injure the machinery, it brings about a natural tendency on the part of the operator to be constantly cleaning or picking the "fly" out of the machine.

Most plants have rules that the machinery shall not be cleaned while in operation, but they are difficult to enforce. Out of a total of 557 mechanical accidents reported by cotton mills to one insurance company, 88 (or about 16 per cent) occurred from cleaning while machinery was in motion. The

[1] Vice-President and Chief Engineer, Liberty Mutual Insurance Company.

[1] Report of Conditions of Women and Child Wage Earners in the United States.

For presentation at the Annual Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York, December 4 to 7, 1917. The paper is here printed in abstract form, and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

tendency to do this is enhanced by the fact that the operators are usually paid on a piece-work basis, hence they do not like to lose any product by having the machines shut down for cleaning.

Thus we have the combination of (1) an exceptionally large mechanical exposure, (2) female and child labor, much of which is non-English-speaking, and (3) an ever-present temptation to clean machines while in motion. Under these circumstances it is not surprising that mechanical accidents form a large percentage of all accidents occurring in the textile industry. That this is actually the case is corroborated by an analysis of accidents in Massachusetts, a state which has approximately one-third of all workmen employed in cotton mills in this country. While mechanical accidents for all industries of the state were only 27 per cent, numerically, of the total number of accidents reported, mechanical accidents in cotton mills were 44 per cent of the total for this

FIG. 1 GUARDS FOR PICKERS

These photographs show an excellent arrangement of guards for belts and chains on pickers. The guards are supported by rods fastened to the framework of the machine, and can be quickly removed by loosening a couple of thumbscrews which secure them to the supports. This permits cleaning the floor underneath the guards without disturbing them, as would be necessary if the guards were supported from the floor. In order to avoid places where "fly" may collect, the guards do not completely enclose the belts and chains, but a transverse section has been placed across each guard, between the two sides of the belt or chain, to prevent danger of a hand being slipped down inside the guard and thus being caught and injured. The projecting end of the beater shaft is protected by a metal cap.

industry, or nearly double the average ratio for the other industries.

An additional study of accidents in the thirteen principal industries of Massachusetts, such as boots and shoes, metal-working, electrical supplies, rubber factories, paper mills, and printing establishments, shows that the lost time per thousand employees resulting from the mechanical hazards of belting, shafting and gearing is three times as great in the cotton mills as the average for the whole thirteen industries.

Mechanical accidents as a class are more serious than non-mechanical accidents.[1] While they represent a little less than one-half of all accidents reported in the cotton industry in Massachusetts, it is probable that they are at least three-quarters of the problem from the standpoint of severity.

While safety education of employees through the organization of safety committees, safety talks, the posting of safety bulletins and signs, etc., are important in this industry, as in all others, there is probably no other industry where so great weight should be given to mechanical guarding, or where effective guards will produce such important results, as in the textile industry.

INTERLOCKING GUARDS

The effort to reduce the mechanical accidents in this industry has resulted in the development of a type of guard which is about as nearly "fool-proof" as any mechanical device can be,—the so-called interlocking guard. In this form of protection the guard is so arranged that it cannot be removed while the machine is running, and the machine cannot be started until the guard is in place.

This result can often be secured by a very simple and inexpensive arrangement; for example, the beater lock shown in Fig. 2. The beater revolves at high speed and the loss of hands and other serious injuries have resulted from employees putting their hands into it while it is running. To prevent such occurrences a disk is keyed to the beater shaft so that it revolves whenever the beater is in motion. Before the beater cover can be raised a projection on the locking arm used to keep the beater cover closed must be slipped through an opening in the disk. This can only be done while the disk and shaft are at a standstill, and so long as the locking arm is in contact with the disk it prevents the machine being started, which means that the cover must be replaced and the locking arm slipped back over it before the machine can be started up. Similar devices are also applied to various kinds of gear covers.

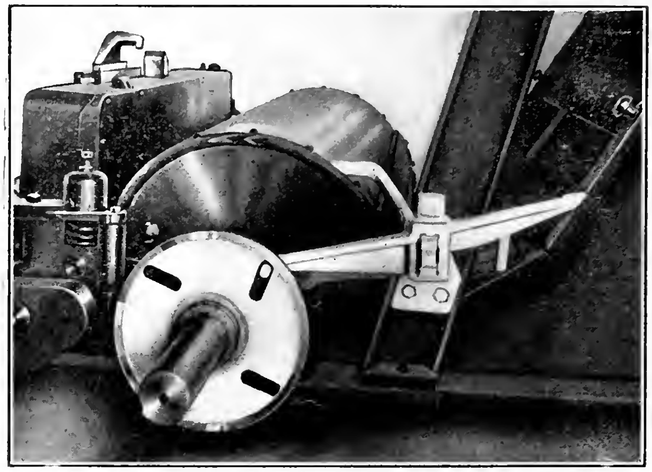

FIG. 2 INTERLOCKING DEVICE FOR BEATER COVER AND DOOR OVER DIRT GRID (PAT.)

In order to open the beater bonnet or the door, a projection on the locking lever (shown in white) must be slipped through the disk on the beater shaft. Obviously this can only be done while the machine is at a standstill. In order to start up the machine again, the locking lever must be slipped out of engagement with the disk, which insures the bonnet and door being closed before the machine is started.

The general application of this principle to textile machinery would eliminate many of the accidents which now occur on account of carelessness or thoughtlessness of the employees.

[1] See paper by the author presented at the 4th Annual Meeting of the International Association of Industrial Accident Boards, and reprinted in the Weekly Underwriter for September 13, 1917. In one state which kept a separate cost record for these classes, the average mechanical accident cost nearly twice as much as the average non-mechanical accident.

WHEN IS A GEAR GUARD NOT A GUARD?

This is a question that has been agitating safety inspectors and plant managers ever since the first gear guard was built. There is a natural desire on the part of everyone to make guards as simple and inexpensive as possible. Unfortunately, this perfectly legitimate desire has resulted in two types of guards for gears which are so ineffective that they have tended to discredit guarding to a certain extent, because accidents still occur after the so-called guards are installed. One is a band over the face of the gear following more or less closely the outline of the gear, but leaving the most dangerous part, the mesh point, exposed sufficiently to admit a finger or even a hand. Another is to provide a guard which protects the mesh point, but which is not carried around the periphery of the gear, and thus forms a shearing action between the teeth of the gear and the edge of the guard at the point where the teeth pass underneath the guard.

Many of the pioneer concerns in the safety movement, such as the United States Steel Corporation, started out by installing gear guards of the above types; but found that they did not eliminate the accidents and later changed them to guards completely enclosing the gears. There are many partial gear guards in the textile industry today, and they sometimes contribute to accident occurrence from the false sense of security they inspire.

An analysis of 550 textile-machine accidents reported consecutively to an insurance company showed that 88 of these

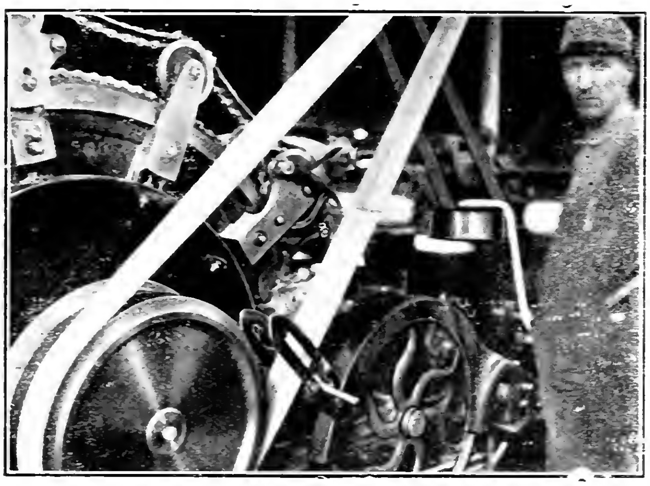

Fig. 3 Belt Shifter for Cards

This shifter can be installed by simply securing it to the circular flange above the pulley by means of one or two set screws. It only requires a few seconds to loosen these set screws and slip off the shifter when it is necessary to reverse the belt for grinding.

accidents, or about 16 per cent, were from gearing; more than a third of the gear accidents were due to cleaning the machinery while in motion.

It is not practicable to apply the interlocking principle to all gearing on textile machinery, but it is practicable to fully enclose the gears; and where the guards are not interlocked they should be firmly fixed in position by cap bolts or other means that make it difficult for the operatives to remove them quickly, and tend to restrict their removal to properly authorized mechanics.

From a list of Massachusetts accidents, out of a total of 1087 gear accidents occurring in one year the cotton mills contributed 400; in addition, the woolen and worsted mills had 236. Thus we see that cotton and woolen mills were responsible for considerably more than half the total number, although they only employed about one-quarter of the workmen engaged in manufacturing industries in the state.

BELT GUARDS

There were 254 accidents from belting in Massachusetts cotton mills during one year and 113 accidents in woolen mills, or a total of 367 for the two industries; this shows that belt guards are also important for textile machinery.

A good many textile machines, such as roving, spinning and twisting frames, have an outboard bearing, supported by a framework around the pulley, that tends to keep employees away from the pulley and offers a certain degree of protection. In addition, these machines are commonly provided with belt shifters, and where the shifter comes down close to the point of contact between the belt and pulley it considerably reduces the chance of anyone being caught at this point, where most of the serious belt accidents occur.

Fig. 4 Belt Guard on Spooler

This shows a belt guard which has been developed by one of the machinery builders. This is a simple and inexpensive type of guard, but taken in conjunction with the outboard bearing and belt shifter it gives quite a good degree of protection.

Several manufacturers of these machines have provided an excellent guard, consisting merely of a semi-circular disk casting or plate which is fastened to the outboard bearing of the machine. This guard only extends a few inches above the contact point between the belt and pulley, and does not guard the upper part of the belt to the height which is commonly prescribed in insurance and other mechanical standards for safeguards.

For other types of machines it is usually impossible for the machinery manufacturer to provide belt guards as an integral part of the machine, on account of the fact that the driving belts lead off at various angles which can only be determined by the local arrangement of each plant. Under such conditions it is necessary for the belt guards to be installed at the plant, after the machinery is in place.

BELT SHIFTERS

Some types of textile machinery, such as roving and spinning frames, have long been equipped with belt shifters as an operating necessity, since the operators need to shut down the machines at some distance from the driving belt.

Other machines, such as cards, are commonly found with-

out shifters. There has been a notion generally prevalent among mill owners that it was impracticable to apply belt shifters to cards on account of the grinding operation, which requires the belt to be reversed. Shifters which are thoroughly practical in operation have been developed, however, and cards, as well as other textile machines, should be so equipped.

OTHER SAFETY PROVISIONS

Various additional forms of mechanical protection are desirable for textile machinery, such as the elimination of all protruding set screws, keys, bolts or other dangerous projections from revolving parts, and the guarding of projecting shaft ends. Crushing or shearing actions in some machines, such as mule spinning frames, should be protected, as should also rope drives on mule frames.

Many eye injuries have been caused by shuttles flying from looms, and shuttle guards are accordingly important for weaving equipment.

Steam heated drums or cylinders of slashers, calenders, etc., should be provided with relief valves, and the use of a reducing valve with pressure gage and safety valve on the low-pressure side of the line is an important item of safety equipment for the steam line supplying auxiliaries of this kind.

There were 1776 accidents in one year in Massachusetts caused by machinery peculiar to the cotton mills, and 903 by machinery peculiar to the woolen and worsted mills.

GUARDING EXISTING EQUIPMENT

Many machines in each textile plant are usually duplicates of one another, so that the pattern for one guard may apply to several hundred machines. Where the guards are made by the manufacturer and the expense of designing guards and making patterns, etc., can thus be distributed over a number of mills, the cost can be reduced to about the lowest possible minimum.

In spite of this condition, however, when we take into consideration the fact that several thousand guards may be required to fully protect the machinery in a single plant, it is evident that the guarding of existing machinery must necessarily be carried along gradually so as to distribute the labor and expense over a period of years.

GUARDING NEW EQUIPMENT

New machinery is constantly being installed, however, and at the present time much of this machinery is going in an unguarded or partially guarded state, even though the machine builders have developed simple and effective guards for most of the dangerous machinery, and will furnish these guards for new equipment at little or no increased cost. This is an inefficient way of handling the matter, as it is often difficult for the mills to design satisfactory guards after the machinery has been installed, and the cost of the latter method is considerably greater. Worst of all from the safety standpoint, workmen are likely to be injured on the unguarded machinery before it can be protected.

Probably the installation of unguarded machines is due more than anything else to the lack of definite safety standards in this country for textile machinery. As matters stand at present the different textile plants have little opportunity to find out what are effective and practical guards which they could use in ordering new machinery. The machinery builder is also in a quandary, on account of the varying requirements of different states and of different plants. If one builder attempts to furnish complete safeguards for his equipment he is likely to be underbid by a competitor who economizes on cost by omitting the guards.

SAFETY STANDARDS FOR TEXTILE MACHINERY

Probably the most effective step toward overcoming these difficulties would be the preparation of definite and authoritative safety standards which could be used by the factory manager in ordering new equipment and by the builder in designing his machinery. If such standards were prepared and given wide, general publicity they would undoubtedly be followed for most of the future installations.

It would seem that this might be an excellent line of effort for the Sub-Committee on Protection of Industrial Workers of the Society, or for a special committee which might be appointed. The textile section of the National Safety Council at its annual Congress in New York, 1917, went on record in favor of such standards, and voted to appoint a committee which would coöperate with any others interested in drawing up safety standards for the textile industry.

Much work in the way of developing satisfactory safety devices for textile machinery has already been done, and provisions such as the following, each one of which has been put into practical use by one or more plants, might well be included in these standards:

General Standards for All Textile Machines

1. All gears and sprockets exposed to contact shall be completely enclosed, or have a band guard around the face of the gear or sprocket with side flanges extending inward beyond root of teeth, of such design and arrangement that a finger, cannot project through, over, around or underneath the guard and be caught in mesh point of gears or contact point of chain and sprocket.

2. All dangerous projections on revolving shafting such as protruding set screws, keys, bolts and couplings, shall be made flush with the surface or effectively guarded in such a manner as will prevent their catching clothing of persons which may come in contact with them. Projecting ends of beater shafts shall be encased or otherwise effectively guarded.

3. Driving belts shall be equipped with mechanical shifters.

Additional Standards for Certain Textile Machines

Pickers. All beater covers and doors which can be reached while the machine is running, shall be equipped with interlocking devices which prevent their being opened while the machine is in operation and the machine being started while the covers are in place.

Cards. Cylinder covers or doors shall be equipped with interlocking devices which prevent their being opened while the machine is in operation and the machine being started until the covers are in place.

Lap Machines and Doublers. These machines shall be provided with interlocking guards which will prevent the operator from coming in contact with the in-running rolls while they are in motion.

Drawing, Winding, Ring Spinning and Twisting Frames, Etc. Covers or doors giving access to head end gearing of these machines shall be equipped with interlocking devices which prevent their being opened while the machine is in operation or the machine being started until the covers are in place. A guard shall be placed in front of the driving pulley which will effectively guard the point of contact between the belt and pulley.[1]

Looms. Looms shall be provided with effective shuttle guards.

There can be no disagreement as to the desirability of accident prevention from the humanitarian standpoint; from the business standpoint, however, it takes on a new aspect when we realize its effectiveness in reducing an important item of manufacturing cost. Accident prevention then becomes of vital interest.

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[1] Belt guards should also be provided for other machines, but they can usually be furnished more advantageously by the purchaser than by the machinery builder.

BAGASSE AS A SOURCE OF FUEL

By E. C. FREELAND,[1] BATON ROUGE, LA.

Non-Member

The heating value of one pound of average dry Louisiana bagasse has been found by experiment to be 8300 B.t.u., and despite a high moisture content of about 50 per cent, it is therefore a valuable fuel. While in former years not much attention was paid to the drying of bagasse before burning it, many authorities now claim that a great saving can be effected by such a procedure. The calorific value of this important fuel to the sugar industry, as influenced by the high moisture content, and the benefits of preliminary drying are discussed at length, various methods of calculating the fuel value being given, together with notes on devices employed by various sugar houses in its use for steaming purposes.

THE use of bagasse, or megasse, as it is sometimes called, as a source of fuel, dates from the earliest periods of cane-sugar manufacture. Even before vacuum pans came into use, the sugar manufacturer was wont to burn the sun-dried, or even the green, bagasse under the open kettles. When steam was introduced into the sugar factory as a means of heating the cane juice and syrup, bagasse came to be burned under the boilers as a result. The first boilers designed for bagasse burning differed very little from the coal-burning boilers at that time. As more modern improvements were introduced into cane-sugar manufacture, the methods of burning bagasse were also improved upon, so that, at the present time, very efficient bagasse-burning installations have been perfected. A few of these will be described in a subsequent portion of this paper.

Some of the questions one might ask, when seeking information about this particular fuel, are: Of what value is bagasse as a fuel? How does it compare with coal or oil? What is its composition? It may be well to discuss a few of these points.

Bagasse, chemically, consists mainly of a tough fiber, sugar or sucrose, glucose and other reducing sugars (by a reducing sugar is meant one that will reduce Fehling's solution), and water. The fiber content ranges from 30 to 50 per cent; the sucrose from an almost negligible quantity to as high as 10 per cent; and the water from 40 to 65 per cent; the other constituents occur in such small amounts that they may be disregarded. Its composition varies greatly, according to the method and effectiveness of milling the cane; good milling resulting in a bagasse very suitable for burning, or low sugar and water content. In Louisiana the fiber content averages about 40 per cent and the moisture about 53 per cent; the remaining 7 per cent being mainly sucrose.

METHODS OF CALCULATING THE FUEL VALUE OF BAGASSE

There are several methods in use for calculating the fuel value of bagasse. In this country Prof. E. W. Kerr's formula is in general use. According to one of his bulletins, the fuel value of one pound of bagasse is calculated as follows:

The heat value of one pound of dry bagasse, by experiment, is 8300 B.t.u. Assume that the moisture content of a bagasse is 48 per cent, and that this bagasse is burned in a furnace the stack temperature of which is 500 deg. fahr. One hundred per cent minus 48 equals 52 per cent dry matter in bagasse. Fifty-two per cent multiplied by 8300 equals 4316 B.t.u. in the dry bagasse. Assume the temperature of the bagasse as 80 deg. fahr. Then the water in the bagasse will have to be raised from 80 deg. up to its boiling point (212 deg. fahr.), and then vaporized before the bagasse can be completely burned. The calculations for the heat necessary to vaporize this water are as follows:

212 deg. — 80 deg. = 132 deg.; 500 deg. — 212 deg. = 288 deg.

Heat necessary to raise the water in 1 lb. of bagasse to the boiling point = $0.48 \times 1 \times 132 = 63.4$ B.t.u.

Heat necessary to vaporize the water in 1 lb. of bagasse from a temperature of 212 deg. = $0.48 \times 1 \times 970 = 465.6$ B.t.u.

Heat necessary to superheat vapor from 212 deg. to 500 deg. = $0.48 \times 1 \times 288 \times 0.5 = 69.1$ B.t.u., where 0.5 is taken as the specific heat of superheated steam.

Heat lost in the water = $63.4 + 465.6 + 69.1 = 598.1$ B.t.u.

Net heating value of 1 lb. of bagasse = $4316 - 598.1 = 3717.9$ B.t.u.

Prinsen Geerligs, the noted authority on cane-sugar manufacture, has introduced the following formula for calculating the fuel value of bagasse, according to its composition:

Calorific value in B.t.u. of 1 lb. bagasse = (8550 × per cent fiber) + (7119 × per cent sucrose) + (6750 × per cent glucose) — (972 × per cent water)

The results obtained by using this formula compare very well with the results obtained by burning the fuel in a calorimeter. The one point in favor of using Professor Kerr's formula is that it does not require a complete chemical analysis of the bagasse, while in using the latter a complete analysis is absolutely necessary.

It has been found that the average Louisiana bagasse has a calorific value of about 8300 B.t.u. per pound of dry bagasse and from 3620 B.t.u. gross (with bagasse containing 56.7 per cent moisture) to 4800 B.t.u. gross (containing 42.8 per cent moisture). The net heating values are respectively 2200 and 3350 B.t.u. It is thus seen that the heating value per pound ranges between wide limits, according to the moisture content. In all of the above, 5 per cent was allowed for radiation and no excess air present. The calorific value of Cuban bagasse approaches that of Louisiana very closely for a given moisture content, but for a given per cent extraction on weight of cane the calorific value of a pound of Cuban bagasse is greater than that of a pound of Louisiana bagasse, due to a lower moisture content of the Cuban product. The results given in the tables at the top of p. 920 are typical.

The Louisiana varieties of sugar cane yield from 400 to 580 lb. of bagasse per ton of cane, or on an average of 20 to 30 per cent of the total amount of cane ground. In a 1000-ton house (1000 tons every 24 hours) this would amount to about 480,000 lb. a day, or from 19,500 to 21,000 lb. per hour.

One pound of bagasse will evaporate from 2 to 3½ lb. of

[1] Louisiana State University.

For presentation at the Annual Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York, December 4 to 7, 1917. All papers are subject to revision.

With an 80 per cent juice extraction on weight of cane:

Variety of Bagasse	Moisture, per cent	Fiber, per cent	Heating Value, B.t.u. per Lb.	
			Total	Net
Cuban	32.8	60	5628	4092
Louisiana	42.8	50	4816	3345

With nearly equal moisture contents:

Variety of Bagasse	Extraction, per cent	Moisture, per cent	Fiber, per cent	Heating Value, B.t.u. per Lb.	
				Total	Net
Cuban	75	42.6	48	4807	3335
Louisiana	80	42.8	50	4816	3345

(For a table of this kind, see La. Bulletin 117, p. 45.)

water "from and at 212 fahr." Assuming coal and fuel oil to have, respectively, calorific values of 14,000 and 19,000 B.t.u. per lb., then from 4 to 6 lb. of bagasse are equivalent to 1 lb. of coal and from 43 to 65 lb. equivalent to 1 gal. (about 7.6 lb.) of oil.

Professor Kerr found, in his latest tests at Louisiana sugar houses, that the bagasse from one ton of cane generated from 1.16 to 1.44 boiler horsepower. Thus the bagasse from a 1000-ton house for 24 hours will generate from 1160 to 1440 boiler hp. during that period of time. It would require about 60 tons of coal per day to do the same work, assuming that the coal equivalent of the bagasse from 1 ton of cane is 120 lb. It is thus seen that bagasse plays an important role as a source of fuel in the sugar house.

METHODS USED IN DRYING BAGASSE

In former years not much attention was paid to the drying of bagasse before burning it. It was was the custom either to sun-dry it or feed it to the furnaces in a wet condition, just as it came from the mills. Of later years, however, many devices have been put into use in order to dry it partially before it is burned.

In Mauritius, apparatus known as "secheries" have been put into use for this purpose. They consist of a chamber near the chimneys, in which is arranged a system of belts alternately traveling in opposite directions. The flue gases go through this apparatus, and thus the waste heat of the gases is utilized to dry the wet bagasse. In countries where labor is cheap and fuel high, as in some parts of Egypt, other devices, whereby the bagasse is conveyed around the smoke-stack and smokebox of the boilers by means of a screw-like conveyor, have come into use to remove part of the moisture from the bagasse.

A very efficient bagasse drier has been designed by Professor Kerr (La. Bulletin 128), which is in the form of a tower-like structure. The bagasse is conveyed to the top and falls downward over a series of inclined shelves placed opposite each other. The dried bagasse is conveyed from the bottom of the drier to the furnaces. The furnace gases are used to dry the bagasse and are conveyed to the bottom of the drier and pass upward, the hottest gases coming in contact with the driest portion of the bagasse. An induced-draft system is employed, the fan being placed near the top of the drier.

Of late, especially in Cuba and Hawaii, in large factories stokers are being put into use to dry bagasse. These stokers are mainly of the step-grate type, some with front feed and others with double feed. The bagasse is fed at the top or upper back part of the stoker in the same manner as coal. They have proved to be very efficient as a means of drying bagasse, as well as in regulating the combustion or burning of the bagasse.

As to the economy of bagasse drying, many authorities claim that a great saving can be effected by drying this fuel before it is fed to the furnaces. This has been proved as a result of many experiments. Noel Deerr states that in Mauritius he found that bagasse entering a secherie with 50 per cent of moisture would leave containing only 35 per cent; this amount of water corresponds very closely with the evaporation of half the original moisture. In a calculation of the heat lost in the flue gases, he found that 565 B.t.u. per lb. of bagasse were carried away in the associated water; a saving of half of this would be 282 B.t.u., reducing the heat carried away in flue gases from 1675 to 1393 B.t.u.; or, expressed as a percentage on the total heat of 1 lb. of bagasse, the loss in the flue gases is 30.4 per cent as compared with 36.6 per cent loss calculated for wet bagasse. Professor Kerr says that in Louisiana 16 per cent of the total heat generated by the combustion of 1 lb. of bagasse is required to evaporate the moisture present. About 14½ per cent of the moisture in Louisiana bagasse was removed by drying it, and the dried bagasse had a heating value 55 per cent greater than the wet bagasse. This means that a saving of over 2½ gal. of oil will be effected per ton of cane ground. In a factory grinding 60,000 tons of cane per season this means a saving of about 154,000 gal. oil, or 3670 bbl., which, at $1.25 per bbl., means a saving of $4,587.50 per season.

BOILER FURNACES FOR BURNING BAGASSE

As has been said before, bagasse was formerly burnt in furnaces very similar to those used for burning coal. During recent years, however, many improvements have been made along this line. In present practice furnaces of the Dutch-oven type are very widely used. Boilers of all types, including those of the Scotch-marine type, are used in connection with the Dutch-oven type of furnace.

The following shows the types of boilers in use at a few Louisiana sugar houses:

House	Type of Boiler
Angola	Horizontal return tubular, with Dutch oven and small draft fan.
Cinclare	Scotch marine, with suspension furnaces and Dutch oven.
Poplar Grove	Stirling, with Dutch oven.
Adeline	Horizontal return tubular, with large and elaborate combustion chamber.
Vermilion	Horizontal return tubular, with Quinn flat-top furnace.

Other types in use in Louisiana (given in Bulletin 117, La. Expt. Station) are: Babcock and Wilcox; Cook water-tube (vertical tubular); Climax water-tube (vertical tubular); and various types of boilers of the "half" and "full" Dutch-oven types.

In Demerara the Abel type of furnace is used in connection with the standard types of boilers. By using this furnace the

heated gases of combustion pass three times along the boiler. The essential difference between the Dutch-oven and Abel type of furnace is in the size of the combustion chamber, which in the latter type is much larger.

In Louisiana, the combustion chambers of sugar-house boilers are, in general, large. Where oil is burned in connection with bagasse, which is the case in many houses, there is a tendency to make the combustion chamber smaller as the burning oil causes a better combustion of the bagasse, the furnace temperatures being higher when burning these two fuels together than the furnace temperatures obtained by burning either of them alone.

The grate surface should be small in furnaces used for burning bagasse, as the rate of combustion is high, sometimes running as high as 300 lb. per hr. per sq. ft. of grate surface. This corresponds to about 20 boiler hp. per sq. ft. of grate surface. Some of the recently installed 500-hp. boilers in the tropics have only 25 sq. ft. of grate surface. Small grates require less manipulation and care in order to prevent excessive air losses than is the case with large grates, there being less danger of portions of the grate being uncovered, etc. The amount of grate surface per boiler hp. also varies with the amount of moisture in the bagasse—the less moisture there is, the smaller the grate surface can be made. In Professor Kerr's recent tests, the highest rate of combustion was at Adeline (225 lb. bagasse per hr. per sq. ft. of grate surface), while the lowest was at Vermilion (85 lb. per hr. per sq. ft.); corresponding to about 15 and 6.5 boiler hp. per unit area, respectively. It is probable that a mean between these two sizes would be good practice.

TABLE 1 DATA ON BOILER TESTS AT LOUISIANA SUGAR HOUSES

Item	Sugar House		
	Adeline	Angola	Vermilion
Bagasse burnt, per hr., lb...	3777 to 5614	2345 to 3441	3586 to 3687
Moisture in bagasse, per cent..	45.4 to 53.0	53.1 to 58.6	46.3 to 47.0
Grate surface, sq. ft	25	25.89	42
Heating surface, sq. ft. ...	2500	1512	2450
Equivalent evaporation from and at 212 deg. per hr., lb.	8636 to 13093	2197 to 6476	9131 to 9469
Bagasse burnt per hour per sq. ft. of grate surface, lb....	151 to 225	79.6 to 119	85.4 to 87.8
Steam pressure, lb. per sq. in. abs....	97 to 119	87.8 to 105	108.7 to 109.[illegible]
Quality of steam, per cent dry	98.3 to 99.8	98.5 to 99.6	98.5 to 98.7
Draft in flues, in. of water	0.464 to 0.634	0.300 to 0.487	0.417 to 0.434
Equivalent evaporation from and at 212 deg. per lb. of bagasse, lb............	2.13 to 2.35	1.36 to 1.90	2.48 to 2.64
Efficiency of furnace and grate, per cent.	a56.83 to 64.61 b63.17 to 71.9	a48.96 to 60.[illegible] b55.26 to 67.6	a61.15 to 66.65 b[illegible]7.65 to 73.81

It is the practice in Louisiana to use systems of forced or induced draft as a source of air supply. Bagasse contains a great amount of air, but when burned on a small amount of grate surface, with a high rate of combustion, it requires a high draft. When, however, it is burned in furnaces having a large combustion chamber and a large surface, air in nearly all cases is supplied in great excess, which lowers the efficiency of the boiler and grate. Where forced draft is used in Louisiana, the general tendency, it is found, is to supply air in great excess.

In order to show comparative figures on boiler tests at Louisiana sugar houses, a partial list of results is given in Table 1, which shows in each case the highest and lowest values obtained.

In calculating the efficiencies in Table 1, the following methods were used: Efficiency a = heat leaving in steam per lb. wet bagasse divided by net heating value of 1 lb. of wet bagasse [gross heating value per pound minus (heat necessary to vaporize moisture present in it plus heat necessary to raise to stack temperature)].

Efficiency b = heat leaving the steam per lb. wet bagasse divided by [net heating value per pound (same as above) plus heat required to vaporize moisture formed by the combination of the hydrogen and oxygen in the fuel]. It is probable that the latter method of calculating efficiencies is more suitable for making comparisons where there is a considerable variation in the quality of bagasse.

In conclusion, it may be said, that, although many recent improvements have been made in the methods of burning bagasse, there are yet many fields open along this same line. Methods of regulating the air supply, improvements in furnaces and driers, and utilization of the heat in the waste flue gases are some of the problems being worked upon by the sugar-house engineer of today, with a view of conserving as much of the heat as possible furnished by this most valuable by-product of the sugar house.

The latent heat of steam of standard pressure and temperature is a fundamental constant, the value of which has long been less satisfactorily known than was desirable. The values given in Kaye and Laby's Physical and Chemical Constants differ appreciably, ranging from the 537 calories of Regnault obtained in 1847 to the 540 calories found by Joly in 1895. A new determination is described in a paper by Mr. T. Carlton-Sutton, published in a recent issue of the Proceedings of the Royal Society. The plan of the experiments consisted in weighing the quantity of steam condensed upon a bulb, both when empty and when filled with water. From the two observations the latent heat can be deduced, the value found being 538.88 mean calories. It is claimed that this figure is correct to the fourth significant figure.—*Engineering*, August 24, 1917, p. 200.

One of the great events of the war has been to create a tremendous demand for labor at a time when a vast quantity of the best grade of labor formerly available has been taken away from useful occupations. According to the latest data published in the daily press, approximately 37,000,000 men are now engaged on the fighting lines. Somebody had to take their places. Part of their work is being done by machinery through an increased employment of automatic and semi-automatic machines, but a large share of the work could be done only by human agencies, and even where automatic machinery is employed, back of the engine must be the human hand.

Women have had to be called in, therefore, to take the place of men, and all indications point to an increased demand for female labor, at least in the next few years. In this connection the discussion of Female Labor's Place in Automotive Industry, by Allen Sinsheimer, is of interest, as the writer goes into a number of particular details. From what he states, it appears that female labor may be very advantageously employed in certain lines under certain reasonable conditions. On the other hand, it appears also from a quotation of a statement by Samuel Gompers relating to German war conditions that female labor may be easily abused with most disastrous results to the women thus misemployed.

THE STEAM MOTOR IN THE AUTOMOTIVE FIELD

By E. T. ADAMS, SYRACUSE, N. Y.

Member of the Society

At the present time the question as to the relative fitness of the gasoline as compared with the steam motor for automotive service is receiving most serious attention. New developments and new inventions in steam motors have revolutionized the status of steam at the very time when the oil industry has reached a position absolutely the reverse of that which led to, and fostered, the growth of the gasoline engine. Two interrelated economic developments are especially noteworthy. First is the tremendous increase in the demand for automotive power. The use of the automobile has become universal, the use of the truck is at the beginning of an era of expansion which may prove equally great, and the farm tractor marks the beginning of a demand greater than all the others. The farm is the greatest single user of power; few people realize how huge a portion of the earth's surface must annually be cut into slices, turned upside down and pulverized to form a seed bed, or the expenditure of power which this involves. The excellence of the gasoline motor has led to its adoption for this and for other service for which it is economically unfitted, and we are fast working toward a condition where gasoline alone is not produced in sufficient quantity to meet the demand.

The tremendous increase in the demand for automotive power has outdistanced the ability of the gasoline engine to meet this demand, chiefly for the reason that the supply of fuel is not now equal to the requirements.

The steam unit has many advantages for automotive service. Its high torque at low speed, its overload capacity, its smooth, flexible speed and power control have remained the standards of excellence reached for but never attained by any gasoline motor.

The design of the steam unit is simple, and many features of construction have been introduced which tend toward long life and low cost of upkeep.

The difference in cost between gasoline and power oil, when coupled with a reduced cost of lubricating oil, represents an appreciable reduction in fuel cost in favor of the steam unit and one of importance to the truck and tractor operator.

Numbers of new steam trucks, tractors and pleasure cars are in service, or in process of manufacture or design. This effort and this demand will have a profound influence on the automotive industry.

Second is the fuel situation. When the automobile industry was young the oil industry was dependent on the use of oil for light, and gasoline was a by-product,—cheap, abundant and of excellent quality. Today the oil industry is based on oil for power, and gasoline is its foremost product. The supply, even with lowered quality and new processes of manufacture, is not equal to the demand, and the price is too high for many commercial uses. There will be some gain due to the perfection of vaporizing types of carburetor which will permit further lowering of the quality of gasoline, and some gain due to increased attention to economy, but the growth of the use of power in this field will be greatly hampered unless there is an increase in the quantity of fuel available far greater than can be expected from this source alone. This means the use of oils other than gasoline, and of methods other than carburetion and burning in an internal-combustion engine.

The steam-driven motor is the type which most readily meets this condition, and its use will receive a further impetus because the demand for gasoline is a seasonable demand and a steam unit using unpurified kerosene or similar light distillates will use these by-products of gasoline manufacture during the season in which they are produced. These by-products are produced in great quantities, are relatively cheap and furnish an ideal fuel for the small-power steam boiler.

The steam unit has many advantages for automotive service. Its high torque at low speed, its overload capacity, its smooth, flexible speed and power control have remained the standards of excellence reached for but never attained by any gasoline motor. The connection from motor to axle is simple and direct, without clutch, reverse or change gears. Steam is available at full boiler pressure and for practically full stroke to give torque to lift a loaded rear axle slowly and gently from a rut. Ahead and reverse follow the movement of a single lever, and acceleration and hill-climbing capacity hitherto unknown are at the operator's command.

High steam pressures and temperatures have been the rule, but a light, compact motor construction and high economy are attainable with steam pressures between 400 and 500 lb. gage, and thereby we avoid the tendency to carbonize the lubricating oil which is found at higher temperatures. There has been much interesting speculation on the economies due to the use of higher steam pressures and the best division of a given total heat between superheat and the temperature due to evaporation. But in the small units here considered, practical considerations such as have been outlined will doubtless govern design.

The chief force which is bringing about the increased use of the steam motor is its superior fitness for automotive service, especially in the commercial field. First, in truck service the upkeep of the gasoline truck, even with the expert service, is now beyond reason and is a serious handicap to the business. Overloading and incompetent handling are blamed for this condition, but, practically, overloading is not preventable, and starting from a bad position is an unavoidable hazard. Racing the motor, coupled with the sudden application of the clutch, is the only answer to these conditions which the gasoline motor affords. The result is destructive to both power plant and transmission. The steam motor meets this situation by using steam for practically the full stroke of the piston and at any pressure which the tractive power of the wheel will permit.

For presentation at the Annual Meeting of The American Society of Mechanical Engineers, New York, December 4 to 7, 1917. The paper is here printed in abstract form, and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

The available mean effective pressure on the steam piston under these conditions is fully five times the maximum available with a gasoline motor, and the motor speed for the same torque may be correspondingly low. With the steam unit the load is picked up gently, exactly as a locomotive starts a train. This tends toward low cost of upkeep.

Another point in favor of the steam unit is the extreme simplicity of the transmission—one pair of bevels or spurs, or direct drive on the worm shaft is all that is required for light and moderate power work, with one additional reduction for heavy work and tractor service. There is no clutch, no reverse gear—only a simple direct drive from motor to axle. This again tends toward low upkeep and long life.

In early constructions the motor naturally followed locomotive or marine lines. Modern steam motors are preferably of the multiple-cylinder type, designed for quantity production using the tool equipment and shop methods of the modern gasoline-motor manufacturer. They are carefully balanced, are light and simple and capable of as high speed as may be desired. The uniflow type is largely used because of its simplicity and its high economy when operated non-condensing. Because of the high steam pressure, the most economical mean effective pressure is about the same as the full-load m.e.p. of the gasoline motor, and for the same power the cylinder sizes are about the same in the two cases. With this construction piston and valve require but little lubrication, the amount of lubricating oil necessary being far less than that used by older types of steam or by modern types of gasoline motors. The pistons and rods follow automobile practice. Alloy steel and aluminum are freely employed and ball-bearing construction is used where possible. Crankshafts and pins are oiled by a forced-lubrication system, bearing areas are ample, and the labor cost for adjustment and repair is naturally extremely low.

Boiler design exhibits greater variety than any other portion of the steam unit. The cylindrical fire-tube types, both with and without a water leg, have their advocates. The ordinary flash type is in use but not so much in favor, due, among other things, to its especial tendency to carbonize any lubricating oil introduced with the fuel. Tube boilers with natural or forced circulation are popular and effective. A forced circulation, contraflow-tube type seems especially commendable in that it may be forced to almost any degree and is, therefore, responsive, light, compact and economical. The stack temperatures are readily brought down to 50 deg. above feed temperatures; the superheat is under good control and danger of burning or injury to the tubes is negligible. One advantage of the tube type is its absolute safety from destructive explosions.

All these features exhibit a very great advance over older constructions. They are popular because of their economy and safety, and because all these improvements tend toward longer life and lower cost of upkeep.

The furnace is the most important feature of the modern unit. All precedent is swept aside. With a light power oil as the established fuel, there is no excuse for following old practice and merely firing oil into a combustion space originally designed for coal, and in later designs this is not done. First, proper conditions are established for burning the oil; second, proper conditions are established for utilizing the heat thus generated, and these are then combined. In one installation this leads to a design with the furnace practically at the top of the boiler, with force feed of oil and air; this has proved a most acceptable and desirable location.

Various methods of controlling the oil are in general service. In the oldest type the oil under pressure is converted into a highly superheated vapor, which discharges past an adjustable needle valve drawing with it an air supply, fed and controlled as in a bunsen burner. After proper mixing the mixture is burned as it issues from fine perforations in the grate. A pilot light which keeps the oil supply superheated is a necessary part of the equipment. In spite of its high economy and its honorable record in service, this system is steadily being displaced in the more modern designs. Objection is made that under certain conditions the pilot light and the heated oil under pressure are highly dangerous, and the clogging of the control valve by carbon and tars formed by the cracking of the oil is objectionable and expensive.

The mechanical atomizer of the type used in larger furnaces and with heavier oils does not appear in use, but would seem to be well suited to the service. New systems of this general class are being very extensively tried out. These systems are important because they consider not only the proper burning of the oil, but also the commercially more important item of control. Considered as a unit, the vital control of the motor must be at the furnace. There must be control in proportion to load, to steam pressure, and to maximum steam temperature, and also control directly responsive to the demands of the public. In a pleasure car, starting from cold, there must be steam to enable the car to be driven away in one minute. The mechanism or control, to be commercially successful, must be no more burdensome than the movement of a lever or the throwing of a switch. In a truck or tractor the demands are somewhat more moderate; but in general the steam unit must be practically on a par, in the matter of starting, with the gasoline unit, and the fact that in this respect also steam is now on a par with gasoline is one reason for the present impetus toward steam.

Where both air and oil are metered in under forced draft and in a boiler as flexible as those here described, it appears that a simple and entirely satisfactory method of heat graduation is to "cut in and cut out"; that is, to stop the supply of both oil and air entirely where it is desired to limit pressure or temperature, and to cut in again at full power when the pressure or temperature falls, this action, of course, being entirely automatic. With the safety which a tube boiler provides, a satisfactory system of water supply is a feed pump operated by any means whose speed or time of operation is directly proportional to the load. This involves attention to the water level and occasional adjustment by the operator, but as there is no serious penalty for his failure this seems an entirely satisfactory method—perhaps more satisfactory than a type more strictly automatic.

Next to the fuel situation and the desire for reduced cost of upkeep, this new system of control is the most important development affecting the renaissance of the steam motor in the automotive field.

The exhaust is condensed to atmospheric pressure in an ordinary type of automobile radiator. The type with wide surfaces and thin water spaces has proved most effective. In a pleasure car complete condensation is secured in a small radiator often without the use of a fan. The efficiency of the radiator is reduced by excessive oil in the feed, but otherwise there are no disagreeable effects. Under these conditions fresh-water supply is only needed at rare intervals, which again is a feature which has served greatly to increase the demand for the steam motor.

It is characteristic of the internal-combustion motor that it gives its highest economy at its maximum load, with rapid reduction in economy as the load is decreased. The reverse is

time of the steam unit. It results from this that under usual operating conditions the steam unit is operating at its maximum efficiency, whereas the gasoline unit is operating at only fair efficiency. These efficiencies tend to meet, and in the two cases in actual service the quantity of fuel per brake horsepower should not be materially different.

The difference in cost between gasoline and power oil, when coupled with a reduced cost of lubricating oil, represents an appreciable reduction in fuel cost in favor of the steam unit and one of importance to the truck and tractor operator. In the case of the automobile where a small horsepower represents great mileage, this item is of lesser importance; but it lends romance to engineering to note that the joy of driving the smooth, flexible steam motor is likely to cause its extensive adoption first in the field which commercially needs it least.

WORK OF THE BOILER CODE COMMITTEE

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in The Journal, in order that any one interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee in Cases Nos. 174-176, inclusive, as formulated at the meeting of September 20, and approved by the Council on October 12, 1917. In this report, as previously, the names of inquirers have been omitted.

Case No. 174

Inquiry: What type of stays does Par. 200 of the Boiler Code refer to in its requirements for the drilling of tell-tale holes in their ends? The rules of the Interstate Commerce Commission establish the distinction that all stays shorter than 8 in. in length shall be termed staybolts.

Reply: It has been proposed to revise Par. 200 to read as follows:

> 200 *Staybolts.* The ends of screwed staybolts shall be riveted over or upset by equivalent process. Staybolts must be hollow or the outside ends of solid staybolts, 8 in. and less in length, shall be drilled with a hole at least 3/16 in. diameter to a depth extending at least 1/2 in. beyond the inside of the plates, except on boilers having a grate area not exceeding 15 sq. ft., or the equivalent in gas or oil-fired boilers, where the drilling of the staybolts is optional. Solid staybolts over 8 in. long and flexible staybolts of either the jointed or ball and socket type need not be drilled.

Case No. 175

Inquiry: Is it necessary under the rules of the A.S.M.E. Boiler Code that the outside firebox plate of locomotive type boilers be of the same thickness as the barrel sheets when it is reinforced by stays to the inner firebox sheet? It is customary in locomotive boiler practice to make the outside firebox plate of less thickness than the barrel plate for reason of this staying.

Reply: The Committee now has this matter under consideration and will render a formal reply as soon as the investigations now under way have been completed.

Case No. 176

Inquiry: What factor of safety shall be used under the rules of the Boiler Code, *a.* when the longitudinal joint of a dome less than 24 in. in diameter is lap riveted, and, *b.* when such dome is attached to the shell of the boiler by a flanged ring construction in accordance with Par. 261?

Reply: When the longitudinal joint of a dome less than 24 in. in diameter is lap riveted, the longitudinal barrel of the dome must be designed on the basis of a factor of safety of not less than 8. When such a dome is attached to the shell of the boiler by a flanged ring construction, in accordance with Par. 261, the flanged construction shall have a factor of safety of not less than 5, but this does not involve any change in the factor of safety of not less than 8 in the dome barrel.

The Governor of Michigan has appointed the following men as members of the Board of Boiler Rules, in accordance with the terms of the Hanley Act, passed by the legislature last winter: G. W. Bissell, East Lansing; E. C. Fisher, Saginaw; J. C. McCabe, Detroit; S. Milan, Grand Rapids; G. E. Christensen, Houghton.

Autogenous welding entered upon what is bound to be a fruitful period when recently in the Engineering Societies Building, New York City, committees of various societies and manufacturers met and formed the National Welding Council. All the industries were represented, together with the insurance companies and the constituted authorities, such, for example, as represented by J. C. McCabe, safety engineer for the City of Detroit.

The purpose of the National Welding Council is, in the beginning, at least, divided into four divisions, to accomplish the following ends: Uniformity of design of pressure vessels to be autogenous welded; licensing of welders for pressure-vessel work; research to determine an infallible test that will reveal unsafe welds, and fourth, to investigate the microstructure and physics of welds. As autogenous welding is so attractive on account of both the cost and the time of doing such work, the development of the art as applied to pressure vessels suffers because engineers who represent the public as well as private interests cannot be certain of the safety of an autogenous weld. The frank statements by Mr. McCabe, and by the insurance interests represented at the meeting by T. T. Parker, of the Fidelity and Casualty Co., and J. G. Shaw, of the Travelers Insurance Co., were most commendable. These gentlemen gave the welders to understand that until some reliable tests that would enable one to determine the safety of a weld had been found, they would not permit of the use of welds in pressure vessels subject to tension. This also is the attitude of responsible engineers, many of whom have applied welds to pressure vessels that are unlikely to rupture or other accident, and which, if ruptured, will not cause serious damage to surrounding property or loss of life.—*Power*, Oct. 9, 1917.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

Inspection in Munitions Manufacture

To the Editor:

In his paper on The Importance of Intelligent Inspection in Munitions Manufacture, presented at the Spring Meeting of the Society at Cincinnati in May of this year, Mr. Walsh put forth some statements and considerations in regard to difficulties experienced in the inspection of big artillery orders in the United States in 1915-16.

The members of the Russian Artillery Commission readily acknowledge the justice and value of Mr. Walsh's statements, as well as those in other papers presented at the same meeting.

Unfortunately for some who were not familiar with the execution of an order by the Canadian Car & Foundry Company for 5,000,000 3-in. shrapnel and high-explosive shells for the Russian Government, some expressions in Mr. Walsh's paper and examples used in his illustrations may be understood in an undesirable way from the standpoint of the Russian Commission, and may be interpreted and generalized in such a way which, we hope, the author himself did not have in view.

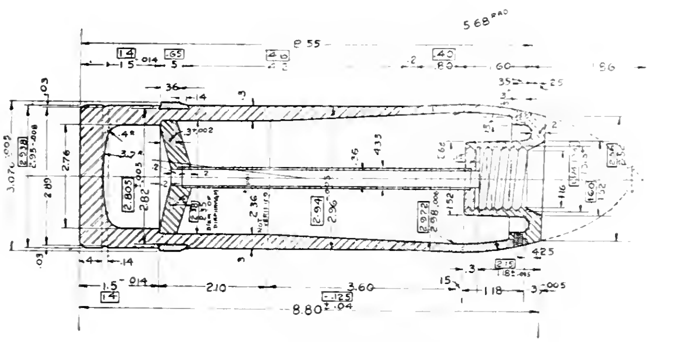

Fig. 1 Additional Tolerances for Russian Shells

For example, in Par. 2 Mr. Walsh states: "Russia was as little prepared to provide the required number of qualified inspectors as was the contractor, and in consequence the manufacturer had inflicted upon him so-called inspectors who were selected from every walk in life, it seemed, except the mechanical, and barbers, bartenders, butchers, students and teachers were the usual thing and the practical man the exception."

The inspectors who were selected, as the author justly points, "from every walk of life except the mechanical," were not, in reality, the Russian inspectors, but the inspectors of the contractors, who were eventually taught by the Russian representatives. Naturally, the provision of all the necessary number of inspectors from Russia to America during the war could not and should not be realized. The Russian Government sent to the United States, as it did to Japan, England and France, a small contingent of skilled inspectors, under the supervision of whom were the American inspectors.

We readily admit that even an inspector thoroughly familiar with his business is not free sometimes from extreme strictness, and sometimes even from so-called "discretion," but we wish to draw attention to the fact that every sub-contractor, for whom each requirement of the inspector results in a loss of money, is naturally inclined to exaggerate, in a disadvantageous manner, the actions of the inspectors, so it would be well to look upon such statements with prudence, and particularly when such statements cannot be verified. That, in the main, the Russian inspection was not too strict is indicated by Fig. 1 given herewith, which shows additional tolerances which, it is true, were not announced to the factory and which were used by the Russian representatives, and only owing to which, however good the production, can be explained the fact that the whole quantity of finally rejected shells did not exceed 1 to 1½ per cent.

It is interesting to note in respect to this, that out of the total number of accepted complete rounds, only 40 per cent of that number were fully in accordance with the contract specifications; the other 60 per cent did not conform with contract specifications.

All Russian inspectors who had an opportunity to see Mr. Walsh's paper cannot help but agree with the statements made by him in Pars. 5 to 12 with regard to technicalities of inspection.

Russian 3-in. Shell Department,
Captain S. N. Petrenko.

Heat Transfer in Condensers

To the Editor:

The transfer of heat in surface condensers is a subject which has frequently been discussed in the Society's proceedings, so that the following method of determining one factor may be of interest.

The design of surface condensers, water heaters, and, generally, any apparatus for the heating or cooling of fluids where the hot medium is never mixed with the cold one, requires the determination of the mean temperature difference.

Suppose two fluids, A and B, to enter a vessel in separate compartments for the interchange of heat.

Let T_1 = temperature of fluid A at the point at which it begins to have contact with fluid B

T_2 = temperature of fluid B at the point at which it begins to have contact with fluid A

T_3 = temperature of fluid A at the point at which it ceases to have contact with fluid B

T_4 = temperature of fluid B at the point at which it ceases to have contact with fluid A.

Then, for parallel flow, Fig. 1, the difference in temperature at the beginning of contact is $T_1 - T_2$, and the difference where the fluids cease to have contact is $T_3 - T_4$.

For counter-current flow, Fig. 2, the difference in temperature at beginning of contact is $T_1 - T_4$, and the difference where the fluids cease to be in contact is $T_3 - T_2$.

If the differences in temperature are represented by D_1 and D_2, then

For parallel flow, $D_1 = T_1 - T_2$ and $D_2 = T_3 - T_4$.

For counter-current flow, $D_1 = T_1 - T_4$ and $D_2 = T_3 - T_2$.

Let D_m = mean temperature difference; then, according to Hausbrand,[1]

$$D_m = \frac{D_1 - D_2}{\log_e (D_1 / D_2)}$$

This formula can be equally well written

$$D_m = \frac{D_2 - D_1}{\log_e (D_2 / D_1)}$$

as can be shown by a simple algebraic proof. Hence it makes no difference whether D_1, as determined by the rule above, is greater or less than D_2. The numerator of the fraction must always be positive, and the denominator must be the Napierian logarithm of an improper fraction.

In determining the design of a piece of apparatus it is often necessary to solve this formula three or four times, as it rarely happens that stock designs will fit a specific case exactly. It is also often desirable to determine the effect upon the apparatus of slight changes in the conditions.

A ready means of solving the formula rapidly is shown in the calculating chart, Fig. 3, which will give solutions in a few seconds, accurate enough for all practical purposes. The chart

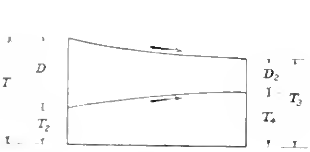

FIG. 1

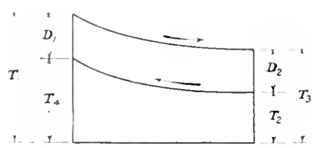

FIG. 2

Fig. 1 Fluids Entering Compartments in Parallel Flow
Fig. 2 Fluids Entering Compartments in Counter-Current Flow

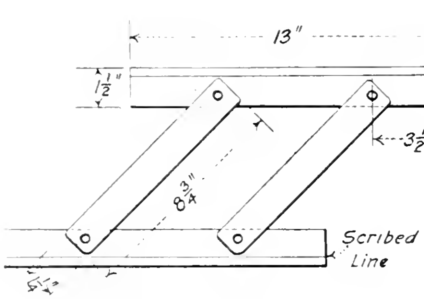

Fig. 4 Scribed Parallel Rule

is made up of four scales: On the left-hand side of the left-hand scale the values of D_1 are plotted; the right-hand scale contains the values of D_2; the difference between these quantities, $D_1 - D_2$, is plotted on the right-hand side of the left-hand (D_1) scale; the diagonal scale gives the values of D_m, the mean temperature difference.

To use the chart, join the given values of D_1 and D_2 with a straight line, and draw a line parallel to this line through their difference, $D_1 - D_2$. This line will intersect the D_m scale at the required value.

An example will show the procedure. Steam enters a closed parallel-flow heater at 215 deg. fahr. and water enters at 50 deg. fahr.; the steam leaves at 212 deg. fahr. and the water is heated to 180 deg. fahr.

[1] Evaporating, Condensing and Cooling Apparatus, by E. Hausbrand. For Hausbrand's formula, see Trans. Am.Soc.M.E., vol. 32, pp. 1151 and 1211.

$T_1 = 215$
$T_2 = 50$ $\qquad D_1 = T_1 - T_2 = 215 - 50 = 165$
$T_3 = 212$ $\qquad D_2 = T_3 - T_4 = 212 - 180 = 32$
$T_4 = 180$ $\qquad D_1 - D_2 = 165 - 32 = 133$

Join 165 on D_1 scale with 32 on D_2 scale and draw a parallel line through 133 on the $D_1 - D_2$ scale; this cuts the D_m scale at 81.2, the required value of mean temperature difference. Numerical solution gives the answer as 81.05.

The chart depends upon the principles of similar triangles. A proof of the principles upon which it is constructed may be found in the *Journal of the Western Society of Engineers*, February 1911, Vol XVI, No. 2, p. 112.

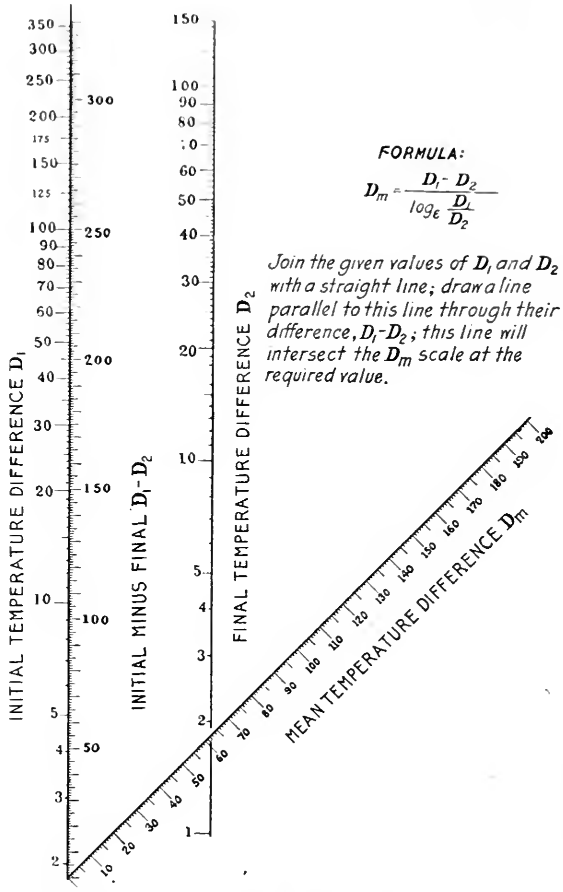

Fig. 3 Chart for Determining Mean Temperature Difference

A convenient device for using the chart is a parallel rule made of transparent celluloid about 0.025 in. or 0.03 in. thick, with fine lines scribed on the under side of the parallel links. Such a rule is illustrated in Fig. 4.

Howard M. Ingham.

New York, N. Y.

At the annual meeting of the national advisory committee for aeronautics held recently, Dr. W. F. Durand, Mem.Am. Soc.M.E., was reelected chairman and Dr. S. W. Stratton, Mem.Am.Soc.M.E., was reelected secretary. Members of the executive committee were elected as follows: Dr. Joseph S. Ames, Dr. Charles F. Marvin, Dr. Michael I. Pupin, Major-General George O. Squier, U. S. A.; Dr. S. W. Stratton, Mem.Am.Soc.M.E.; Rear-Admiral D. W. Taylor, U. S. N., and Dr. Charles D. Walcott. At the organization meeting of the executive committee, Dr. Charles D. Walcott was elected chairman and Dr. S. W. Stratton, secretary.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

ANNUAL MEETING PROGRAM

New York, December 4 to 7, 1917

Tuesday, December 4

12.00 m. Opening of Registration Bureau in Engineering Societies Building

2.00 p.m. Council Meeting

8.30 p.m. Report of Tellers of Election and Introduction of the President-elect
Conferring of Honorary Membership upon Major-General George W. Goethals, followed by an address by Hon. William H. Taft
Reception by the President and the President-elect

Wednesday, December 5

9.45 a.m. Business Meeting, to be followed by the Keynote Session

It will be suggested to the Council that the Business Meeting be adjourned to Thursday morning to allow more time for the Keynote Session

10.00 a.m. Keynote Session on The Service of the Engineer to the Public in Times of Crises

Universal Public Service in Peace and War, Dr. Ira N. Hollis. This will be the presidential address by Dr. Hollis, after which there will be other addresses by distinguished men of national reputation on the following subjects relating to problems incident to the war: Agricultural problem; fuel problem; transportation; motor transportation; building of a merchant marine; aircraft problem; special education in time of war; engineering research. This will be an all-day session

12.30 p.m. Buffet Luncheon

2.00 p.m. Continuation of Keynote Session on The Service of the Engineer to the Public in Times of Crises

2.30 p.m. Simultaneous Sessions

POWER-PLANT SESSION

Preventable Waste of Coal in the United States, David Moffat Myers

The Cooling of Water for Power Plant Purposes, C. C. Thomas

Bagasse as a Source of Fuel, E. C. Freeland

The Steam Motor in the Automotive Field, E. T. Adams

GENERAL SESSION

The Transfer of Heat Between a Flowing Gas and a Containing Flue, Lawford H. Fry

A Study of Surface Resistance with Glass as the Transmission Medium, H. R. Hammond and C. W. Holmberg

Cooling and Drying Air and the Removing of Infinitesimal Dust Therefrom, W. J. Baldwin.

Recent Developments in Balancing Apparatus, N. W. Akimoff.

Plotting Blower-Test Curves, A. H. Anderson (*By title only.*)

Cross-Current Predeterminations from Crank-Effort Diagrams, Louis Illmer (*By title only.*)

INDUSTRIAL-SAFETY SESSION

Several codes will be presented for discussion by the Sub-Committee on Protection of Industrial Workers, among them Codes of Safety Standards for Elevators and Woodworking Machinery.

(*Continued on Next Page.*)

Wednesday, December 5 (*Continued*)

3.00 p.m. Ladies' Reception and Tea

8.15 p.m. Smoker

Get-together meeting for members. Mr. John R. Freeman, Past-President Am.Soc.M.E., will give an illustrated talk upon his trip to the Orient taken last winter with Dr. John A. Brashear and Mr. Ambrose Swasey, Past-Presidents Am.Soc.M.E. Music by Glee Club. Refreshments

Thursday, December 6

10.00 a.m. Business Meeting continued, followed by General Sessions

LOCAL-SECTIONS SESSION

This session will be held under the direction of the Sections Committee, for a discussion of the work of the Sections and of Society Affairs, by representatives of the 24 Sections of the Society

GENERAL SESSION

An Account of the Engineering Work of E. D. Leavitt, F. W. Dean

Expenses and Costs, H. L. Gantt

The following papers contributed by Local Sections will be presented by title:

By-Product Coke and Coking Operations, C. J. Ramsburg and F. W. Sperr, Jr.

The Submarine, C. H. Bedell

Combined Stresses, A. L. Jenkins

The Trumble Refining Process, N. W. Thompson

12.30 p.m. Luncheon, at which there will be an address on The Relation of Industrial Management to Engineering, by Prof. Dexter S. Kimball

2.30 p.m. Simultaneous Sessions

MACHINE-SHOP SESSION

Under the auspices of the Sub-Committee on Machine Shop Practice

Topical Discussion on the subject of Inspection with the following introductory discussions:

The Logic of Inspection, A. L. DeLeeuw

The Relation of Inspection to Product, F. A. Waldron

General Principles of Government Inspection and Relations Between Inspectors and Manufacturers, Col. B. W. Dunn

TEXTILE SESSION

Under the auspices of the Sub-Committee on Textiles

Labor-Turnover Records and the Labor Problem, Richard B. Gregg

Accident Prevention in the Textile Industry, David S. Beyer

The Moisture Content of Textiles and Some of its Effects, William D. Hartshorne

8.30 p.m. Lecture and Annual Reunion

The Beautiful in Commonplace Things, Dr. John A. Brashear. Following the lecture there will be a reunion and dance, with refreshments, on the fifth floor of the Engineering Societies Building

Friday, December 7

10.00 a.m. Simultaneous Sessions

MANAGEMENT SESSION

Topical discussion on the Employment of Women in the Skilled Industries, with particular reference to war conditions. To be introduced by Mr. John W. Upp, General Electric Co., and Mr. C. B. Lord, Wagner Electric Manufacturing Co.

The Engineer, the Cripple and the New Education, by Major Frank B. Gilbreth

POWER-TEST HEARING

A public hearing by the Power Test Committee, preliminary to a proposed revision of the Power Test Code of the Society, comprising rules for conducting tests on prime movers of different types, and auxiliary apparatus

2.00 p.m. Council Meeting

NOTE:—The above program was tentatively accepted at the meeting of the Committee on Meetings on October 26. It is possible that the arrangement of sessions may be modified slightly, but the program is issued in the present form to enable members and others to make their arrangements to attend the meeting. In the final program some of the features here announced will be augmented

COUNCIL NOTES

THE October meeting of the Council, the first meeting following the summer recess, was held on October 12 to enable President Hollis to attend before leaving for his visit to the Pacific Coast Sections. The following members were present: Ira N. Hollis, *President;* John H. Barr, C. H. Benjamin, Robert H. Fernald, Frederick R. Hutton, D. S. Jacobus, C. T. Main, C. T. Plunkett, John A. Stevens, and Calvin W. Rice, *Secretary.*

Executive Committee. Actions of the Executive Committee, taken on June 2, 21 and July 13, were made the basis of the following minutes:

It was voted to approve the appointment of the Committee on Coöperation and Organization, Mr. Fred J. Miller, *Chairman:* Messrs. L. P. Alford, Elmer H. Neff and F. A. Waldron.

Messrs. Victor J. Azbe, Bert L. Baldwin, T. J. Cookson, G. F. Gebhardt, J. J. Hoppes and F. E. Idell were approved as a Committee on Standardization of Feedwater Heaters.

Messrs. E. H. Ahara, G. M. Bartlett, C. H. Benjamin, J. R. Cantley, J. J. Flather, F. V. Hetzel and F. Morse were approved as a Committee on Standardization of Roller Chains.

Interpretations No. 153 to 161 of the Boiler Code Committee were approved.

Messrs. H. E. Harris, *Chairman;* John H. Barr, William A. Viall and L. A. Fischer were approved as a committee of this Society to develop a central bureau for the certification of gages and for the consideration of adequate facilities for certifying gages used throughout the United States in the manufacture and inspection of munitions of war.

Additional appropriations to the House Committee, Publication Committee and Committee on Engineering Resources, as recommended and approved by the Finance Committee, were approved.

Remission of Dues. The Committee on Constitution and By-Laws was requested to draw a by-law providing for the automatic remission of dues of a member reaching a certain age or having paid dues for a certain number of years.

Dues of Members in Military Service. The Secretary was requested to prepare a list of all members now in military service, to be published and distributed at the Annual Meeting.

It was the sense of the Council that such members should have their dues absolutely remitted for the period of the war and until six months after the declaration of peace.

Increase of Membership Committee. S. J. Hoexter was appointed chairman of the Michigan sub-committee, and C. R. Burt chairman of the Ontario, Canada, sub-committee.

Power Test Committee. It was voted to conduct a public hearing of the Power Test Code at the forthcoming Annual Meeting. Announcement of this hearing is given elsewhere in this issue.

An Advisory Committee was appointed to attend this and future hearings, and to confer with the Power Test Committee on request.

American Engineering Standards. The report of this committee was approved, and Messrs. Henry Hess, W. F. Kiesel and Carl Schwartz were appointed on the committee.

Engineering Council. The President reported on the present status of the work of this body and the call it would soon make for funds to carry on work principally for the Government in the present crisis.

American Institute of Architects. Mr. Clyde R. Place and Prof. J. W. Roe were approved to represent the Society as honorary vice-presidents in a conference with the American Institute of Architects' Committee on Quantity Production.

Machine Screw Nuts. Messrs. E. H. Ehrmann, E. Burdsall and Charles Glover were approved as a Committee on Machine Screw Nut Standardization, to coöperate with a similar committee of the Society of Automotive Engineers. Announcements regarding this joint committee have already appeared in THE JOURNAL.

Finance Committee. It was voted to approve and authorize the budget recommended by the Finance Committee of two hundred and five thousand five hundred and five dollars, with the understanding that this sum shall include an appropriation of five hundred dollars for the Standing Committee on Public Relations, and, further, the Finance Committee is authorized to make such adjustments within this appropriation as may be required during the year to meet the extraordinary demands upon the engineering societies occasioned by the war.

Second Liberty Loan. The Finance Committee was authorized to invest the sum of ten thousand dollars ($10,000) in the Second Liberty Loan.

Committee on Meetings. On recommendation of this committee, Messrs. W. W. Bird, *Chairman;* Stanley G. Flagg, Jr., B. D. Fuller, Robert E. Newcomb, Charles E. Knoeppel, Wilfred Lewis and Richard Moldenke were approved as a Sub-Committee on Foundry Practice.

Visits to the Sections. The President reported that in response to invitations from the Sections, he had arranged to visit St. Louis, El Paso, Los Angeles, San Francisco, Seattle and Portland. An account of Dr. Hollis's trip will be given in the next issue of THE JOURNAL.

Public Relations Committee. Mr. C. T. Main, member of this committee, reported its organization meeting on October 11, with Dr. F. H. Newell as chairman and Mr. Morris L. Cooke as secretary.

Constitution and By-Laws. Prof. F. R. Hutton, as chairman of this committee, presented a report of suggested new by-laws for the government of the local sections. This was adopted, and the By-Laws are published in this issue of THE JOURNAL under Sections.

Professor Hutton also reported suggested changes in the by-laws to meet the constitutional changes announced in the October issue of THE JOURNAL and to be voted on at the Annual Meeting.

Junior and Student Prizes. Recommendations of the committees on Award of Junior and Student Prizes were accepted, and the awards made will be announced at the Annual Meeting.

Committee on Sections. The organization of the Connecticut State Section was approved, with headquarters at New Haven and branches at Meriden, Bridgeport, Hartford and Waterbury.

Mr. W. L. Roueche was appointed secretary-treasurer of the Birmingham Section.

Adjournment was taken to meet in Chicago on November 16.

CALVIN W. RICE,
Secretary.

Those members who have not yet received Vol. 38 of TRANSACTIONS are notified that the delay has been caused by embargos on freight shipments to some points.

ROLL OF HONOR

In the May issue of The Journal we published the first list of members of the Society who have enlisted in the service of the country in its great drive "to make the world safe for democracy," and it is interesting to note the rapid growth of the Honor Roll. We have published notices of 566 members from all parts of the Union who have notified us of their enlistment. A large proportion of members listed are commissioned in the Engineer Officers' Reserve Corps or in the Ordnance Department, Officers' Reserve Corps. The Aviation Section of the Signal Corps, and the Naval Reserve, are also well represented.

If any members have joined the armed forces of the country, but have so far not been listed in the Roll of Honor, they are invited to send in their names to the Secretary. The Society is proud of their action and is anxious to apprise their fellow members of it. Further, the Society would be pleased to publish, and members at home would be interested to read, "experience letters" from men who are out on active service.

The following Roll of Honor supplements those already published:

Adams, C. F., 103rd Regiment Field Artillery, 26th Division American Expeditionary Forces.
Allen, Jared E., First Lieutenant, 26th Engineer Regiment, Camp Dix, N. J.
Ames, John H., First Lieutenant, Ordnance Department, U. S. R.

Baird, Lyman S., First Lieutenant, Aviation Section, Officers' Reserve Signal Corps.
Bakker, George S., First Lieutenant, Ordnance Department, U. S. A.
Bates, Harry H., Officers' Training Camp, Ft. Myer, Va.
Besse, E. E., First Lieutenant, Ordnance Department, Officers' Reserve Corps.
Bond, F. M., Captain, Inspector of Ordnance, St. Louis, Mo.
Boyd, Hugh M., Second Lieutenant, F. A. O. R. C., Camp Upton, L. I.
Boyer, Fred. O., First Lieutenant, Second U. S. Engineers.
Brennan, E. M., First Lieutenant, 309th Engineers, Camp Taylor, Louisville, Ky.
Brown, Eugene L., Jr., First Lieutenant, Engineer Officers' Reserve Corps.
Brown, Fred W., Captain, Ordnance Department, Officers' Reserve Corps.
Burton, W. Dean, Aeronautical Mechanical Engineer, U. S. Signal Service, Fort Omaha, Neb.

Campbell, E. D., Captain, Ordnance Department, Carriage Division, Washington, D. C.
Cassidy, Perry R., Captain, Coast Artillery, Officers' Reserve Corps.
Chamberlain, Paul M., Ordnance Section, Officers' Reserve Corps.
Christen, A. B., First Lieutenant, Signal Corps.

Dallis, Park A., Engineers' Training Camp, Atlanta, Ga.

Eichenberg, M. A., Inspector of Aeroplanes and Aeroplane Engines, United States Signal Corps.
Ellsworth, Perry F., First Lieutenant, Signal Corps, U. S. R.

Farr, Roy S., Second Lieutenant, Co. 1, Engineer Reserve Officers' Training Camp, American University, Washington, D. C.
Felker, George F., Captain, Ordnance Department, U. S. R., Camp Wheeler, Macon, Ga.
Fowler, W. S., First Lieutenant, Ordnance Department, Carriage Division, U. S. R.

Gaillard, D. P., First Lieutenant, Ordnance Officers' Reserve Corps, Division T, U. S. A.
Gfrorer, Albert H., First Lieutenant, Officers' Reserve Corps, Ordnance Department.
Gilbreth, Frank B., Major, Ordnance Department, U. S. A.
Gilman, F. W., First Lieutenant, Engineer Officers' Reserve Corps, Reserve Officers' Training Camp, Ft. Myer, Va.
Githens, Thos. F., Plattsburg Training Camp.

Glenn, E. R., Officers' Training Camp, U. S. A., Oglethorpe, Ga.
Goltzberger, R. L., First Lieutenant, Ordnance Department, U. S. R., American Expeditionary Forces.
Gregory, W. B., Major, Engineer Officers' Reserve Corps, American Expeditionary Force.
Geise, H. B., Major, Ordnance Department, Officers' Reserve Corps.
Gutierras, J. G., Lieutenant, 4th Engineers, Vancouver Barracks, Wash.
Guthrie, James, Major, Ordnance Department, Officers' Reserve Corps, U. S. A.

Hale, Henry A., Jr., Captain, Engineer Officers' Reserve Corps.
Hall, Keppele, Captain, Ordnance Department, U. S. R.
Hall, Quincy A., Captain, Engineers' Section, Officers' Reserve Corps.
Harries, George H., Major General, Headquarters 59th Depot Brigade, Camp Cody, Deming, N. M.
Hewitt, R. B., Captain, Engineers' Department, Fort Sam Houston, Texas.
Hirsch, Gustav, Major Signal Corps, U. S. R.
Holman, R. C., Captain, I. O. M. O. C., 53rd Ordnance Mobile Workshop (Light), British Expeditionary Forces, France.
Hurxthal, A. O., First Lieutenant, Ordnance Department, Officers' Reserve Corps, U. S. A.

Jurgensen, J. C., Major, Ordnance Department.

Kaelin, Charles G., Captain, Ordnance Department, U. S. R., Frankford Arsenal, Bridesburg, Pa.
Kaley, George B., First Lieutenant, Ordnance Department, Officers' Reserve Corps, U. S. A.
Kent, Edward R., Officers' Training Camp, Ft. Myer, Va.
Kilpatrick, John D., Major, National Guard, N. J.

Lacombe, C. F., Captain, Engineer Officers' Reserve Corps, U. S. A.
Larsen, Charles, Captain, 26th Engineers, Camp Dix, N. J.
Le Fevre, C. D., Ordnance Officers' Reserve Corps.
Lipsner, B. B., Captain, Ordnance Department, Motor Section, U. S. A.
Longley, Francis B., Major, Engineering Department, Signal Corps Aviation School, San Diego, Cal.
Longstreth, Charles, Lieut. Commander, U. S. Naval Reserve Force.
Lord, Harold S., First Lieutenant, Engineers, U. S. R.

MacMaster, R. K., First Lieutenant, Engineer Corps.
Mallory, Chas. K., Lieutenant, U. S. N., Bureau of Steam Engineering, Washington, D. C.
Mann, Carl P., Officers' Training Camp, Ft. Myer, Va.
May, O. J., Captain, Engineers' Division, U. S. A.
Metz, W. R., Captain, Quartermaster Corps, U. S. R.
Meixner, Bernard A., First Lieutenant, Ordnance Department, Officers' Reserve Corps.
Mickle, Frank A., First Lieutenant, Ordnance Department, Officers' Reserve Corps.
Middleton, Nathan A., Captain, Engineer Officers' Reserve Corps, U. S. A.
Miller, Philip F., First Lieutenant, Field Artillery Section, Carriage Division, Ordnance Department, U. S. R.
Misch, Arthur A., First Lieutenant, Ordnance Section, Officers' Reserve Corps, U. S. A.
Myers, J. L., First Lieutenant, Ordnance Department, Officers' Reserve Corps.

Nigh, G. W., Camp Funston, Fort Riley, Kan.
Norris, Earle B., Captain, Ordnance Officers' Reserve Corps, Field Artillery Section, Carriage Division, Ordnance Department.

Pratt, Prof. Joseph Hyde, Major, Engineers, Separate Battalion, N. C.

Rathjens, G. W., Major, 313th Engineers, Camp Dodge, Des Moines, Iowa.
Richardson, Edward B., Major, American Expeditionary Forces, France.

Short, Frank, First Lieutenant, Ordnance Department, U. S. A.
Smith, Horace L., First Lieutenant, 1st Regiment of Engineers, France.
Stark, W. E., Lieutenant, Company C, 5th Engineers, Corpus Christi, Tex.
Stepanek, Emil, Battery B, 333rd Field Artillery, Camp Grant, Ill.
Stetson, John B., Jr., Aviation Section, U. S. A.
Streeter, Robert L., Captain, Ordnance Department, U. S. R.
Summers, Daniel, First Lieutenant, Engineer Officers' Reserve Corps, Camp Meade, Md.

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* Acceptance of commission pending at date of latest list from War Department.

SWAIN, P. W., Second Lieutenant, Field Artillery, Camp Devens, Mass.
SWIFT, HARLEY L., First Lieutenant, 16th Regiment Engineers, Engineer Officers' Reserve Corps.
SWETTING, J. R., Second Lieutenant, Engineer Officers' Reserve Corps.

TALBOT, J. A., Second Lieutenant, Field Artillery Section, Officers' Reserve Corps.
THOMPSON, P. W., First Lieutenant, Inspector of Ordnance, Ordnance Department, U. S. R.
TILSON, HOWARD, Ordnance Department, Officers' Reserve Corps.
TROWBRIDGE, AMASA, Major, Ordnance Department, Officers' Reserve Corps.

VINNEDGE, EARLE W., Second Lieutenant, 309th Engineers, Camp Taylor, Louisville, Ky.

WALKER, L. E., First Lieutenant, Ordnance Officers' Reserve Corps, Carriage Division
WEBSTER, LAWRENCE B., Captain, Ordnance Department, U. S. A.
WELLING, LINDSAY H., Ordnance Department, Rock Island Arsenal, Rock Island, Ill.
WIELAND, C. F., Captain, Officers' Reserve Corps, U. S. A.
WILLIAMS, S. S., Signal Service, U. S. A., Atlanta, Ga.
WOODBURY, J. G., Major, Ordnance Department, U. S. R.
WRIGHT, DOUGLASS B., Second Lieutenant, Engineer Officers' Reserve Corps, United States Expeditionary Forces, France.

ZEIGER, N. A., First Lieutenant, Ordnance Department, U. S. R.

Secretary's Letter

Have you subscribed for a Liberty Bond? If not, won't you please immediately telephone your bank offering to take a bond if not too late, or to subscribe to the next issue? Also arrange to pay for it out of future savings, not by selling investments or withdrawing moneys in savings banks,—both of which are required to continue, without embarrassment, the existing industrial conditions.

Then won't you take up the matter in your business relations? Get everybody saving and investing their savings in Liberty Bonds. Every member of your department should take a bond; if not, know why.

Only ten per cent of the face of a bond need be paid in. The bank will carry the balance at four per cent, the same as the Government pays. If your bank is unwilling to do this, notify me and I will advise you of a bank that will. Business is done on credit. The Government needs the credit of the people. Why not lend your credit to your Government?

Are you aware that to win this war, 10,000,000 people must subscribe for bonds, and that only by the combined energies of every man, woman and child we can win? If you can, take out a bond for every member of your family and instruct them to help pay for it out of sacrifices, candy, entertainments, clothing, everything that is unnecessary. Don't fear that you are going to put people out of employment if every one stops waste. The United States is starting on a rate of production that is going to require the labor of 10,000,000 people on war activities alone!

I know of factories going up where there are all manner of machine tools, lathes, planers, boring machines, etc., and not only now is every employee a woman, but no men are to be employed because there is no prospect that there will be any men for an indefinite period.

Come to the Annual Meeting and hear all about the employment of women in the industries and how the several problems have been met.

Every feature of our Annual Meeting is of vital interest to you. Learn how you can be of greater service to your country in this crisis. It is your duty to your profession to have it render the greatest service to the nation.

CALVIN W. RICE,
Secretary.

A.S.M.E. Standards

SOON after its foundation in 1880, the Society instituted the procedure of creating standards of method and dimensional standards and of issuing such standards in printed form for general use. To date upward of fifty such standards, or codes, have been formulated, and some of them have been widely adopted and have become the basis of extensive manufactures.

The consideration of a proposed standard by the Society has usually been inaugurated as the result of its attention being called to diversities of proportions existing in similar pieces produced by different manufacturers; variances in methods of measurement of similar quantities; lack of a uniform basis of expression of certain facts; absence of interchangeability, etc.

Sometimes the absence of the standard, and the consequent necessity of it, has been pointed out by a competent authority in a paper embodying a resolution recommending the expediency of the Society considering the matter and reporting. Sometimes an interested party has addressed the Society requesting an opinion, which has later been made the basis of a standard. Sometimes the Society itself has recognized the necessity for a uniform procedure and has taken the initial step toward its creation.

In all cases, upon affirmative action by the Council of the Society, accepting the duty to formulate the standard, a committee of competent persons, members of the Society and other authorities, has been appointed to frame recommendations. Such committees have always been charged to take into their confidence all interested parties and to submit their findings to such parties for inspection and criticism before reporting them to the Society.

Reports of standards committees are presented at a general meeting of the Society and are, upon presentation, open for discussion by the whole membership and by others interested. Following such discussion, if, by vote, the recommendations still stand, the report is referred to the Council, who receive it and, upon approval by them, order it entered upon the record and printed in the TRANSACTIONS of the Society.

In cases where the field of action covered by a committee is very wide, viz., such as that of the Boiler Code Committee or the Power Test Committee, it has become the practice, on the acceptance of the committee's report and its subsequent discharge, to appoint a permanent committee to interpret the rules when called upon to do so, to make such revisions as may be found desirable, and to modify the rules to meet such new conditions as arise. These interpretations and rules are formally approved at meetings of the permanent committee, and by letter ballot submitted to the members who could not attend the meeting. They are thereupon submitted to the Council, and if approved printed in THE JOURNAL. The permanent committee holds meetings from time to time, at which all interested parties are given an opportunity to present suggestions with regard to the standards under consideration. These meetings constitute "revision periods" and take place at stated intervals, for instance, once in two or more years. All revisions of the codes or standards involving a change of meaning are reserved for these meetings, which may also take the character of "public hearings" so as to afford everybody interested an opportunity of stating his case in public.

Recent developments in the standardization work of the Society include the appointment, by amendment to the Constitution in the Spring of 1915, of the Standardization Committee as a standing committee of the Society. It is the function of this committee to standardize the method of making

and arriving at standards rather than create standards themselves. This committee endeavors to bring about a unification of the standardizing work of the Society, and for this purpose national and international coöperation between organizations and governments, including an exchange of information with regard to standardization.

Finally there is the Standardization Committee of the national engineering societies to coöperate by representation on a proposed Joint Committee composed of three representatives each from the national engineering societies, to consider and report back to their respective societies suggested means of bringing about coöperation in the formulation of American Engineering Standards.

The Society is at all times prepared to formulate standards within its field of activity and to assist other organizations in the preparation of standards, and will, upon request, appoint members to serve on committees for this purpose. Several such coöperative committees are at work at the present time.

It should be reiterated that none of the reports are adopted by the Society. They are simply actions which carry weight and a recommendation, but no further obligation. In practically all cases the standards have been accepted by outside parties, but of course without request by the Society.

Catskill Aqueduct Celebration by Engineers

The completion of the Catskill Aqueduct is an event of such extraordinary engineering importance that, notwithstanding the war, the citizens of New York decided that it should not pass unobserved. As an engineering feat, the aqueduct is the greatest accomplishment of its kind in history and a monument to American genius.


THE CATSKILL AQUEDUCT MEDAL

To plan and carry out the arrangements for the commemoration, the Mayor of New York, Hon. John Purroy Mitchel, appointed a Mayor's Catskill Aqueduct Celebration Committee, with Hon. George McAneny as chairman and with various sub-committees. The Sub-Committee on Art, Scientific and Historical Exhibitions, Dr. George F. Kunz, chairman, in turn invited the United Engineering Society to appoint a committee to coöperate with it in planning the engineering features of the celebration. This committee consists of Messrs. Samuel Sheldon, Chairman; Charles Warren Hunt, Calvin W. Rice and E. Gybbon Spilsbury.

The celebration commenced on October 12 with appropriate exercises, such as turning on the Catskill water at new fountains in City Hall and Central Parks; emptying the lower Croton reservoir, now to be abandoned; civic parade; exercises in the public schools and exhibitions by the historical, scientific and art societies.

The United Engineering Societies Committee, working with Dr. Kunz's sub-committee, has planned an Aqueduct Celebration by engineers to be held in the Engineering Societies Building, New York City, on November 14. Mr. George H. Pegram, President of the American Society of Civil Engineers, will preside, and there will be addresses by Hon. John Purroy Mitchel and Major-General George W. Goethals. Mr. A. D. Flinn, deputy chief engineer of the Metropolitan Board of Water Supply, will deliver an illustrated lecture on the Catskill Aqueduct.

Power Test Hearing

A public hearing of the Rules for Conducting Tests of Power Plant Apparatus (Power Test Code of 1915) will be held in the Engineering Societies Building, New York, December 7, in connection with the Annual Meeting. The hearing will be conducted by the Power Test Committee, and the Advisory Committee of this Committee will attend.

Condensed Catalogues

The Seventh Annual Volume of the A.S.M.E. Condensed Catalogues is the largest and most comprehensive edition of this book yet published. An endeavor has been made in the new volume to increase the value of this publication to the membership and to the mechanical profession at large. Many more firms than ever before are represented by publication of their data in the Catalogue Section.

The general Mechanical Equipment Directory, which was inaugurated as a new and distinctive feature in the 1916 volume, appears in this edition in enlarged and improved form. In its preparation the suggestions received from members and others, following the initial appearance of the Directory in the issue for last year, have been of much assistance. During the past year the Society's records relating to manufacturers of mechanical equipment have also been extended, with the result that in this edition the Directory contains the names and addresses of more than 3200 different firms, indexed and cross-indexed under upward of 2500 subject headings.

The section of Engineering Data has also been extended and improved in this volume. In addition to the data selected from THE JOURNAL and TRANSACTIONS for the past year, a summary of the work of the standards committees of the Society is included this year.

PRESIDENT HOLLIS ADDRESSES THE CLEVELAND ENGINEERING SOCIETY

On September 11, Dr. Ira N. Hollis, President of The Am.Soc.M.E., addressed the Cleveland Engineering Society on the subject of Engineering and Coöperation, in which he urged most earnestly that the engineers of the country come together for those interests which they hold in common. He expressed the hope that the Engineering Council would soon become representative of every engineering society in this country, local as well as national, making the council a body of men, in number between sixty and seventy, who can truly speak for the engineers of the country, and having power delegated to them to speak. Dr. Hollis said in part:

ENGINEERING AND COÖPERATION

How can coöperation be applied to engineers in a special way so that they can be more able to serve the colors or to dedicate themselves to real service? How can the engineers best work together? We call this an age of specialization in connection with engineering and everything else; but what is specialization but coöperation?

There are various methods by which coöperation may be brought about, and I care not how it is brought about, whether through national engineering societies, local engineering societies, engineering clubs, or through colleges, so long as it is effective.

In the national societies we have made an effort during the past few years, by means of sections of the societies in various parts of the country, to interest groups of our men in what the national bodies want to do. The American Society of Mechanical Engineers, for example, has sections in a great many of the large cities all the way to California. That does not mean that the parent society is unfriendly to local societies. I have often said, in fact, I always say in a city like this, we desire every engineer to belong to one of the national societies, and, above all else, to his local society of engineers.

We have made many efforts to bring the societies together into what might be called a great national society, and they have always been failures. They have appeared in the form often of conference committees representing a number of societies.

We have had special conferences on all kinds of subjects, started for the purpose of elucidating some one subject in which all of the engineers are interested. I recently proposed in a letter to the chief engineering societies, the constituting of a council that would last for all time and recognize this condition of certain things common to all engineers as apart from the technical matters we want to study and work out in our own societies. The idea was threshed out for three or four months, and I thought it was going to fail. It did not, however, and we have now in the Engineering Council at least an attempt to solve questions among civil, mechanical, electrical and mining engineers of this country.

What are the kinds of questions common to engineers? The American Society of Mechanical Engineers was founded, and in the ideas of its founders was constituted, for the education of its members in technical matters by the interchange of papers, by reading papers for one another's education, and we have profited by that. It is truly an educational institution. Now, out of that society there have grown, as the result of experience, certain needs for a better understanding of the relation of that society to the public. The reading of a technical paper is a very good thing, but if we do nothing else than listen to technical papers and meet only to exchange views about machinery, we are narrowing our viewpoints a good deal, and depriving the members of our society of the opportunity to become really enlightened in the application of their profession to the great needs of society.

The way to solve our problem of coöperation in the United States amongst the engineers is not by establishing a new society for that purpose, but by making use of the agencies that already exist—all the national and local engineering societies.

It seemed to me that we might have a congress of engineers. I asked a year ago if it was not possible to take the four national societies that are rather concrete and within reach, so that getting them together would be practical at least, and see if we could not have one meeting, where all of us met. I have sometimes thought that it would be a good thing if we could extend this idea to the whole of the United States, and have one grand roundup at some place in this country where we could all get together and perhaps spend a week in threshing out one another's full ideas and bringing something out of the discussion that would be worth while. I have despaired of being able to carry out this plan through pressure of other work. I do not know of any other way to do it than to bring the societies face to face from month to month with the numerous problems that are common to them all, and that is what we propose to do through the medium of the Engineering Council.

My hope for the Engineering Council is that it is simply the beginning of a council backed by the engineering societies themselves, having power delegated to them to solve certain questions without any reference back to the societies at all, as engineers, and my hope is that every engineering society in this country, local as well as national, will in the course of a few years belong to the Council, making it a body of men, in number between sixty and seventy, who can truly speak for the engineers of the country, and having power delegated to them to speak.

To my mind, I think we have in the Council the greatest opportunity the engineers have ever had in the history of this country for all of us to get together. All of us ought to go to work to help it and strengthen it in every way, and if it does not broaden itself out so that other societies become members of it and have their voice—their voices are just the same as those of the men who are working in the Engineering Societies Building in New York—it should be made to.

I do not know of any better way, to begin with what I call real coöperation, than to take the agency which has gradually grown out of a necessity in New York City, and strengthen it into a truly national council that represents you engineers in Cleveland just as much as it represents the men in New York or the men in any other place.

In connection with the extension of representation on the Engineering Council, I appointed a committee, each of whose members represents seven or eight societies, for the purpose of seeing what can be done toward compiling a complete directory of all the engineers of the country. There are four types of engineers so far as their relation to the societies is concerned: those who belong to one or more national societies, those who belong to a local society and a national society, those who belong to a local society and do not belong to a national society, and those who belong to no society at all. All ought to come in our listing as part of the public service that the societies can do for the engineers. I think the directory, if compiled, ought to be in two places, one in the Engineering Societies Building in New York, being a complete list, and the other a local list for use in every locality; so that there are two places where we ought to have such a list, one that applies to Cleveland, we will say, and one that applies to the whole nation.

This committee has been putting in no end of time and study. For the purpose of the war they have already made out a first-class list of fifteen hundred or two thousand men who have intimate knowledge and great experience in specialties. That list is used by the United States Government; in fact, hardly a day goes by that we do not have some request in connection with it. But there is the after-war condition, where such a committee representing all the engineers could be of great use in connection with the readjustment of our industries.

We know as engineers why we ought to work together. There is, however, a last thought I want to put into your minds, that we gather strength just in proportion as we impress upon the other citizens of this country that we belong to a truly great profession interested in the welfare of this country. I sat down in Washington the other day to listen to Mr. Post, assistant to the Secretary of Labor, and other gentlemen speak on the establishment of what they call a public-service reserve, which would naturally belong to the army or navy. Mr. Post gave me a list of the positions that he proposed to fill, including plumbers, boilermakers, blacksmiths, all down through all the trades. I said to him, "Why, Mr. Post, you misunderstood the situation; you must be thinking of engine drivers." "Oh, no," he said, "I am thinking of the engineer." "Well, but," I said, "the engineers

are professional men?" "Oh, no," he replied, "they are wage earners." Now, that was a description that is totally false. We are wage earners in the sense that the lawyer and the doctor is a wage earner, but we are not wage earners in the sense that a man who goes to work ten hours a day for so much an hour is. We may have to go through that apprenticeship, and it is a good thing to go through it, but nevertheless when we talk of engineering we mean the profession involving the same amount of thought, the same interest in the development of our country that the lawyer or the doctor has.

Consequently, I emphasize the word *profession*, and I believe that in coming together as engineers (not necessarily in one great engineering society, which I think is a piece of Utopian foolishness) our national and local societies can cultivate the vocation peculiar to themselves just as well after they come together as they do now, and to come together for those things common to all and that relate to the public relations of the engineering societies. Do not let us surrender the fact that we are professional men, that whether we get our education in college, or whether we get it by the hard knocks of experience, we have learned a great profession without which our country would be an undeveloped and barren waste.

WAR ACTIVITIES OF TECHNICAL SOCIETIES

By CALVIN W. RICE, NEW YORK

Secretary, The American Society of Mechanical Engineers

WAR is a science; in fact, it is one of the most complex of sciences. This has been recognized for ages, but in the present war it has become particularly evident. War in the air, war under the sea, war by means of novel surface machines, bombs and gases have all added to the complexity of the science.

War has become a matter of complete military and economic organization, into which every man, woman and child must be massed. The sole thought and effort of the nation in modern war must be concentrated on the business of making war. Particularly is this true in "our" war.

In this complete organization the technical men play not a small part, and it is, therefore, but natural that the several technical societies representing them should be active as such in the war period. It is, however, with no thought of taking peculiar credit that the following activities of the technical organizations are enumerated—it is realized that at this time the nation places dependence on everyone, no matter what his talent or connections.

It was during the Civil War in 1863 that the National Academy of Sciences was formed and Congress gave it a charter to advise the Government in all technical matters. Therefore, it was to be expected that with the war problems accumulating, as they did last year, the Academy should again offer its services, and the President of the United States officially received them in September, 1916. President Wilson invited the President of the Academy at that time to form what is known as the National Research Council. The Council has functioned continuously since its appointment and has performed excellent service.

The Council is a body of about 40 men, members of technical societies, who have in turn arranged themselves into numerous committees to study all realms of research. The following is part of a statement kindly prepared by the Vice-Chairman of the work of the Council to date, condensed with difficulty on account of the great variety and scope of its activities:

BROAD WORK OF THE NATIONAL RESEARCH COUNCIL

All of the work of the National Research Council that touches upon Army and Navy problems is carried on with the advice, coöperation or control, as the case may be, of the representatives of the various Departments of the Army or Navy under which such work comes.

The Council has coöperated in the establishment and organization of the submarine experimental work at Nahant, Mass., and has also established a very active submarine station at New London, Conn., and another at San Pedro, Cal., and has been instrumental in the organization of groups working at New York, Chicago and Madison, Wis. There has resulted a great practical advance in the art of submarine detection which it is not desirable to go into further.

The Physics Committee of the council has distributed to various groups twenty or more large problems in physics, which are being actively worked upon and some of which have already been solved. Among the latter are the location of aircraft by sound, the development of fire control for anti-aircraft guns, telephoning between aeroplanes, protection of balloons from ignition by static charges, and development of new and improved methods of measuring muzzle velocities.

The Chief Officer of the Signal Corps of the Army has asked the National Research Council to act as the Division of Science and Research of the Signal Corps, and in this capacity the Council has organized a sound-ranging service in the Signal Corps, and a new meteorological service in the same corps, and is now drawing specifications for scientific instruments to be used on aeroplanes. It has sent a dozen of the best physicists in the country to France to aid the American Expeditionary Forces with their scientific knowledge, and is selecting a personnel of several hundred men who are to be engaged in the scientific services of the Army and Navy.

The Chemistry Committee has perfected an elaborate organization for handling all the chemical problems which arise in the Army and Navy, and it has distributed some 150 chemical problems which are being attacked in the chemical laboratories of the country.

The Engineering Committee has contributed in no small degree to the development of devices for the protection of ships from submarines. It has organized a large group which is now working on the development of steel protective devices for use of the soldiers at the front. Through coöperation with the National Advisory Committee for Aeronautics it has carried on extensive and important researches in the development of aeroplanes and aeroplane engines.

The Nitrate Committee has made an elaborate study and report which has been made the basis for the expenditure by the Government of large sums of money upon the erection of a nitrate plant and upon kindred projects.

The Gas Warfare Committee has had for six months 120 chemists working on the problems of gas warfare, and the results already obtained have been of the utmost importance—so important that the Army and Navy have placed large appropriations at the disposal of this committee for its researches.

The Optical Glass Committee, by taking from research laboratories like the Geophysical Laboratory a dozen or more silicate chemists and putting them directly in the works of the Bausch and Lomb Company and the Pittsburgh Plate Glass Company, has in six months' time developed in America the production of optical glass from nothing up to 20,000 lb. a month, and in two months more this figure will have been multiplied two or threefold.

The Foreign Service Committee, which the Council sent abroad at once upon the outbreak of the war, was wholly responsible for the sending back to this country of French, English and Italian Scientific Missions, which brought with them the contributions which science had made to the war, both in the matter of instruments and methods, and unquestionably saved months of time in putting the United States abreast of the European situation, as regards modern scientific methods in warfare. It is difficult to overestimate the stimulus to American participation in the war which resulted directly from the action of the National Research Council in sending abroad at once this Foreign Service Committee composed of seven of the best scientists in the country.

Abstract of address before the Southern Commercial Congress, New York, October 15, 1917. The author wishes to acknowledge his indebtedness to Mr. W. E. Bullock, Associate Editor of THE JOURNAL, for his assistance in the preparation of this paper.

THE ENGINEERING FOUNDATION DONATES ITS INCOME

Just previous to the declaration of war by the United States, the American Society of Civil Engineers, The American Society of Mechanical Engineers, the American Institute of Mining Engineers and the American Institute of Electrical Engineers were developing coöperative relations with the National Academy of Sciences through the Engineering Foundation, this latter being a group of men representing the above societies in the administration of funds devoted to the service of man through the instrumentality of the Engineer. The Foundation promptly placed its financial resources and staff at the disposal of the National Research Council, and these services have been continued until recently, when subventions have been received by the National Research Council sufficient to enable it to maintain independently the many and heavy demands which were fast exceeding the resources of the Foundation.

THE NAVAL CONSULTING BOARD EXAMINES 200 INVENTIONS A DAY

In the preceding fall, in October, 1915, the Secretary of the Navy invited twelve engineering and technical societies to nominate two men each whom he might appoint on the Naval Consulting Board. The societies responding were the four previously mentioned and the American Chemical Society, American Mathematical Society, American Aeronautical Society, Inventor's Guild, Society of Automotive Engineers, American Society of Aeronautical Engineering, American Institute of Metals and the American Electrochemical Society.

You are all familiar with the great industrial census directed by the Committee on Industrial Preparedness, a sub-committee of the Naval Consulting Board, whereby all industries in the United States doing an annual business in excess of $100,000 were listed, together with all pertinent information as to their capacity, number of workmen, location with respect to sources of materials, transportation, etc. These data have all been collated on cards similar to those used in the United States Census.

Committees in each of the forty-eight states, the territories, and the District of Columbia were formed by the following five Societies: American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers and the American Chemical Society, who performed the work, assisted, of course, by the companies themselves. Much if not all the undertaking was without expense to the Government.

A first essential to all work to be done by the people generally must be publicity. To explain and popularize this census the President of the United States wrote a letter inviting the above five societies to undertake the work and the Associated Advertising Clubs of the World raised donations approaching one million dollars of advertising space throughout the press of the United States to display the President's letter and explain the census.

In the matter of inventions alone the Naval Consulting Board is receiving in excess of two hundred propositions a day which require for disposition the continuous voluntary services of a large number of the members of the technical societies.

THE SOCIETIES' INFLUENCE ON WAR LEGISLATION

All these voluntary activities of the people of the nation were consummated in the establishment of the H. R. Bill 16,460, in July 1916, of the Council of National Defense composed of six members of the Cabinet and Advisory Commission of seven civilians.

The Advisory Commission has numerous committees with which the public is now familiar. The principal ones, however, of War Industries and Air Craft, are headed by men originally designated by the technical societies as their representatives in some war work.

The constant aim of all has been to uphold and strengthen the regular departments of the Government and enable them to meet the demands which have taxed them to the utmost.

The four engineering societies already mentioned as taking the industrial census, joined by the American Institute of Consulting Engineers, were active in the movement which resulted in the legislation providing for the Engineer Officers' Reserve.

The nation has by this legislation obtained and placed in military relation the services of thousands of the best men of the profession and augmented the staffs of every bureau of the Government.

THE SOCIETIES AND MILITARY EDUCATION

Very early in the war, and sensitive to the needs of the national engineering societies, the Engineers' Club of New York formed a military engineering committee. The object of this committee was both to arouse the people to the necessity of preparedness and to instruct them in military tactics. The engineers in New York were duly prominent in the preparedness parade, which was the forerunner of similar parades all over the United States.

A series of military lectures was given in the Engineering Societies Building under the auspices of the committee. The lecturers were mainly men loaned by the War Department, but credit is due them for faithfully giving this course lasting several weeks when it is understood that the preparation and giving of the lectures was in addition to and outside of the strenuous work of an army officer preparing for war.

The same committee later supervised and financed the recruiting of a division of engineers for France.

SPLENDID WORK OF THE S.A.E.

No one Society has had a more prominent or important part in war work than the Society of Automotive Engineers. It has not only furnished some of the most valuable volunteer men now in the departments of the Council of National Defense, but as a strictly technical work the Society has undertaken standardization of air-craft production, maintaining a suite of offices and a staff both in New York and in Washington.

The engineers who designed the wonderful Liberty Motor are members of the Society of Automotive Engineers.

The Society is also prominently represented on the Automotive Transport Section of the War Industries Board.

The American Railway Association, coöperating with the Chairman of the Advisory Committee of the National Council of Defense, has a Committee on Transportation consisting of 28 railway executives.

THE AMERICAN MUSEUM OF SAFETY'S CONTRIBUTION

The American Museum of Safety has been coöperating with the Government to conserve the lives and health of workers in federal industries. It undertook a safety survey of federal plants, the director of the Museum being placed in charge of safety inspection work. As the result of this survey the Government placed an experienced safety engineer in each navy yard and arsenal, and a central safety committee has been organized in Washington for directing the Government's accident-prevention work.

The director of the Museum has been appointed chief safety expert of United States Employees' Compensation Commission. The trustees have released the director of the Museum to serve without cost to the Government as advisory safety engineer. Two of the thirteen safety engineers appointed by U. S. Employees' Compensation Commission were selected from the staff of the Museum.

ACTIVITIES OF THE CHEMISTS

The American Chemical Society, in addition to participation in the Research Council and the Naval Consulting Board, has coöperated with the American Institute of Mining Engineers and the U. S. Bureau of Mines in the preparation of a census of chemists, metallurgists and mining engineers, for which there is a great demand.

The society was prominent in the movement to protect the needs of the Government for scientific and industrial work in the matter of platinum supplies.

The society has coöperated in the selective draft, in similar manner to that previously mentioned in connection with the Society for the Promotion of Engineering Education, and arranged that drafted chemists shall be assigned to their special work, for which the Government is in great need.

THE ENGINEERING COUNCIL APPOINTS WAR COMMITTEES

The Engineering Council, representing the Civil Engineers, Mining Engineers, Mechanical Engineers and Electrical Engineers, has a War Committee of Technical Societies and also the American Engineering Service Committee.

The latter has collected already the classification data of several thousand professional engineers and is continually extending its files and eventually plans to have catalogued 110,000 professional engineers and technical men.

Its committee for months has been supplying all departments of the Government and the industries generally with the names of engineers of specialties in all lines. The service is entirely free. Any department of the Government or any industry needing professional engineers may apply at the Engineering Societies [illegible], 29 W. Thirty-ninth Street, New York, and service will be rendered [illegible].

THE SOCIETIES AND GOVERNMENT STANDARDS

In addition to the coöperation in the joint activities already mentioned, The American Society of Mechanical Engineers has committees coöperating with the Government in the matter of certification of gages, in an effort to ensure uniform production throughout the United States. The working out of the idea which is so obvious to all will nevertheless demand the greatest coöperation on the part of everyone.

The American Engineering Standards Committee, representative of several of the societies already mentioned, is assisting in an international as well as national service of standardization of all kinds, both for the period of the war and afterwards.

THE VARIED BUT VITAL ACTIVITIES OF THE SOCIETIES

The American Railway Engineers' Association has published and distributed a manual of recommended practice to all the members of the railway regiments in France.

The National Machine Tool Builders' Association has coöperated with the Council of National Defense, the Air-Craft Production Board and in the production of the new Liberty Motor. A comprehensive list of all the machine tools in the United States ready for delivery was prepared and furnished the Government.

The National Electric Light Association, The Association of Edison Illuminating Companies, The American Gas Institute, assisted also by the American Water Works Association, the Illuminating Engineering Society and the American Society of Refrigerating Engineers have for months maintained an office and staff in Washington and have undertaken a comprehensive service for gas and electricity to the various cantonments regardless of commercial considerations on the one hand, and on the other have been the clearing house to assist municipalities and aid utility companies to secure the coal necessary for their operation. They have also rendered invaluable and timely engineering service to various government departments and the Council of National Defense.

The American Institute of Metals has coöperated with the U. S. Bureau of Standards in the preparation and inspection of non-ferrous metals and has furnished many men for the Engineer Officers' Reserve Corps.

The American Institute of Architects is handling certain emergency work for the Government through its committees appointed by the President of the Institute. A war-service register has been created, comprising over 3000 names, giving qualifications of architects and draughtsmen. This register has been actively used by various branches of the Government service.

The Illuminating Engineering Society has laid out the lighting schemes for the aviation cantonments for flying by night, an absolutely new problem. The society has also prepared industrial lighting codes for the Welfare Section of the Labor Commission of the Council of Defense. It is also at work on some confidential matters.

The Society for the Promotion of Engineering Education has prepared in detail modifications of curricula for students in engineering to meet war conditions, and has worked out a just modification of the draft law so that students who have been drafted may be assigned to finish courses which will specifically prepare them for government service.

Special information has been furnished the departments of the Government, including lists of all books on the application of engineering to the war.

The National Society for Promotion of Industrial Education has trained several hundred electricians for the Navy in connection with the Electrical School of the New York Navy Yard; it has also done similarly for the Signal Corps and is now training men for Marine service.

The Franklin Institute up to date has recruited 721 men for the Aviation Service. Its secretary is a major on General Pershing's staff and the associate secretary is a lieutenant in the Signal Corps. Investigations have also been made by the Institute for the National Research Council.

The National Association of Master Steam and Hot Water Fitters has furnished engineers and draftsmen to lay out the steam work for power and heating to be done in connection with hospitals, officers' quarters, barracks and other buildings at the cantonments, as well as many other buildings already under construction and to be built for several branches of the service.

The National Association of Engine and Boat Manufacturers has turned over to the Government complete inventories of the members' factories and equipment in order to facilitate the work of the Council of National Defense. Practically all of the submarine chasers ordered have been built in the factories of the members of the Association. Recently an arrangement has been effected with the Society of Automotive Engineers whereby the members of the Association have become represented in that organization with particular reference to the formation of a new Committee on Marine Standards, whose work will undoubtedly prove of immeasurable assistance to the Government.

The American Electric Railway Association has a committee with representatives in the several military departments of the Government, who in coöperation with the Council of National Defense are preparing a comprehensive map of all the electric railways and their availability for war.

In the South, the Affiliated Technical Societies of Atlanta have assisted in the industrial census already mentioned and in recruiting an engineer regiment. So many of their members have gone to the front that they cannot hold meetings.

The President of the Engineers' Club of St. Louis is a major. The club has assisted in recruiting some of the railway regiments now in France, has purchased and presented regimental colors and is arranging to send every member at the front a Christmas gift. It has also contributed to the American Red Cross.

The Engineers' Society of Northeastern Pennsylvania has organized a company of engineers which has been accepted by the National Guard and is now in federal service at Camp Hancock. The President of the society is commissioned as a major.

The Florida Engineers' Society maintains a classification list of men available for special service, and over twenty per cent of its membership are at the front.

The returns from more societies throughout the country seem to point to over ten per cent on the average as being now with the colors.

The Engineering Society of the South has sent its secretary, treasurer and ten per cent of its membership to the front. It is furnishing technical data to the Government, and like other organizations has assisted in recruiting the railway regiments.

THE SOCIETIES AND WAR RELIEF

The technical societies with their obvious professional work have not forgotten war relief.

The Engineers' Club of New York has for nearly three years been giving six hundred dollars per month to the suffering in all countries.

About $11,000 was contributed by members of all societies to what is known as the British Professional Classes War Relief, inclusive of artists and others as well as engineers.

Obviously the technical societies, as organizations of professional men, are not content, with this war on our country's hands, to let anything rest, and at this very moment the representatives of the societies are meeting in Washington to discover how they can serve in the tremendously essential work of the conservation of coal.

There is shortly to be held a conference of all the technical committees to see how they may be coördinated, and a permanent headquarters and staff, all at our expense, placed in Washington at the disposal of the Government.

The technical societies are ready and willing to consecrate every ability to make the Stars and Stripes the symbol of that nation whose citizens are capable of the greatest sacrifice and unselfish service to mankind.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER DECEMBER 10, 1917

Below is the list of candidates who have filed applications for membership since the date of the last issue of THE JOURNAL. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate or Associate-Member, those in the third class under Associate-Member or Junior, and those in the fourth under Junior grade only. Applications for change of grading are also posted.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by December 10, 1917, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about January 15, 1918.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be slower than under normal conditions.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

California

TEASDALE, GEORGE W., Master Mechanic, Potrero Mining Co. of Mexico, Los Angeles

Colorado

MALLORY, WALTER F., Instructor, University of Colorado, Boulder

Connecticut

ARKISON, JOHN T., Superintendent, M. J. Daly & Sons, Waterbury

CUDLIPP, CHARLES W., Secretary and Manager, The Rogers Paper Mfg. Co., Inc., South Manchester

SCOTT, NELLIE M., President and General Manager, The Bantam Ball Bearing Co., Bantam

WEBB, THOMAS M., Process Engineer, Remington Arms U. M. C. Co., Bridgeport

Delaware

ACKART, EVERETT G., Supervising Engineer, E. I. du Pont de Nemours & Co., Wilmington

District of Columbia

WOODWARD, MARK R., Engineering Aid, Bureau of Yards & Docks, Navy Dept., Washington

Illinois

BAILEY, ROBERT W., Agent, Structural Steel and Machinery, Chicago

Indiana

BULL, EYVIND H., Engineer, Green Engineering Co., East Chicago

Louisiana

ROBERTS, THOMAS H., General Superintendent, Stern Foundry & Machinery Co., New Orleans

Maine

HARVEY, WALTER O., Mechanical Engineer, American Thread Co., Milo

Maryland

HUSS, HENRY, Second Vice-President, New York & Hagerstown Metal Stamping Co., Hagerstown

Massachusetts

ARNOLD, Arthur A., Mechanical Engineer and Development Manager, American Optical Co., Southbridge

CLARKE, JAMES C., Educator, Head of Coöperative Industrial Course, Hyde Park High School, Boston

EYRE, JOHN J., Engineer on Rifle Parts, New England Westinghouse Co., Springfield

PERKINS, PERCIVAL I., President, P. I. Perkins Co., Boston

SHUTE, FRANK A., Nightingale & Childs Co., Boston

Minnesota

HAWKINS, ROBERT D., Superintendent of Motive Power, Great Northern Railway, St. Paul

New Jersey

BENNETT, HENRY G., General Manager, International Arms & Fuse Co., Bloomfield

DONOVAN, JOHN T. L., Superintendent and Engineer, Equipment Division, Edison Lamp Works of G. E. Co., Harrison

New York

BATTIN, HAROLD T., Chief Engineer, Horace A. Staples, Cons. Engineer, New York

CONRAD, WILLIAM L., Industrial Engineer, with H. L. Gantt, New York

CORLEY, RALPH A., President, Young, Corley & Dolan, New York

CORY, RUSSELL G., Consulting Engineer, New York

EADIE, JOHN G., Consulting Engineer, Eadie, Freund & Campbell, New York

KIBELE, EUGENE, General Manager, Clark Bros. Co., Olean

LEYSON, DAVID J., Assistant Production Engineer, Savage Arms Corp., Utica

LLOYD, ROBERT MCALLISTER, Consulting Engineer, New York

LUDLUM, ALBERT C., President, New York Engineering Co., New York

MACDONALD, COLIN F., Boiler & Factory Inspector, Rochester

RAHILLY, THOMAS A., Mechanical Engineer, Bureau of Sewers, Brooklyn

STROHMANN, WILLIAM, Chief Estimator and Assistant Chief Clerk of Cost Department, R. Hoe & Co., New York

SWEETLAND, ERNEST J., Vice-President and Eastern Manager, United Filters Corp., Brooklyn

Ohio

NIKONOW, JOHN P., Member, Russian Commission on Inspection of Artillery Orders, at Recording & Computing Machines Co., Dayton

SPENGLER, WARREN D., Electrical Engineer, Firestone Tire & Rubber Co., Akron

Pennsylvania

BATES, ERASTUS N., JR., Assistant Professor Mechanical Engineering, Pennsylvania State College, State College

CHERRINGTON, GEORGE H., President, Brown & Zortman Machinery Co., Pittsburgh

HAMILTON, WALTER C., First Lieutenant, Ordnance Department U. S. R., Frankford Arsenal, Philadelphia

HEERING, ERNEST K., Designing Engineer, Wm. Cramp & Sons' Ship & Engine Building Co., Philadelphia

McKENZIE, JOHN C. S., Special Representative, Erie City Iron Works, Erie

PRESCOTT, PERLEY R., Operating Engineer and Engineer of Tests, Erie City Iron Works, Erie

PYLE, LEWIS M., Designing Engineer, Niles-Bement-Pond Co., Philadelphia

Rhode Island

HOUGH, EDWARD B., President, Wightman & Hough Co., Providence

Washington

CAMMACK, ALBERT, Professor of Steam Engineering, Washington State College, Pullman

Australia
WOOD, ARTHUR, Locomotive Designer,
Commonwealth Railways, Melbourne, Victoria

England
FRYER, FREDERICK G., Chief Mechanical Engineer,
Rowntree & Co., Ltd., York

FOR CONSIDERATION AS ASSOCIATE OR ASSOCIATE-MEMBER

California
FLAM, AUGUST, Mechanical Engineer and Designer, Los Angeles

Connecticut
ADISHIAN, PETER K., Tool Designer,
Pratt & Whitney Co., Hartford
NAUHEIM, S. ALBERT, Assistant Superintendent,
Autotyre Co., Oakville

Illinois
COLEMAN, WILLIAM F., Assistant Manager,
Pyott Foundry Co., Chicago
SHEA, JOHN R., Head of Production Methods Division,
Western Electric Co., Chicago

New York
ENNES, JOHN G., Outside Superintendent,
Bayles' Shipyard, Inc., Port Jefferson
LANYI, LOUIS, Chief Engineer, Fan Division,
Green Fuel Economizer Co., Beacon

Ohio
EIPORT, HARRY E., Charge of Machinery and
Equipment of Dept., Babcock & Wilcox Co., Barberton

Oklahoma
CORNELL, HERMAN D., Vice-President and General
Manager,
Higrade Petroleum & Gasoline Co., Tulsa

Wisconsin
SHERRETT, Charles S., Safety Inspector,
National Workmen's Compensation Service Bureau, Milwaukee

Cuba
SOLIS, OCTAVIO, Engineer,
American Trading Co. of Cuba, Havana

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

California
BARE, BERT, Draftsman,
Skandia Pacific Oil Engine Co., Oakland

Connecticut
NASH, DOUGLAS E., Mechanical Engineer and Treasurer,
Nash Engineering Co., South Norwalk

Delaware
GRIER, ALEXANDER M., Sanitary Engineer,
E. I. duPont de Nemours & Co., Wilmington

District of Columbia
MASSEY, MARK F., Draftsman,
Ordnance Office, War Dept., Washington

Massachusetts
HAY, DELOS R., Inspector,
Sanford Riley Stoker Co., Worcester
SAVEDOFF, MORRIS M., Mechanical Engineer,
New England Westinghouse Co., Springfield
SYMONDS, RALPH F., Works Manager,
New England Structural Co., Everett

New Jersey
CONSTABLE, JOHN P., Chief Engineer,
Edison Laboratory, Orange
WALSH, JEREMIAH A., Engineer,
E. H. Mumford Co., Elizabeth

New York
SPATES, THOMAS G., Assistant Power Engineer,
New York & Queens Electric Light & Power Co., Long Island City
STONE, JOSEPH L., First Lieutenant, Ordnance R. C.,
U. S. A.,
Remington Arms Co., Ilion
STRUTHERS, ROYDEN T., Chemical Engineering,
Borden's Condensed Milk Co., New York

Oklahoma
[illegible]LKE, ERWIN L., Superintendent,
Continental Gas Compressing Corp., Lenapah

Pennsylvania
SCHUETTE, ROBERT W., Assistant Chief Engineer,
Steam & Hydraulic Dept.,
Mesta Machine Co., Pittsburgh

SWINBURNE, JAMES G., JR., Salesman and Mechanic,
Brown & Sharpe Mfg. Co., Philadelphia

Washington
MOORE, EDWARD J., Moldloftsman,
J. F. Duthie Shipbuilding Co., Seattle

FOR CONSIDERATION AS JUNIOR

Alabama
WELLS, ELIOT C., Mechanical Engineer,
Alabama Power Co., Birmingham

Colorado
ROSE, ERNEST A., Engineer,
American Beet Sugar Co., Rocky Ford

Connecticut
NASH, HAROLD L., Designing Engineer,
Nash Engineering Co., Norwalk
WRIGHT, ABNER M., in Manufacturing Engineers' Dept.,
Winchester Repeating Arms Co., New Haven

Delaware
KRUG, WILLIAM F., JR., Junior Engineer,
E. I. du Pont de Nemours & Co., Wilmington

District of Columbia
TREUHAFT, Alexander A., Draftsman, French
Warfare Section, Gun Division,
Ordnance Department, Washington

Illinois
BARRY, THOMAS J., Assistant Engineer, Centrifugal
Pump Dept.,
Dayton-Dick Co., Quincy
REYMOND, PAUL L., Head of Engineering Dept.,
Federal Sign System, Chicago

Michigan
WILBUR, ROBERT L., First Lieutenant O. R. C., U. S. A.,
Office of Inspector of Ordnance, Detroit

New York
BUNKER, ARTHUR H., Refrigerating Engineer,
American Ice Co., New York

Ohio
FILLMORE, HERBERT W., Engineer on Time Study,
Cincinnati Milling Machine Co., Cincinnati
HUST, WILLIAM, Draftsman,
The J. H. Day Co., Cincinnati
PERRIS, NORRIS, Sales Engineer,
The Baker-Dunbar-Allen Co., Cleveland
WUERTH, EDWARD A., Mechanical Draftsman,
The J. H. Day Co., Cincinnati

Pennsylvania
CHRISTIE, WALLACE T., Assistant to President,
The Pneumatic Elevator and Conveyor Co., Philadelphia

Rhode Island
FULLER, JOSEPH O., Instructor in Mechanical
Engineering,
Brown University, Providence

West Virginia
BERRY, BERNARD C., Master Mechanic,
Potomac Light & Power Co., Martinsburg

Wisconsin
WILKINSON, JOHN B., Draftsman,
Nordberg Mfg. Co., Milwaukee

APPLICATION FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

Pennsylvania
GREENE, HARRIS R., Sales Engineer,
Riley Stoker Dept., B. F. Sturtevant Co., Philadelphia

PROMOTION FROM ASSOCIATE-MEMBER

Connecticut
DAVIS, EDWIN P., Superintendent,
Modern Manufacturing Co., Bridgeport

Missouri
DANIEL, ALLAN P., Designing and Consulting
Mechanical Engineer,
Bituminized Road Co., Kansas City

Pennsylvania
CAHILL, Edward H., Mechanical Engineer,
Arthur Brock, Jr., Engineering Co., Philadelphia

PROMOTION FROM JUNIOR

Maryland

STUART, Milton C., Mechanical Engineer, U. S. Naval Engineering Experiment Station, Annapolis

New York

DOW, Benjamin W., Mechanical Engineer, The Elbert Clarke Co., Rochester

HARTFORD, Claude, Engineer, Contract Dept., New York Steam Co., New York

QUICK, Ray L., Instructor, Experimental Engineering, Sibley College, Cornell University, Ithaca

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Promotion from Associate-Member	3
Promotion from Junior	4
Total	100

NECROLOGY

EARLE C. BACON

Earle C. Bacon was born on May 29, 1859. He served his apprenticeship with the Delamater Iron Works in New York. While there, though but twenty-one years old, he designed the Bacon trunk-cylinder hoisting engine, which had a patented connecting rod with an inside rod for taking up the wear on brasses. This engine was the first used in New York for lifting brick, etc., in building construction. The same engine is still being manufactured for use as a winze hoist and for surface work around mines.

Mr. Bacon served as consulting engineer and furnished machinery for a great many mining companies, as he made a specialty of mining and quarry work.

He was at different times consulting engineer for the Davis Sulphur Ore Co., the Sulphur Mining & Railroad Co., Virginia, the Nichols Copper Co., the Lavonia Salt & Manufacturing Co., the Bristol Copper Co., and many others.

Mr. Bacon was also a pioneer in the asbestos field in Quebec, being employed as consulting engineer in that line, and designing and equipping the first mill for the reduction of asbestos in that region.

He was a member of the Union League Club and of the Machinery Club. He became a member of the Society in 1885. He died on April 9, 1917.

WILNER E. JOHNSON

Wilner E. Johnson was born on May 16, 1881, in Sweden. In 1903 he began his apprenticeship with the Brooklyn Rapid Transit System as a draftsman in the 52nd St. shop of the System. He held successively the positions of chief draftsman in 1907, engineer of car equipment in 1911, and engineer of car construction for the allied New York Municipal Railway Corporation in 1913.

In 1912 Mr. Johnson made a country-wide study of car designs in relation to speed of passenger interchange, the direct result of which was the development and adoption of the center-entrance type of car, which has since become a model for many other roads. Mr. Johnson's most noteworthy achievements for his company were the detailed working out and development of the Brooklyn center-entrance surface car and the New York Municipal Subway car.

As a member of the committee on equipment of the American Electric Railway Association, he spared no effort to make the committee's researches and standards of real value and of active interest to the industry at large.

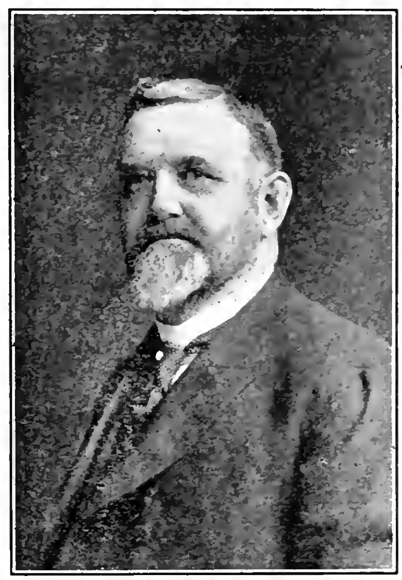
Mr. Johnson became a member of the Society in 1914. He died on July 27, 1917, at his home in Brooklyn.

ALFRED EUGENE KENRICK

Alfred E. Kenrick was born in Brookline, Mass., on February 15, 1851. He was educated in the public schools of that town, and started his apprenticeship at the age of sixteen. In 1885, having learned his trade, he entered into partnership with his father in the firm of Kenrick Bros.

His most successful piece of engineering work is considered to be his invention of the water-heating system for the Brookline Public Bath House.

Mr. Kenrick was an active member of a number of societies in connection with his work. In January 1907 the American Society of Heating and Ventilating Engineers presented him with a silver loving cup in token of his services to that society. He held during his membership in the Master Steam and Hot Water Fitters' Association of the United States every office



Alfred E. Kenrick

within its gift, and on the twenty-fifth anniversary of the Association, in 1913, he was presented with a silver pitcher and salver in appreciation and recognition of his fidelity. He was a member also of the Master Plumbers' Association of Boston.

For over twenty years he served the town of Brookline on its appropriation committee, and for nearly thirty years he was associated with the Brookline Savings Bank, as a member of its board of investment and also as vice-president.

He became a member of the Society in 1896. He died at his home on January 17, 1917.

With the assistance of leading professors in technical schools, business men and social workers, the Advisory Committee for Industrial Service Movement of the International Committee of Young Men's Christian Associations, has prepared a comprehensive outline of suggested college courses on the Human Side of Engineering. The courses are intended to be supplemented by engineering trips to study certain industrial conditions and the betterment work of selected companies.

AMONG THE SECTIONS

IMPORTANT additions to the By-Laws of the Society pertaining to the government of the Sections were passed at the meeting of the Council on October 12. The Sections have now been in existence about ten years, and their activities have extended continuously and uniformly until they now constitute one of the major activities of the Society.

The Committee on Constitution and By-Laws has been working with the Sections Committee for about two years in drawing up suitable By-Laws to cover all the phases of the Sections' work to be found in different parts of the country, to afford the Sections every opportunity to carry on activities of local interest, and at the same time ensure that their procedure be conducted in uniformity with the Constitution of the Society, and the report presented by the former at the October Council meeting represents the consummation of these efforts. The new By-Laws which go into effect immediately are printed below:

New By-Laws Governing Sections

B48 Committee on Local Sections:

The Committee on Local Sections shall consist of five Members, Associates or Associate-Members. The term of office of one member of the Committee shall expire at the end of each Annual Meeting.

It shall be the duty of the Committee to confer with the officers and members of the Local Sections, and to consider, and make recommendations to the Council upon all matters affecting the welfare of the Local Sections. It shall confer with the Finance Committee as to the appropriation for the expenses of Local Sections in each annual budget of the Society, and shall determine the portion of that appropriation which shall be allotted to each Local Section. The Committee shall have such other duties as may be given to it by the Council.

B49 Local Sections:

(a) Formation of a Section

When a number of the membership of The American Society of Mechanical Engineers in any territory desire to form a Local Section, a preliminary meeting shall be called and notice sent to the entire membership of the Society residing in that territory. At this preliminary meeting a petition for the formation of a Local Section, containing suggestions as to the territory to be included in the Section, shall be presented, and if adopted shall be sent to the Committee on Local Sections for presentation to the Council with its recommendation. This petition shall be signed by such of the membership of the Society residing in the territory as favor the formation of such Section.

If the formation of a Local Section be approved by the Council, a meeting of the signers of the petition shall be held for organization and to elect a Local Committee of at least five from among the Section members. This Local Committee shall have charge of and be responsible for the proceedings of the Local Section.

(b) Territory of a Section

The territory of a Section shall include the locality naturally tributary thereto.

(c) Name of a Section

A Section shall be known as The (name of place) Section of The American Society of Mechanical Engineers.

(d) Membership of a Section

All members in every grade of the Society residing in the territory of a Local Section shall be Section Members of that Local Section. A member of the Society shall be entitled to vote or hold office in one Local Section only.

Any other person interested in engineering may be invited by the Local Committee to join its Section as a Local Member, but he shall not have the right to vote or hold office. Such Local Member shall pay dues to the Section not to exceed \$5.00 per annum, which shall be due and payable in advance on October 1 of each year of his enrollment. Local Members shall not be considered in the allotment of expenses to the Section.

Members of Student Branches living in the territory of a Local Section shall be entitled to receive notices of and to attend all meetings of that Section for the period of two years after graduation. Such graduates shall be counted as members of a Local Section in the consideration of the allotment for expenses of that Section.

(e) Activities of a Section

The principal activity of a Local Section shall be the holding of meetings for the presentation and discussion of papers relating to engineering and to the allied arts and sciences; it may also hold meetings for social intercourse.

(f) Meetings and Papers of Sections

The provisions of the Constitution, By-Laws, and Rules of The American Society of Mechanical Engineers, and the precedents of the Society with respect to professional sessions for the discussion of papers, shall govern the procedure of the Local Sections, except that no meeting of a Section shall be considered a meeting of the Society as a whole.

Papers read before a Local Section shall be submitted to the Committee on Publication and Papers of the Society for possible publication in The Journal. The Committee on Meetings of the Society may select from among the papers presented before the Local Sections any paper for presentation before meetings of the Society. A Local Section shall not publish or permit to be published under the authority of the Section any paper as presented before that Section in whole or in part without first obtaining the approval of the Committee on Publication and Papers.

(g) Coöperation of Local Sections

A Local Section of the Society may arrange to hold joint meetings with other local engineering organizations, and may invite members of such organizations to attend its meetings.

A Local Section may affiliate with existing local engineering organizations, or form jointly with them new local engineering organizations, but the plan of such affiliation or organization, and the obligations assumed by the Local Section and the Society thereby, shall first be approved by the Council.

A Section may take action in any undertaking having the approval of the Council, and may coöperate in such action with any other local organization.

(h) Delegates of Sections

Each Local Section shall have the privilege of representation at the Annual Meeting of the Society by one official delegate. Such delegate, the chairman, if possible, may have such portion of his expenses for transportation to the meeting refunded by the Society as the Committee on Local Sections may direct.

(i) Management of Sections

All Local Sections shall be managed in conformity with the Constitution, By-Laws, and Rules of the Society.

Each Local Section shall be managed by a Local Committee of at least five members, consisting of a Chairman, a Secretary,

and such other officers as may be found desirable. Such officers shall be elected by ballot from the membership of The American Society of Mechanical Engineers who are members of the Local Section. They shall be elected before June 1 of each year, and shall take office on July 1.

The Chairman of each Local Section shall receive notices and have the privilege of attending all meetings of the Committee on Local Sections.

The Secretary of each Local Section shall report the Proceedings of that Section to the Secretary of the Society. He shall discharge the duties of Secretary of the Section, and shall perform such other duties as may be prescribed by the Local Committee.

(*j*) *Appropriation for Sections*

Appropriation by the Council for the use of Local Sections shall be used for expenses incurred in holding their professional meetings.

Expenditures chargeable to the Society for purposes of any Local Section must be provided for in the annual budget approved by the Council. No liability otherwise incurred shall be binding upon the Society.

An allotment for a Local Section may be drawn by its Committee as desired, provided that not more than one-half of the total yearly allotment shall be drawn between October 1 to February 1, and that an itemized account of its expenditures during that period shall be rendered to the Secretary of the Society before the remaining amount of the appropriation can be drawn, and provided also that the remainder of the allotment shall be drawn only during the remaining half of the fiscal year, and that an accounting of the second half shall be rendered at the end of the fiscal year.

(*k*) *Stationery for Sections*

All Sections shall use only such uniform stationery as shall be supplied by the Secretary of the Society.

(*l*) *Disbanding of a Section*

The Council of The American Society of Mechanical Engineers may, on sixty days' notice, suspend or disband any Local Section.

Our Present Sections

The Society has now a Connecticut State Section, with branches at Bridgeport, Hartford, Meriden, New Haven, and Waterbury. It also has a Minnesota Section, with meetings held alternately at St. Paul and Minneapolis. Sections are also established in the cities of Atlanta, Baltimore, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Detroit, Erie, Indianapolis, Los Angeles, New Orleans, New York, Philadelphia, St. Louis, San Francisco, Toronto (Canada) and Worcester. The Providence Engineering Society is affiliated with our Society, and its monthly meetings are reported in The Journal with the Sections' reports. The geographical distribution of the Sections is strikingly shown on the accompanying map.

This Year's Work

Two events of importance have started off the Sections' work this year. At the time of going to press, President Hollis is visiting the Sections at St. Louis, Los Angeles and San Francisco, and is also speaking on behalf of the Society at El Paso, Seattle and Portland. At the same time the Committee on Sections is visiting St. Louis, Milwaukee, Chicago and Detroit, to meet the Executive Committees personally and discuss ways and means for Sections' development. Accounts of both these events will be given in the next issue of The Journal.

Below are published some of the plans of the Sections for their work for the coming winter. In common with the other activities of the Society, the Sections have in some cases experienced difficulties at this time on account of committee members, speakers, etc., being called into active service, in consequence of which all have not been able to send in their programs. However, those missing from this issue we hope to publish in the December number. Reports of the first meetings of some of the Sections for the new season are likewise here included.

The Committee on Sections is alive to the opportunities and possibilities of the Sections, and has under consideration means for developing these and making them available to the membership to the fullest degree. The Sections' organization can be made one of the strongest, if not the strongest, element in the life of the Society, for through it the benefits of the Society can be distributed to every individual member, wherever resident. Prospects at the present time for such development are exceedingly bright; there is work to be done, and the Sections Committee and the Executive Committees are ready and eager to do it. With the new By-Laws in force, providing unity and organization for this activity, great and far-reaching results may be looked for.

SECTIONS REPORTS

BALTIMORE

Plans for the coming year are now in progress and it is expected to hold the first meeting of the season early in November, the exact date to be announced later.

A. G. Christie,
Section Chairman.

BOSTON

A most successful meeting was held on October 11, at which it was expected Captain Amann, who has recently returned from Verdun, would speak, but he was called away and Lieutenant Morize substituted most acceptably. Major Edwin T. Cole, Commandant at Massachusetts Institute of Technology, was our guest of honor.

Lieutenant Morize contrasted the differences between the present methods of warfare and those in vogue only a few years ago. He spoke for over an hour to an audience that listened breathlessly to his every word, and at the conclusion of his address answered a number of questions. Major Cole followed with an informal talk on the same subject.

Both speakers were enthusiastically applauded and the thanks of meeting voted them at its conclusion.

Lieut-Colonel L. Rees, V.C., M.C., of the Royal Flying Corps, who has recently arrived from England to assist with our aviation work, was the speaker at a meeting on October 25 which was similar to the one held on the 11th. A full account of this meeting will appear in a following issue of The Journal.

W. G. Starkweather,
Section Secretary.

BUFFALO

The sixth season of the Engineering Society of Buffalo and affiliated branches was opened at the Hotel Statler, on October 10, with 125 members participating. After dinner Mr. Geo. W. Dunham, Mem.Am.Soc.M.E., president of the Society of Automotive Engineers, read an interesting and timely paper on the Internal Combustion Engine and the War, laying special emphasis on the functions and work of the automotive engineer in the great war.

David C. Howard, Mem.Am.Soc.M.E., chairman of the military-affairs committee and vice-president of the Chamber of Commerce, announced plans under way for the organization of engineers in wartime so as to increase their usefulness. Mr. Howard also asked the members to help the government catalogue the various war orders which have been placed in Buffalo and vicinity, and to offer assistance to the manufacturers filling these orders.

Industrial Production was the subject of a paper given by Wm. M. Dollar, Mem.Am.Soc.M.E., at the meeting on October 31. Mr. Dollar said that the essentials of modern industrial production,

such as shop order and cost systems, planning and routing systems, piece rate, premium and bonus systems, welfare work, etc., which have been worked out satisfactorily in larger shops and factories, have proved too cumbersome and costly for the small and medium shops which in the aggregate produce a very large portion of the total output of the country. The speaker, who has made a lifelong study of this subject, pointed out the advantage of such systems to these smaller shops and the benefits to be derived without material addition to the clerical work in shop or office.

LOUIS J. FOLEY,
Assistant to Section Secretary.

CHICAGO

As THE JOURNAL goes to press we would make mention of the visit of the Committee on Sections to this Section on October 21. There will be a luncheon with the Executive Committee and a dinner with representative members present to discuss plans for meetings and coöperation for the coming season; details will be given in the next issue.

Chicago has decided to devote its meetings this year to the discussion of timely subjects, giving predominance to topics likely to bring out valuable information in connection with the war. At this date the following speakers and subjects can be announced:

November 16. Cantonment Construction, by Major P. J. Junkersfeld.

January 18. Airplane Engineering, speaker to be announced.

March 15. Engineering Problems of the New Union Terminal, by G. W. Hibbard.

May 17. Progress of the Shipbuilding Program of the United States, speaker to be announced.

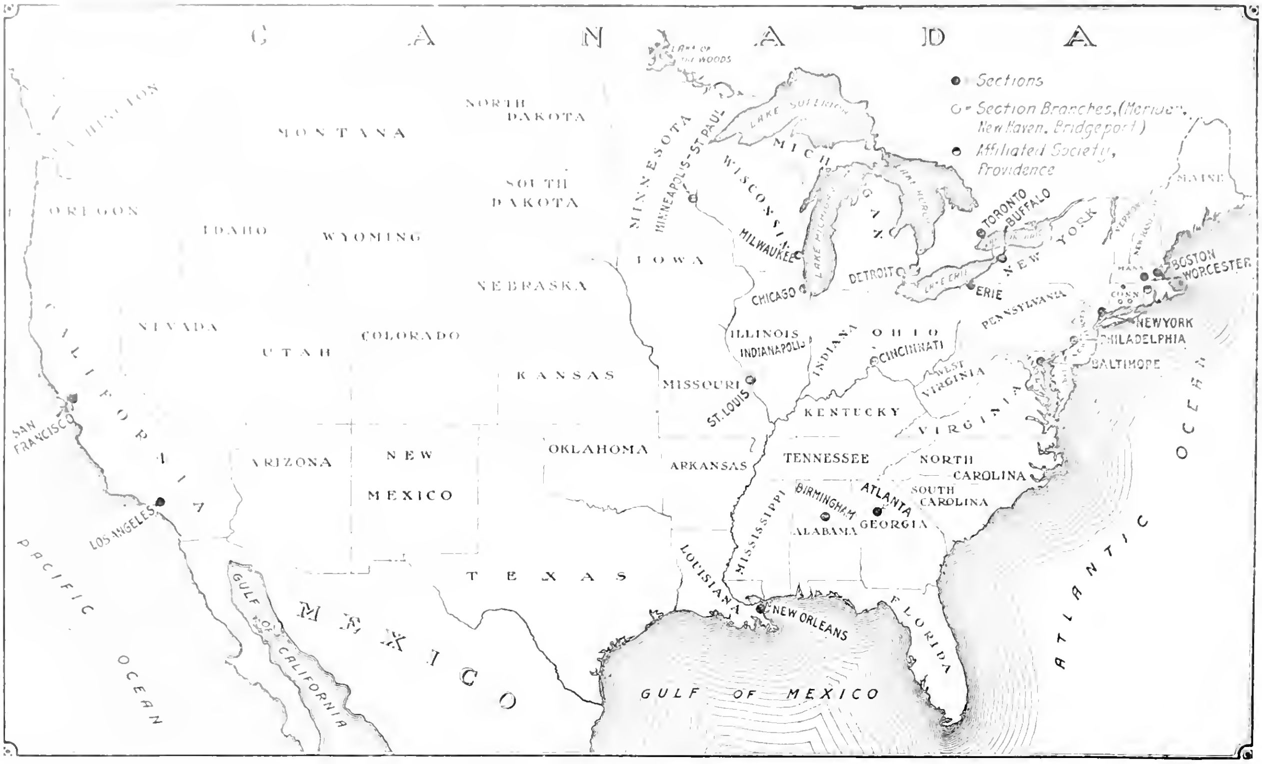
A. D. BAILEY,
Section Chairman.

CONNECTICUT (*Hartford Branch*)

At a meeting attended by men eminent in the profession and prominent in work closely affiliated with the engineering world, the Hartford Branch of the Connecticut Section was organized in the assembly hall of the Insurance Institute on September 28. The local branch will be one of five in the state. Bridgeport, New Haven, Meriden and Waterbury are the other Branches which compose the Section, and members of the Executive Committee of each were present.

The officers elected are as follows: B. W. M. Hanson, *chairman;* Hiram P. Maxim, *vice-chairman;* Sherwood F. Jeter, *secretary-treasurer;* M. D. Church, *chairman* Membership and Acquaintanceship Committee, and C. L. Grohmann, W. H. Honiss, C. D. Rice, A. D. Risteen, C. H. Veeder, members of the Executive Committee.

Mr. Jeter officiated as temporary chairman, and after a brief address introduced President Hollis. Dr. Hollis, in his talk, impressed the necessity for coöperation and sustained interest for the growth and success of the local branch; he advocated regular meetings and fusion of mechanical, civil, mining and electrical engineers, the main point being for the members to meet and exchange ideas. He brought before the audience the great part being played in the war by the engineers and pointed out the important work there would be for the engineer in the work of reconstruction after the war.



GEOGRAPHICAL DISTRIBUTION OF A.S.M.E. SECTIONS

Past-President Jacobus followed with an address on the necessity of petitioning local representatives in Congress in order to bring about good results for the engineering profession. He said there was a time when the national body instructed its members to abstain from politics, but politics are conducted differently now and the individual politician must be reached and convinced.

Secretary Rice spoke of the importance to a municipality of an organization such as this branch. As citizens its members could demand efficient service. In a number of cities, he said, improvements in city streets, water supplies and other important things have been brought about by such organizations as the present one. Ernest Hartford, secretary of the national Committee on Sections, called attention to the numerous desirable opportunities for publicity the Sections have through the columns of THE JOURNAL and the medium of the technical press. F. R. Low, Mem.Am.Soc. M.E., editor of *Power*, told the gathering that owing to new discoveries and great achievements of the engineering profession the world was becoming a better place to live in. P. B. Morgan, chairman of the Worcester Section, told of the work of organizing that Section and hoped that the Hartford Branch would profit by its experience; he also conveyed an idea of some of the problems that might confront the newly organized branch. Henry B. Sargent, of the Executive Committee of the Connecticut Section, described the work already accomplished in the state by the New

Haven Section which now becomes a Branch of the Connecticut Section.

H. B. Sargent,
Section Chairman.

DETROIT

A meeting was held by the Sectional Committee of this Section early in October and officers of the Executive Committee were designated. The chairman was authorized to solicit papers for future meetings and suitable for publication in The Journal.

On October 25 a Dinner-Smoker was held at the Board of Commerce, at which the guests of the evening were the national Committee on Sections. A few select, brief papers were presented on timely topics, including a discussion on Problems of Shop Management by Messrs. Walter Rautenstrauch and D. Robert Yarnall. The plans were formulated for a party to attend the Annual Meeting in New York.

G. W. Bissell,
Section Chairman.

LOS ANGELES

A dinner was arranged by the Section with the Joint Technical Societies on October 23, on which occasion President Hollis and Dr. George E. Hale addressed the meeting. Dr. Hollis addressed the student branch at Throop Polytechnic while in this city. A full account of Dr. Hollis's visit will be given later.

As for the plans of the Section for the year, the Joint Societies will meet at luncheon every Thursday noon and enjoy a short talk, the speaker for the day being furnished by the various societies in accordance with a pro rata list extending through the year.

Francis G. Pease,
Section Chairman.

MILWAUKEE

On October 3 an illustrated lecture by Chester A. Lucas, Mem. Am.Soc.M.E., on the Manufacture of a 9.2 High-Explosive Howitzer Shell, attracted the largest and one of the most interested audiences we have ever had, there being over a thousand present.

With the aid of an actual shell and of lantern slides showing drawings, Mr. Lucas described very fully all the parts of high-explosive shells and also all the machine operations necessary to produce them.

He supplemented this description by motion pictures of the complete process of shell making. The different methods were then shown.

The members of the Committee on Sections arrived at Milwaukee on October 23 and were met by the local committee; luncheon was served at the Milwaukee Club and a visit to the Allis-Chalmers plant made in the afternoon. In the evening a large number of interested local engineers were present at a dinner and took part in a discussion of Society matters. A full account of this visit will appear in the next issue of The Journal.

Fred H. Dorner,
Section Secretary.

NEW ORLEANS

Notes on Shipbuilding was the subject of an interesting paper read by F. J. French on September 7. The speaker illustrated his lecture with lantern slides showing construction work on tank steamers now being built for the Mexican Petroleum Company, of which he is engineer. These are the only steel vessels being built in New Orleans and the paper was received with much interest and caused considerable discussion.

The Section has planned only two technical papers for this year and has appointed a committee to arrange for monthly visits to various industrial plants.

H. L. Hutson,
Section Chairman.

NEW YORK

At the opening meeting of the New York Section on October 16, Dr. T. Kennard Thomson, Mem.Am.Soc.M.E., delivered an address on The Evolution of Manhattan from an Indian Village to a Great Metropolis, contrasting by means of colored lantern slides the early conditions on the island with those now existing. In connection with his address he spoke of the congested port facilities of the City of New York and described a novel plan for relieving this condition, the essentials of which included filling in the present East River and replacing it by a new channel through Long Island, extending Manhattan Island and constructing three new islands in New York Bay.

A. D. Blake,
Section Secretary.

PHILADELPHIA

The following interesting program has been arranged for the coming season by the Philadelphia Section:

October 23. The War's Effect on Merchant Shipbuilding, by Homer L. Ferguson, President and General Manager of the Newport Drydock and Shipbuilding Company. Joint meeting with the Engineers' Club in Witherspoon Hall.

November 27. Program to be arranged and include a visit by the national Committee on Sections. Meeting at Engineers' Club.

December 11. Offensive Against the Submarine, by Jos. A. Steinmetz. Joint meeting with The Franklin Institute.

January 22. Our Navy and the War, by Prof. Wm. L. Cathcart, U.S.N. (retired). Joint meeting with The Illuminating Engineers' Society will probably be arranged.

February 26. Supplement to Taylor's Art of Cutting Metals, by Carl G. Barth, Mem.Am.Soc.M.E.

March 26. Recent Developments in Material Specifications, by Dr. S. W. Stratton, Mem.Am.Soc.M.E., Director of U. S. Bureau of Standards.

Tentative program for the following:

April 23. Major W. P. Barba, Mem.Am.Soc.M.E., and Major A. S. Cushman.

May 28. George Satterthwaite and Professor Henry M. Howe.

June 25. Admiral Taylor and Chester Larner.

PROVIDENCE

The Power Section held an interesting meeting on October 10, at which Professor Dean A. Fales, Mem.Am.Soc.M.E., gave a most interesting talk on The Gasoline Engine, with Particular Reference to Aeronautics.

Professor Fales is in charge of the instruction work in gasoline engines for both the Army and Navy Ground Schools of Aeronautics in Massachusetts Institute of Technology. He described the special problems arising in the design of the aeroplane engine and the present practice in solving these problems. His descriptions of the best types of engines used by the British, French and Germans were extremely interesting.

The Army Cantonment at Ayer, Mass., was the subject of an illustrated lecture given on October 16 before the Providence Engineering Society by F. A. Barbour, who was the supervising engineer in charge of construction of this work.

Mr. Barbour gave a most interesting account of the engineering problems which had to be met to complete this camp within the schedule time. The contract for the camp included 692 buildings to be completed by September 1 and actually ready several days before that time, in addition to 124 buildings, including a 100-bed hospital unit costing \$500,000, refrigerating plants, storehouses, bakeries and miscellaneous buildings. The completion of this \$6,000,000 contract necessitated a force of 9000 men, a weekly payroll of \$400,000, the delivery of 30,000,000 ft. of lumber, the unloading of 50 carloads of material daily and the building of a complete sewerage system with 20 miles of pipe.

James A. Hall,
Correspondent.

ST. LOUIS

The first fall meeting of the Section, held on September 21, was attended by about forty members. The early part of the evening was given over to a dinner, after which a great deal of enthusiasm was aroused by the speakers of the evening.

Judge Thomas L. Anderson, of St. Louis, delivered a very stirring address upon the subject of patriotism, and the remarks he made were very pertinent to the work and requirements of the mechanical engineer in the war.

R. L. Radcliffe, Mem.Am.Soc.M.E., chairman of the Section, brought very forcibly before the members the work which is anticipated by the Membership and the National Sections Committee during the coming year. A committee to arrange for the preparation of technical papers which could be published in THE JOURNAL and a committee on research work were appointed. The committee on program reported the schedule of dinners and papers for which arrangements have been made.

Topics of vital interest to mechanical engineers in St. Louis were then discussed by Messrs. J. Hunter, Mem.Am.Soc.M.E.; L. Gustafson, Mem.Am.Soc.M.E., H. R. Setz, Mem.Am.Soc.M.E., and G. R. Wadleigh, Mem.Am.Soc.M.E., all of whom indicated very clearly to the membership that there was a large amount of work laid out for the coming year and that it was to be carried forward with great earnestness. Indications are that the Section is on a very strong footing and that the work which may be expected of it during the coming year will be of great value to the Section as well as to the Society.

On October 22 a meeting of the Section was held at which Mr. John Hunter, Chief Engineer, Union Electric Light and Power Co., presented a very interesting paper on the recent improvements at the Ashley Street power plant of his company. The progress of the work was shown by lantern slides. The guests of the evening were the members of the Committee on Sections.

THE JOURNAL goes to press as the meeting is being held and a complete report will be given in the December issue.

SAN FRANCISCO

M. M. O'Shaughnessy spoke at the regular bi-monthly meeting on October 16 on the subject of The Tunnels of San Francisco. The speaker described the general features of tunnel construction and the methods of payment therefor, illustrating his remarks with stereopticon views.

On October 25 a joint meeting of mechanical, civil, electrical, mining and chemical engineers, was held with Dr. Ira N. Hollis, Pres.Am.Soc.M.E., as the speaker and guest of honor. Full reports of these meetings will appear in the December issue. The following day it was expected that Dr. Hollis would address the student members either at the Leland Stanford Jr. University or the University of California, and the next day leave for Seattle where he would address the members of the Society in that city on the 29th.

B. F. RABER,
Section Chairman.

STUDENT BRANCHES

The Society has now affiliated with it forty-five Student Branches, which are independent organizations of students in the following educational institutions:

Armour Institute of Technology................Chicago, Ill.
Bucknell College...........................Lewisburg, Pa.
Carnegie Institute of Technology...........Pittsburgh, Pa.
Case School of Applied Science.............Cleveland, Ohio
Colorado State Agricultural College.......Fort Collins, Colo.
Columbia University............................New York
Cornell University...........................Ithaca, N. Y.
Georgia School of Technology..................Atlanta, Ga.
Johns Hopkins University..................Baltimore, Md.
Kansas State Agriculture College..........Manhattan, Kan.
Lehigh University.........................So. Bethlehem, Pa.
Leland Stanford, Jr., University....Stanford University, Cal.
Louisiana State University...............Baton Rouge, La.
Massachusetts Institute of Technology.....Cambridge, Mass.
New York University.......................New York, N. Y.
Ohio State University.......................Columbus, Ohio
Pennsylvania State College................State College, Pa.
Oregon Agricultural College.................Corvallis, Ore.
Polytechnic Institute of Brooklyn..........Brooklyn, N. Y.
Purdue University..........................Lafayette, Ind.
Rensselaer Polytechnic Institute..............Troy, N. Y.
State University of Iowa..........................Iowa, Ia.
State University of Kentucky................Lexington, Ky.
Stevens Institute of Technology............Hoboken, N. J.
Syracuse University.......................Syracuse, N. Y.
Throop College of Technology..............Pasadena, Cal.
University of Arkansas...................Fayetteville, Ark.
University of California....................Berkeley, Cal.
University of Cincinnati..................Cincinnati, Ohio
University of Colorado......................Boulder, Colo.
University of Illinois..........................Urbana, Ill.
University of Kansas........................Lawrence, Kan.
University of Maine..........................Orono, Me.
University of Michigan....................Ann Arbor, Mich.
University of Minnesota..................Minneapolis, Minn.
University of Missouri.....................Columbia, Mo.
University of Nebraska......................Lincoln, Neb.
University of Oklahoma.................Stillwater, Okla.
University of Pittsburgh.................Pittsburgh, Pa.
University of Washington..................Seattle, Wash.
University of Wisconsin....................Madison, Wis.
Virginia Polytechnic Institute............Blacksburg, Va.
Washington University....................St. Louis, Mo.
Worcester Polytechnic Institute..........Worcester, Mass.
Yale University.........................New Haven, Conn.

Institutions in which the entrance requirements are equivalent to those established by the Carnegie Foundation are eligible for Student Branches. Bodies of students in the engineering departments of such colleges are invited to apply to the Secretary of the Society for information regarding the form of petition to the Council for a Student Branch.

The Student Branches are now commencing activities for the year, and accounts of their first meetings appear below.

This Month's Reports

BUCKNELL UNIVERSITY

October 1. The season opened with a well-attended business meeting, and was followed by a lecture on The Standing of the Engineer, by Professor F. E. Burpee, Mem.Am.Soc.M.E.

H. R. PARS,
Branch Secretary.

UNIVERSITY OF NEBRASKA

October 2. Several honorary and regular members were elected at the first meeting of the Student Branch this season.

Dean Stout told briefly of the organization of The American Society of Mechanical Engineers and the importance of Student Branches. He was followed by Professor Seaton, who told of his experience when a student in connection with the Society. E. C. Hurd, a consulting engineer, of Lincoln, Nebraska, gave a short and interesting talk on The Practical Side of Engineering.

R. B. SAXON,
Branch Secretary.

RENSSELAER POLYTECHNIC INSTITUTE

September 30. The first meeting of the Student Branch for the season took the form of a smoker and gave every indication that the Branch will be very active this year.

After the regular business an illustrated lecture was read by Professor Fairfield on the Manufacture of the S. K. F. Ball Bearings. The slides were especially good, and the lecture that accompanied them proved most interesting to all present. Professors Greene, Fairfield, Anderson and DuPriest, who were present, took part in the discussion which followed, answering many questions.

R. A. MARRIOTT,
Branch Secretary.

WORCESTER POLYTECHNIC INSTITUTE

October 5. Alfred C. Carhart, Mem.Am.Soc.M.E., works manager of the Crosby Steam Gage & Valve Co., gave a most instructive and interesting talk at the first meeting on Opportunities to Young Engineers.

The speaker emphasized several points for the students' consideration along the lines of real efficiency, management of men, service to mankind and finding one's real place in the engineering world. Each point was sent home by a pleasing story, as well as serious comment on things as one finds them.

It is seldom that the students have listened to so keen a thinker along industrial-management lines who could, by his mingling of the serious and the humorous, better drive his points home to the mind and heart.

H. P. FAIRFIELD,
Branch Secretary.

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping anyone desiring engineering services. The Society acts only as a clearing house in these matters.

IN forwarding applications, stamps should be enclosed for transmittal to advertisers; applications of non-members should be accompanied by a letter of reference or introduction from a member, such reference letter to be filed with the Society.

GOVERNMENT POSITIONS

The Society has been asked to make suggestions of men for the following positions with the Government. Non-members of the Society having the qualifications may avail themselves of these notices by enclosing with their reply a personal introduction to the Secretary.

FIFTY ENGINEERS, with building construction or superintendent's experience for immediate work in France, in construction department of the Signal Corps, U.S.A., to receive the rank of First Lieutenant. Age limit 21 to 40, but men from 25 to 35 years of age are preferred. Technical-school men with military experience desired. Usual army physical examination required. 2254.

PAPER MAKER, familiar with the operation of paper machines, preferably man of experience; not prejudiced against man past middle life. Salary depends upon man. Location New York. 2262.

SIXTEEN ENGINEERS, to have charge under commanding officer of the engineering service in troop cantonment and to receive commissions as Majors in Quartermaster General's Department. Would be called upon to operate and maintain all electrical and mechanical equipment, including heat, light, power, plumbing, roads, sewage disposal and water service. 2272.

ORGANIZING ENGINEER in oil-well machinery, etc., to handle routing of work through the shops. Location Oklahoma. 2280.

SHOP SUPERINTENDENTS, ASSISTANTS AND FOREMEN for arsenal assignments. Location Massachusetts. 2290.

ORDNANCE INSPECTORS, 15 to 20 men, technically trained, with ability and good judgment. 2291.

ENGINEERS who may be classified as secretarial engineers or business managers. Experienced office men who combine engineering education with intensive office experience. Immediate problems have to deal with an increase of office force and erection and equipment of building for office purposes. 2323.

MECHANICAL DRAFTSMAN. Salary about \$150. Location New York office. 2325.

HIGH-GRADE MECHANICAL ENGINEER with technical education and motor-transportation experience in Quartermaster Mechanical Repair Shop, for technical supervision of wagon, harness, clothing, shoe and tentage repair shops. Suitable men will be commissioned Captains. 2329 A.

GENERAL PRODUCTION SUPERINTENDENT of equally high grade for same shops. 2329 B.

FOREMAN, FIRST AND SECOND LIEUTENANTS. 2329 C.

SUPERINTENDENTS for new artillery-munition plant operating for Government. Experienced men to be commissioned for duration of War. Retained in civilian capacity after the War. (A) in general charge of plant, (B) in charge of high explosives, (C) in charge of shrapnel, (D) in charge of manufacture of fuses and primers, (E) in charge of wood-working plant for boxes to ship and pack ammunition. 2336.

ENGINEER of pronounced ability in mechanical lines for Government work. He must be able to build machinery of accuracy and precision, not only superintend the construction of the tools and jigs, etc., but organize an excellent inspection department. Pre[illegible] from St. Louis vicinity. 2343.

MECHANICAL ENGINEER of proven ability, with considerable experience with electric auxiliary machinery and hydraulic [illegible] machinery. Man of very highest standing is desired. Salary not considered commensurate by the Government to qualifications d[illegible]d. It is hoped rather that man of the highest standing in his profession will volunteer his services for this at nominal salary in part of patriotic contribution to success of the War. To act in a more or less consulting capacity in mechanical matters affecting ship design. 2359.

SUPERINTENDENT, with drafting experience on structural steel. College graduate preferred. Age 35. To serve in civilian capacity. Salary \$2000. Location near New York. 2361.

DRAFTSMAN on building construction and structural steel, to serve in civilian capacity. Salary \$1600. Location near New York. 2362.

PLANT ENGINEER on per-diem or annual basis of pay, familiar with layout of factories, especially along lines as similar as possible to armor-plant work. 2363.

CIVILIAN POSITIONS

TOOL DESIGNER who is resourceful and can follow work through to completion. Technical man with practical shop experience. Location Connecticut. 185.

SALES ENGINEERS, between 25 and 30, good appearance, graduates of approved engineering college, preferably M.E.; would be expected to undergo period of probation and training in various offices of company before being given more responsible work. Apply by letter in own handwriting. State age, education, previous business training, if any, salary desired, etc. Location New York. 205.

DRAFTSMEN AND DESIGNERS experienced on valves and fittings. Good future with large concern. State experience in full, salary expected and references. Confidential. Location New England. 1002.

DRAFTSMAN AND ESTIMATORS for work of varied character with large concern. Offers good opportunity for advancement. Location New Jersey. 1104

GRADUATE MECHANICAL ENGINEER with theoretical knowledge of centrifugal machinery, preferably fans, pumps and compressors, also thoroughly familiar with design and methods of testing. Apply by letter. Location New York. 1140.

MECHANICAL DRAFTSMAN on automatic machinery. Salary \$20 to \$25. Location New Jersey. 1168.

TECHNICAL GRADUATE for drafting and engineering department for structural work and machine design. Conveying-machinery experience will be of advantage. Splendid future to right man. State fully education, experience, age, salary expected, etc. Record and applications confidential. Location Missouri. 1185.

SALESMAN, preferably experienced on conveying machinery. Splendid opening with good future for right man. Give full details of experience, age, salary expected, etc. Record and applications confidential. Location Missouri. 1186.

FACTORY EXECUTIVE, technical graduate, 30 to 35, for large textile-machinery manufacturing plant. Knowledge of up-to-date shop methods essential, also successful experience in handling of mechanics. Applicant would be required to spend from one to two years in shop to become familiar with various classes of work, after which position of assistant superintendent with further excellent opportunities for promotion will be open to him. Salary to start about \$2500. Location Massachusetts. 1191.

DESIGNER, experienced on jigs and fixtures for miscellaneous machine-shop production work, including turbines, reduction gears,

[illegible] and [illegible] arranged. Attractive offer to man who would be capable of handling this class of work. Location Maryland. 2008.

DRAFTSMAN for general design of new machinery and improvement of existing machinery in large going plant. Position leads to industrial management work. Give full particulars. Location Maine. 2020.

DESIGNERS, thoroughly experienced in turbines. Salary $200 to $300. Location New York. 2021.

DRAFTSMAN for concern manufacturing wire-rope tramways who would develop along lines of overseeing, erecting, etc. Salary $25 to $30. Location New York. 2032.

DRAFTSMAN familiar with water-wheel equipment. Technical graduate preferred. Unusual future in central Massachusetts concern. 2042.

YOUNG MECHANICAL ENGINEER, industrious and capable, familiar with fuel-economy tests, power plant, and with practical experience in construction and testing of modern Westinghouse steam turbines. Possibilities for advancement to right man. Location New Jersey. 2055.

DRAFTSMAN on a-c. or d-c. motor design. Salary about $40. Location New Jersey. 2058.

DRAFTSMEN on mechanical-stoker work, men familiar with boiler room layouts, building and construction or heavy machine design acceptable. Salary up to $30 to start, depending upon ability and experience. Permanent position. Location Pennsylvania. 2069 A.

DESIGNING DRAFTSMEN experienced in auxiliary marine machinery, hoisting engines, and hoisting-engine design in connection with this class of machines. Salary up to $30. Location Pennsylvania. 2069 B.

TECHNICAL GRADUATE as instructor in mechanical engineering, tracing, machine design, gas engines and machine shops, for southern university. Give age, education, experience, references and salary desired. 2098.

ESTIMATOR for New York concern engaged as engineers and contractors for power plant, ventilation, steam and hot-water heating. 2103.

TECHNICAL GRADUATES. Large growing paper-manufacturing corporation offers excellent opportunity for interesting and effective work to two young technical graduates with tact, initiative, ability and common sense. Non-graduates with two or more years' manufacturing experience considered. Desire men who can develop, and have vision to see and grasp opportunity. Fair living salary offered to start, with future dependent on self. Give complete information. Location Canada. 2105.

EXPERT TOOL- AND FIXTURE-DESIGNING DRAFTSMAN for line of safety valves, steam gages and similar equipment. Must have sufficient education and experience to take charge of drafting department within reasonable time. Location New York. 2115.

EMPLOYMENT MANAGER for plant employing 600 men in Pittsburgh district. Exceptional opportunity for experienced man. 2122.

COMPETENT YOUNG ENGINEER, with good education and previous experience with large concern dealing with marine and power specialties. Location New York. 2158.

PHYSICISTS, CHEMISTS, ENGINEERS, DESIGNERS AND DRAFTSMEN, for work of research, development, and design related to problems of telephonic, telegraphic and radio communication, which are matters of public importance. Opportunities for such men in both temporary and permanent positions. Apply by letter. Location New York. 2178.

PRODUCTION MANAGER, 25 to 33, technical graduate with practical experience. Clean cut, aggressive and of generous build. Work involves handling 500 men to 600 men assembling 1000 to 2000 radiators daily of 12 to 20 different kinds and keeping production moving. Design of tools and jigs taken care of separately, and position in[illegible] of assembled parts. Salary approximately [illegible] Location New York State. 2233.

MASTER MECHANIC, technically educated, experienced in main[illegible] electrically driven mine machinery, air compressors, centrifugal pumps, etc. Two-year contract. State salary and experience. Location Peru, elevation 15,000 ft. 2238.

DESIGNERS for stationary engines of 1000 hp. and larger. Must have theoretical as well as long designing experience. Salary no object; will pay up to $5000 for right man. Immediate employment. Location Massachusetts. 2240.

CHIEF ENGINEER, in charge of designing railroad equipment and supplies, including motor cars, hand, push and velocipede cars, and locomotive standpipes. Technical graduate preferred. Line is competitive, requiring man with business point of view. Salary secondary consideration if right man can be secured. Location Middle West. 2247.

LABORATORY ASSISTANT, capable of making simple chemical tests of lubricants, etc., and investigations into qualities of steel, etc. Location Connecticut. 2256.

MECHANICAL DRAFTSMAN, capable of checking calculations. Location Connecticut. 2257.

YOUNG MECHANICAL ENGINEER to have charge of returned-material department. Work to consist of inspecting all returned material and writing up reports on its final disposition. Location Connecticut. 2258.

SAFETY INSPECTORS capable of inspecting manufacturing plants, contracting risks, apartment houses, hotels, stores, etc., and elevators. Prefer to employ men who have had previous experience in this kind of work with other insurance companies, state rating boards, or those who have held positions as safety inspectors in large plants; but any bright man who has had a mechanical training and is willing to work is in line for a position of this kind. 2259.

DRAFTSMEN for rolling-mill work. Technical graduates preferred. Steady employment and chances for advancement. Location Pennsylvania. 2265.

METER-PRODUCTION MAN, preferably mechanical engineer who understands the making of small meters, etc. Considerable experience in this line and ability to get production essentials. Location Long Island. 2267.

FOREMAN in machine shop, capable of handling standard machines, lathes, boring mills, drills, etc., for conveying machinery equipment. Salary $35 to $40. Location New York State. 2275.

SHOP SUPERINTENDENT for factory employing 5000 men engaged in producing medium-caliber projectiles for Government. Previous ammunition experience desired but not essential. Salary dependent upon ability. Location Pennsylvania. 2276.

DESIGNER of elevators, conveyors and mechanical equipment for industrial buildings. Location Massachusetts. 2283.

MAN OR WOMAN, preferably with technical education, for engineering computation department and the answering of engineering correspondence. Location Massachusetts. 2284.

YOUNG ENGINEER, experienced in general plant-construction work. Good opportunities for advancement. Prefer man exempt from military duty. Location Illinois. 2286.

ASSISTANT PROFESSOR of machine design and superintendent of shops, to teach machine design, mechanical and electrical, give lectures on shop organization and manufacturing processes and superintend work in forge, foundry, wood-working and machinery departments. Salary $1400 for college year. Location New England. 2287.

MASTER MECHANIC for large southern cotton mill controlled by established western corporation with many branches. Policy is to build up such a man from an M.E. or E.E. technical graduate with two or three years' general experience. Married man preferred. Salary to start $1800. Liberal opportunities for promotion. 2293.

YOUNG ELECTRICAL ENGINEER as assistant to chief in research department. Require man with experience, logical thinker, and resourceful habits. Salary $20 to $25 per week. Location New Jersey. 2294.

COAL- AND WATER-GAS MANUFACTURING SUPERINTENDENT. Large and progressive organization in the East considering extensions and reorganization, desires to get into communication with one or two vigorous, experienced executives, having technical knowledge of coal gas and water gas, and ability to keep on top of difficult labor conditions. 2295.

ASSISTANT SUPERINTENDENT OR MASTER MECHANIC. Fine opening for ambitious, progressive man. Salary according to ability. 2296.

DESIGNING SUPERINTENDENT for general supervision and maintenance work in chemical plant. Young man to grow with organization. Salary to begin $1800. Location New York. 2299.

MECHANICAL DRAFTSMAN experienced in working up design of detail parts, and some experience upon general design. Good opportunity with recently incorporated firm in Philadelphia. State experience, references, age and salary expected. 2300.

SUPERINTENDENT for machine shop manufacturing high-grade printing machinery. Must be good executive and thoroughly versed in modern methods of interchangeable manufacture. Give age, nationality and complete experience. Salary depends upon individual. Location New York State. 2301.

ASSISTANT in department of mechanical engineering of large university in Middle West. 1917 M.E. graduate. To help in grading class exercises. Salary $850 to $900. 2308.

MAN to superintend work of laboratory in school of military aeronautics; also man to operate aeronautical engines under their own power. Salary of former $175 to $200 and of latter $150 to $175. Location large university in Middle West. 2309.

DESIGNING DRAFTSMAN for chemical apparatus of all kinds. Location New York. 2311.

ORIGINAL DESIGNING DRAFTSMAN, capable of taking initiative in the design of high tension electrical-power transmission and substation work (32,000 v.). Confine statement of experience to this particular line and be specific. State age, nationality, married or single. $190. Location Canada. 2312 A.

ORIGINAL DESIGNING DRAFTSMAN, capable of taking initiative in design of metallurgical-mill construction and equipment. Confine statement of experience to this particular line and be specific. State age, nationality, married or single. Salary $190. Location Canada. 2312 B.

TECHNICAL GRADUATES. Opportunity for several young technically trained men, preferably with some practical experience in mechanical or electrical engineering. Give age, training and experience. Salary $90 to start. Location New York. 2317.

MECHANICAL DRAFTSMAN, exempt or over draft age, preferably about 35 to 37, good on general design of industrial-plant machinery such as necessary in manufacture of ingredients and dyestuffs. Salary $150 to $175. Location New Jersey. 2319.

ENGINEER in charge of maintenance and repairs, capable of handling 200 or 300 men of varying mechanical trades, and take charge of drafting room. To work directly under vice-president and chief mechanical engineer. Location New Jersey. 2320.

YOUNG MAN with practical experience in shop production; also some knowledge of designing, drawing, etc. Salary $2000 to start, increase according to ability. Location New York State. 2322.

MECHANICAL AND ELECTRICAL DRAFTSMAN, with some experience in power-house design. Salary $100. Location Arkansas. 2324.

CONSULTING ENGINEER to certify to plant and capacity of small snap manufacturing plant in Massachusetts. Italian origin preferred. 2326.

YOUNG MECHANICAL OR ELECTRICAL ENGINEER for office of power plant. Technical graduate preferred. Salary $100. Location New York. 2327.

INSTRUMENT MAKERS. Must be American citizens. Desire men capable of doing bench work connected with the assembly of exact mechanical and electrical devices, skilled in the final fitting for assembling, and capable of reading micrometers and blueprints. 2334.

HIGH-GRADE DESIGNER experienced in distilling apparatus, dieproducts, etc. Location New York. 2337.

ASSISTANT PROFESSOR of experimental engineering wanted by Pacific Coast engineering school. Must have had good technical training in laboratory work, especially along steam, gas-engine and hydraulic lines, also practical experience preferably in operation and installing of power machinery. Previous teaching experience desirable but not required. Salary about $1600, depending on qualifications. Man 26 to 30 preferred. Send complete data, experience record, personal details, recent photo, recommendations, etc., in first letter, as position must be filled as soon as possible. 2338.

TECHNICAL GRADUATE, with three or four years practical experience in efficient operation of boilers and stokers, wanted for position of traveling engineer. Exceptional opportunity for man with initiative and ability to become expert combustion and steam engineer. Work requires extensive traveling in connection with investigation of power plants throughout the country. 2340.

DRAFTSMEN on jigs and fixtures in connection with Government work. Salary $30 to $40. Location Connecticut. 2341.

EXPERIENCED DRAFTSMAN, for power plant and boiler work. Salary $125. Location New York. 2342.

ENGINEER AND DRAFTSMAN. High grade man as head man, or inexperienced man as second man. Location Oklahoma. 2344.

RECENT GRADUATES in mechanical engineering from schools of recognized standing desired for testing work in large steam-operated electric-power plants. Applicants with experience in testing work and now located in and around New York City will be given preference. State education, experience and salary desired. 2345.

ENGINEER familiar with abrasive processes as engineering sales manager with concern manufacturing metal finishing tools and equipment. Location New York State. 2346.

GENERAL SHOP SUPERVISOR, not less than 35, who would be shop representative or director of works. Must be American citizen, who has had considerable machine-shop experience on parts relating to electrical-instrument manufacture. Should be broad-minded, have executive ability, and be capable of intelligently handling minor details connected with shop supervision. Salary about $200. Location New York. 2350.

EMPLOYMENT SUPERVISOR, not less than 35. Must have broad shop practice and training to ask leading and pertinent questions regarding experience applicants have had. Should be good judge of human nature and capable of handling miscellaneous complaints and misunderstandings in shop. Should be systematic; would be required to supervise employees' records and application files, and attend to references given employees on leaving. American. Location New York. 2351.

FOREIGN REPRESENTATIVES for iron, steel and metals, export engineering and contracting, to be given five or six months' training in home office and then employed on staffs of the various local firms representing company in foreign countries. Representative Americans wanted; character, honesty, reliability, loyalty essential. Prefer single men over 30. Must have training as mechanical engineers, technical knowledge of steel; be practical salesmen, with commercial sense and considerable commercial experience. Salary $150 during training period, and as soon as definitely accepted as foreign representative small commission on any and all business done in territory to which assigned. 2352.

PURCHASING ENGINEERS for machinery in the engineering department of export firm. Immediate employment. Training in machine-shop practice, internal-combustion engines, steam-power plants, and some knowledge of electricity as well as of export business desirable but not essential. Salary to start $1800. Location New York. 2353.

ASSISTANT TO FACTORY MANAGER in small rubber-goods factory. Young mechanical engineer, two or three years' experience, who can undertake the design and operation of machinery and relieve factory manager of routine work. Experience in rubber business not essential. Location New York. 2360.

ESTIMATOR, young college graduate, for work in manufacturing and jobbing business. Location New Jersey. 2364.

SALES ENGINEER. Man of mature judgment, sales ability and some mechanical training, capable of meeting high class of prospects, to act as sales representative for a leading automobile-parts manufacturer, with headquarters in Detroit, Michigan. State age, experience and salary expected. 2365.

TWO MECHANICAL ENGINEERS familiar with building construction, power-plant design, installation of machinery. Location New Jersey. 2366.

EVAPORATOR EXPERT. Engineer experienced on design and sale of evaporating apparatus for large concern desirous of extending evaporating business. Letter should contain detailed information as to past experience, qualifications and salary expected. Location New York State. 2367.

CHIEF DRAFTSMAN with executive ability, capable designer, competent to supervise ordering of materials and with capacity for details. Experience in general machine design, structural steel and electrical machinery. Salary $[illegible]. Location New York. 2372

GENERAL MANAGER for concern in the Middle West employing 250 operatives. Product is light hardware in pressed sheet brass, etc. Press and automatic screw machine work, small intricate machines with dies and tools. Should be experienced in locating and buying material, cost accounting, selling and factory management in metal trades. Prefer one who has a desire to become a member of the firm [illegible] capital in expanding the business. 2384

MEN AVAILABLE

CONSTRUCTION SUPERINTENDENT. Japanese, age 42. Fourteen years' [illegible] experience in mechanical and electrical installation work as [illegible] inspector of railroad cars and electrical building construction. At present employed in one of the largest traction companies as power plant and sub-station designer. K-368.

STEAM AND COMBUSTION ENGINEER. Technical graduate, age [illegible], married. Nine years' practical experience with large concerns, including executive experience and the handling of men. Desires change of location. K-369.

MECHANICAL DRAFTSMAN, age 25, experienced in the design, erection and operation of power plants, wishes a permanent position with a power company or consulting engineer. Not less than $125 per month to start. Position in New York City or on Long Island preferred. At present employed. K-370.

CHIEF DRAFTSMAN OR ASSISTANT ENGINEER. Associate-member, age 26. American-born and single, desires change of location. Now chief draftsman of a staff of twelve, totaling a monthly payroll of over $2000. Specialty, large industrial plants, as mining and smelting, covering all branches of engineering. Salary $250 a month. K-371.

SUPERINTENDENT OR MASTER MECHANIC. Associate-member, age 40. Thoroughly experienced in modern factory methods, organizing, planning and supervising the manufacture of interchangeable products. A-1 designer of tools, dies, fixtures and labor-saving devices for rapid production. Has been employed for a number of years in executive capacities as toolroom foreman, master mechanic and superintendent. Lately connected with munitions manufacture as assistant general superintendent of factory employing 500 hands. Immediately available. K-372.

MECHANICAL ENGINEER. Member, age 37, married, with sixteen years' experience in design, manufacture and operation of Diesel and hot-bulb engines for stationary and marine work, will be open for engagement January next. At present prominently connected in this line. Prepared to take charge of and follow up work already started or to design and develop any size or type of marine or stationary oil engine. K-373.

MECHANICAL ENGINEER, age 40, with broad experience in design, estimating, sales, and executive work. Especially qualified for power-plant design and sales, including sugar factories. At present employed as manager of branch office of machinery-export company. Desires position of responsibility where commercial and technical sides of engineering are combined. Speaks Spanish. Position must be permanent and offer a future. K-374.

WAR INDUSTRY MANAGER. Opportunity for active work on war necessities, such as ships, guns or ammunition desired by man of 38, experienced in Corliss-engine building, heavy machine work, and steam-power-plant design and construction. Has held machine-shop positions from apprentice to works manager. Organized and operated for a year a successful shell-manufacturing plant. Rejected for active military service on account of minor physical defect. Present position not directly useful in conduct of war. No position not directly necessary to United States at war will be considered. K-375.

CHIEF ENGINEER OR MASTER MECHANIC, with thorough technical and practical experience, covering construction, operation and [illegible] of steel plant. Specialty, metallurgical work, heating and melting furnaces. K-376.

SAFETY ENGINEER, with six years' thorough technical and practical experience in this capacity with large steel works in Pennsylvania. K-377.

COMBUSTION ENGINEER. M.E. graduate, age 35, with considerable sales experience, would like to devote part time to the sale of high-grade boiler-room specialties on a commission basis, in and around Cincinnati. K-378.

ROLLING MILL ENGINEER, technical graduate, age 36, desires responsible position. Has had fourteen years' experience in entire charge of the design of billet, rod and strip mills, merchant mills, etc.; also complete wire-mill plants. At present employed. K-379.

PRODUCTION MANAGER OR SUPERINTENDENT, member, age 35. Present connection, 17 years with large metal-working corporation; last five years as production manager. Experience covers detailed knowledge of metal trades and manufacturing. Versed in industrial engineering. Location immaterial. Salary to start, $4000. K-380.

FOUNDRY SUPERINTENDENT. Member, at present employed in high-grade plant, desires change. Practical molder, coremaker and melter of gray iron, semi-steel and non-ferrous metals. Technical graduate with broad experience in modern shop methods and various types of molding machines. Good organizer. Can furnish excellent references from present and past employers. Nearly seven years in present position. Must be open shop. K-381.

GRADUATE MECHANICAL ENGINEER, age 30, born in Russia, and speaking Russian. Five years' general machine-shop experience; two years' experience in the manufacture of small tools and instruments; one year in the automobile business. Wishes to connect with concern presently doing business with Russia, or contemplating same after the war. K-382.

EXECUTIVE MECHANICAL ENGINEER, WORKS ENGINEER, CONSTRUCTION SUPERINTENDENT OR DRAFTING-ROOM DIRECTOR. Associate-member, American, age 34, married. Eight years' general engineering experience, covering complete design, construction and maintenance of steam-electric power stations and other public-utility properties. Easily adaptable to conditions; energetic and ambitious. Has reached limit of advancement with present employers. Prefers to connect with an industrial concern in a position offering possibilities. Will be available upon two weeks' notice. K-383.

MECHANICAL ENGINEER OR PLANT ENGINEER. M.I.T. graduate, age 25, desires position in engineering department with opportunity for advancement and greater responsibility. Two and a half years with large textile-finishing concern, in charge of engineering department and drafting office. Experienced in general mill engineering, plant maintenance, machine design, power transmission, building construction, concrete, factory reorganization, installation, and equipment. Can design, supervise, organize or install new work. At present employed. K-384.

MECHANICAL ENGINEER, age 33, with eleven years' estimating, designing and shop experience on boilers, superheaters, stokers and oil burners; also with heating, ventilating and air conditioning, desires position as chief draftsman or assistant to chief engineer or manager of progressive concern, where conditions allow development of ability. Location, New York or Brooklyn preferred. K-385.

EXECUTIVE MECHANICAL ENGINEER. Member, age 41, American, married. Twenty years' practical experience as designer, chief engineer, general manager, and consulting engineer. Thoroughly conversant with all details of shipbuilding, medium-size steel and wooden steamers; machine and foundry, business, manufacture of special machinery and tools; steam engines, boilers, hoisting machinery, dredging and excavating machinery, marine auxiliaries, repairs, estimating, cost accounting, purchasing, management, etc. Desires change, preferably with new company on war contracts, ships, engines, or special machinery. Only permanent executive position considered. K-386.

ASSISTANT TO EXECUTIVE. Graduate mechanical engineer, trained in the electrical industry and accustomed to meeting and handling men, desires position where tact, diplomacy and a keen business sense are required. At present employed in position combining engineering with public relations and commercial activities. K-387.

GRADUATE ENGINEER with twelve years' manufacturing, executive, sales and business management experience. Would make good assistant to executive officer or business manager. K-388.

MANUFACTURING EXECUTIVE for interchangeable parts. Technical graduate, age 32, married. Nine years' experience—four and a half years in last position, as head of department laying out routing cards, ordering and specifying tools for new-parts manufacturing; and as chief inspector. K-389.

EXECUTIVE MANAGER. Mechanical engineer of marked ability, with proven successful record and complete experience necessary to conduct machine tool, precision machinery or similar business. Has directed organization of 12,000 men and served with three leading firms in their respective fields. Now employed but open to consideration for further opportunity. K-390.

ENGINEERING SURVEY

A Review of Engineering Progress and Attainment in Mechanical Engineering and Related Fields, Including a Digest of Current Technical Periodicals and a Selected List of Engineering Articles

American Institute of Electrical Engineers

A MEETING held at Philadelphia on October 8, 1917, was devoted to the subject of industrial research.

Prof. A. P. Kennedy presented a paper on Industrial Research and the Colleges, in which he advocated that a proper relationship should exist in the industrial field between the pure science college, the technical college and the industries themselves, and made an attempt to indicate what this relationship should be.

The speaker defined industrial research as scientific investigation directed economically toward improvements in production.

In the non-technical scientific departments of the colleges and universities are included such fundamental subjects as mathematics, physics and chemistry. The teaching and the learning, the latter by carrying on researches in the above-named sciences, have to be carried on interdependently and perpetually. It is probably undesirable that the pure-science departments of colleges and universities should continuously undertake industrial research, because there is so much other important work to be done which calls exclusively to the province of these departments. In physics, chemistry, mathematics there is a limitless field of undreamed-of knowledge where the instructing staffs in the colleges have special facility for advancement. Barring exceptional conditions, such as those due to the present world war, as a general rule, the best contribution of these departments to industry is by restricting their attention to pure science.

The position of the engineering and technical schools is somewhat different. Their field of activity is intellectually narrower, but, on the other hand, they come into closer relations with the needs and problems of the industries. There are various ways in which technical colleges can assist in industrial research, the selection of which depends on conditions of each individual case.

Younger industries, lacking their own research facilities, naturally turn to the technical colleges for help. This is a call which the colleges would desire to meet so far as they can do so without disrupting their regular work of teaching and learning. The stumbling block in the way, however, is the need for secrecy, as the whole atmosphere of any healthy college is one of intellectual freedom, with all knowledge placed at the academic disposition of everybody around.

In the long run, it seems most desirable that the technical colleges should always carry on general researches in their laboratories of such a nature as may advance applied science, stimulate careful observation on the part of students, contribute to the published fund of available technical information and supply new knowledge to the teaching staffs and train students for entering industrial research. Simultaneously, a limited amount of industrial-research work may also be advantageously carried on in the college laboratories.

An ideal international system would be one in which the pure-science colleges should lay the foundations of future industries by enlarging and disseminating the world's knowledge of the basic scientific principles, the technical colleges should do the same for applied science, while at the same time taking a share in the economic applications of science to industry. The industries themselves should undertake their own researches under the guidance of qualified research specialists. Vocational schools would train industrial foremen in the elements of the same principles of science, art, technique, economy, thrift and hard work, as applied to those particular industries in which each nation is, by its peculiar circumstances, specially adapted to excel.

This paper was followed by an address by C. E. Skinner on industrial research and its relation to university and governmental research.

The author divided research activities into three principal classes: university, governmental and industrial.

Of greatest interest is what the author said as to university research. In his opinion, the principal function of university research should be to train research men. Men with the broadest and best training possible are going to be required in ever-increasing numbers for every possible phase of the work. The fundamental training of these men must be gotten in the university, and universities should be equipped to turn out research men just as they are now turning out men with academic and engineering degrees.

In this connection, it is rather a sad fact that the university has not been able to make its teaching positions more attractive by providing compensation more in line with that obtainable in other fields. While writing this paper the author received letters of inquiry for several men for teaching positions, with specifications which could be met only by men of considerable experience. The compensations named were very much less than those which men with the same qualifications could command in other lines.

The teaching profession is said to have many compensations, such as short hours and long vacations, but the average salary is certainly not one of these special attractions. We have splendid endowments for buildings, and sometimes for equipment, but practically no endowment for men of genius who might make notable progress in pure research and at the same time serve as teachers and examples for the training of men for the whole field. If it takes a genius to recognize a genius yet undeveloped and properly stimulate and direct him, how necessary it is that we place men of genius at the head of the research departments of our universities.

Society of Automotive Engineers

AUTOMOTIVE engineering in the great war formed the subject of an address by Geo. G. Dunham before a recent meeting of this society. The term "automotive," according to the speaker, includes the motor-car, aeronautic, tractor, motor-cycle, marine- and stationary-engine fields; in fact, every type of self-propelled vehicle. In time of war these problems become of particular importance, and that is why

the automotive engineer must enter the Government service, as many have already done, or otherwise discharge patriotic duties by the closest cooperation with those in authority.

It is evident that this is not only a war of engineering competition, but that the internal combustion engine is one of the most vital elements in every phase of its conduct, a condition which will explain the reason for the extraordinary activities of the S.A.E.

The automotive engineers have to take charge of the problems to be met in keeping the fleet of army trucks in operation, problems far more serious than those encountered in normal peace times. Wretched conditions of roads and excessive loads make the necessity of repairs and renewal of parts acute. It has been stated on good authority that frequently two-thirds of the trucks on the Western front are out of commission awaiting or undergoing repairs. While this would indicate the imperative necessity of standardization, the Allied governments have not yet adopted a single standard motor-truck design. The American government has already done so and in this was actively helped by the automotive engineers.

As a result, the Government has in process of production a truck which is not only rugged and finished as a design, but is capable of rapid production and above all simple and easy repair, the parts being made with the view to easy renewal and absolute interchangeability. There is also a smaller number of parts and, in many cases, the same parts have been used in both of the two sizes thus far designed.

These trucks were designed primarily by and for the Quartermaster's Department, but will probably be largely used by other departments requiring fairly heavy equipment. On the other hand, the Signal Corps will require relatively light high-speed trucks to act as aeroplane tenders. These trucks will be mounted on pneumatic tires and be capable of a speed of abount 50 miles per hour. In the Medical Corps a somewhat similar chassis is to be used for ambulances. In the Ordnance Department a quite different set of conditions must be faced. The increase in scarcity of horses, the necessity for greater speed and greater tractive effort have made it necessary for the Ordnance Department to undertake extensive motorization of its equipment. Accordingly, a group of automotive engineers, men, for the most part, with experience in the design of tractors, are now working on this problem. In addition to the tractors used by the Ordnance Department a large number of 4-wheel-drive trucks will be provided for the handling of ammunition and other similar purposes.

There is another branch of automotive engineering about which much less has been written, but in which work of great importance is being done—the development of small stationary or semi-portable units for the operation of wireless sets, searchlights, pumps, isolated electric lighting plants and machinery in portable repair shops.

Perhaps, a still more important work done by automotive engineers is concerned with the development and production of the farm tractor. This type of agricultural machinery is playing a tremendous part in the production of food, which, after all, may be the determining factor in winning the war.

The speaker also discussed in some detail the part played by automotive engineers in the development of standardization of motor cycles and aeroplane engines.

American Foundrymen's Association

During the past few months several organizations have chosen Boston as the meeting place for their convention, and the latest of these, that of the American Foundrymen's Association, took place in that city during the week of September 24.

Each morning during that week was given over to business sessions and discussions of foundry subjects covering gray cast iron, malleable cast iron, and steel; while the afternoons were devoted to pleasure trips and sightseeing.

During the week the exhibit of foundry equipment, supplies, etc., attracted many foundrymen to Mechanics' Building, where spaces were taken up by about 160 different exhibitors. The exhibit opened on Monday, at 9.30 a. m., with a simple but patriotic program particularly fitting at this time, and this was repeated each succeeding day of the convention at the same hour in the morning and at 2.30 in the afternoon. It consisted of the formal raising of the American, British and French flags, on the stage in Grand Hall, at the call of the bugle.

This exhibit being a little different from most of those seen at Mechanics' Building, in that the materials exhibited were not particularly interesting to the general public, was, nevertheless, an extremely interesting and instructive one to the foundryman, and it was estimated that thousands of dollars in contracts were placed during that week.

In the different exhibits, the condition of the times seemed to be taken into account, in that the efforts of the exhibitors were along the lines of maximum speed and quantity with less labor and materials.

The labor question being as it is at the present time, it is very evident that every effort should be made toward getting out work with as few men as possible, at the same time keeping the quality and output at the highest point.

This was seen in the various types of molding machines exhibited where hand ramming was done away with and all the movements controlled by the turning of valves.

The show taken as a whole was a very attractive one, and several exhibits were especially artistic. One in particular received a considerable amount of attention: that of the New England Coal and Coke Company. It consisted of a reproduction of Bunker Hill monument built up of coke by that concern. The monument itself reached nearly to the ceiling of Grand Hall and was surrounded at the base by four large statues of typical Puritans.

The exhibit was indeed an attractive one, and drew the attention of over two thousand visitors from different parts of the country.

F. H. COLE.

National Welding Council

On Tuesday, September 25, at a meeting held at the Engineering Societies Building, New York City, representatives of the various societies and manufacturers interested in welding organized what is to be known as the National Welding Council. This council is intended to be somewhat of a permanent organization, at least until this work shall have been completed. Its object is to thoroughly investigate autogenous welding both as to theory and practice, particularly as applied to pressure vessels, utilizing the knowledge and data at present available, and going into further research work if it is found necessary, and all of this with a view of ultimately formulating a code which shall be used to regulate the practice of welding after the manner of the present Boiler Code.

Meetings are to be held monthly, the third Wednesday being the day now set, and the outlook now seems to be very good for definite results.

F. L. FAIRBANKS.

U. S. BUREAU OF STANDARDS

THE following abstracts, with the exception of the last one, have been composed from material courteously supplied to THE JOURNAL, in response to its request, by the Director of the Bureau of Standards.

The last abstract, describing a feature of the activities of the Bureau most intimately connected with the present war, was taken from *The Automobile and Automotive Industries*.

Particular attention is here called to the intensely practical nature of the subjects investigated by the Bureau of Standards. To cite but one instance: properties of glue. Hitherto there were but few concerns which used glue on a large scale in high-grade products, and which had more or less adequate means of testing this capricious material. Not even all glue factories could tell, and prove, what kind of product they were making.

The growing application of glue, especially for aeroplane propellers, necessitates a clearer understanding of the behavior and properties of this material, and the investigation by the Bureau of Standards is therefore a timely one. That it will cover the subject in a scientific as well as exhaustive manner will not be questioned by any one who is at all familiar with the usual type of work by our national laboratory.

Sole-Leather Testing Machine

The Bureau of Standards is using its new type of leather-testing machine in investigating the durability of the shoes of postmen in the District of Columbia. About 20 different brands of sole leather are represented. The relative behavior of these leathers in service will be compared with the results of the laboratory tests, as a basis for developing a standard method of testing sole leather.

The Properties of Glue

The Bureau is conducting an investigation to correlate the physical and chemical properties of glues, with a view to the formulation of rational standards of quality.

Optical-Glass Production

The Bureau of Standards has produced on a manufacturing scale all kinds of optical glass required for military purposes. The Bureau is now coöperating with the manufacturers of glass in the actual production of optical glass in the quantities and kinds required. One critical problem solved was the production of suitable pots in which to melt the glass. The Bureau was obliged to make pots for this purpose which would not discolor the glass and which would not be eaten through during the melt. As yet the pots commercially available are unsuited to the purpose.

Graphite Crucibles

The production of graphite crucibles has been perfected. Eighteen mixtures were made which showed satisfactory service tests.

Researches on Metals

Progress is being made in the metallographic and chemical survey of ingots and blooms, much of the work being done on night shifts. The investigation of the effect of casting and molding methods upon the strength of test bars for copper is being continued. Many castings have been made for investigational purposes. Experimental heat treatment of the steel rings used for ball-bearing races was made as a basis for the magnetic tests for mechanical properties.

Testing of Columns Under Fire and Load Conditions

In the comprehensive program for testing the fire-resistive properties of materials, the Bureau has just tested three columns of gravel concrete under conditions of load and fire and three of limestone-concrete columns under load without fire. The gravel concrete columns showed failure in the outer shell early in the test. This is attributed to the expansion of the outer shell or layer of concrete. The limestone columns thus far tested show no such tendency, the heat penetrations being correspondingly less.

Electrical Conductivity of Porcelain

About one hundred determinations of electrical conductivity of porcelain have been made up to temperatures of 1000 deg.

Military Research

The Bureau is engaged on researches and investigations having direct military application, and involving physics, chemistry, and engineering. These researches are, for the most part, confidential. A very interesting line of work of this kind has to do with the system of standardizing gages for munitions plants and arsenals.

Apparatus for Studying Stresses in Fabrics

Special apparatus has been prepared in the Bureau of Standards for studying the distribution of stresses in fabrics when subjected to a uniformly distributed pressure. The purpose is to aid in the economical design of certain structural fabrics and to obtain a clearer understanding of the control of the variables in textile manufacturing. The testing apparatus for textile research is placed in a room in which the humidity is maintained at a standard constant value by means of humidifying apparatus and control designed and constructed at the Bureau.

Liberty Motor Testing Plant

Description of the aeroplane-motor-testing plant at the Bureau of Standards grounds, in which is a vacuum chamber for the testing of aeroplane engines at atmospheric conditions ranging from that found at sea level to that found at an altitude of 20,000 or more feet. In this chamber the engine can be started at sea level and "fly" as high as need be for observation purposes, and it can "land" as quickly or as slowly as desired.

The chamber is 6 by $6\frac{1}{2}$ by 15 ft., with walls 12 in. thick, made of concrete and reinforced with steel, and not only is the reduction of pressure arranged for, but provision made to care for the exhaust of the engine. Provision also has been made for the heat produced by the engine which, in the open

upper sky, would be dissipated. There is a mounting similar to that for an aeroplane, and the air left in the chamber is kept in rapid motion when tests are on.

One end of the chamber has big refrigerating coils, filled with ammonia, and five big fans provide the circulation. Openings in the side were made necessary for passage through them of water, ammonia, thermometers, pressure gages, and other devices. A shaft runs through a stuffing box to the outside to connect with an electric dynamometer, to observe the power up to 150 hp. The compartment is lined with cork, and the air that supplies the chamber must be brought in at a temperature to correspond with 0 deg. fahr., which aviators find 20,000 ft. above the ground.

Surrounding the chamber is a stucco structure, 21 by 50 ft., containing the ammonia refrigerating plant, an exhaust blower with a capacity of 1500 cu. ft. per min., weighing devices, measuring arrangements for estimating water and heat, including the heat which escapes in the water, the heat which escapes in exhaust gages, and also the heat that leaves the engine in the circulating air around it; also, for gaging the temperatures of air and water, for indicating the pressure of the air in the vacuum chamber, the volume of air used to supply the engine, the power and speed generated, and various other factors.

Doors leading into the chamber weigh 500 lb. each, and they are made so the covering will fall off in case of an explosion, that the chamber may not be wrecked. For observing the test, port holes, covered with glass an inch thick, are provided. (*The Automobile and Automotive Industries*, vol. 37, no. 14, October 4, 1917, *d*)

Eye Accidents in the Industries

The outbreak of the European war brought such a shock to labor conditions that a period of unemployment followed. By the end of the first year, however, the equilibrium was again established, and with the decrease of workers in Europe came the demand for greater manufacturing in the United States than ever before. As a result of the necessity for increased output, the demand for labor became so great that workers unacquainted with industrial hazards entered munition and other factories. That the Committee might know exactly how these new difficulties were being met, the national organization undertook an intensive study of factory conditions in Buffalo, New York. The work of investigation is now completed, and it is expected that a full report will appear in 1917. (Eighth Annual Report of the New York State Committee for the Prevention of Blindness, Nov. 1, 1915 to Nov. 1, 1916)

How to Aid Workers Hurt in War

Every country that has sent men to the front must face the possibility of having some returned crippled and disabled. What to do with these men and how to do it will be the gigantic problems that must be faced, and our ability to solve them successfully will depend to a great extent upon the amount of previous planning and preparation. It is not a pleasant subject for thought: one would readily shut his eyes to it until we find ourselves with our quota of crippled workers, for whom there seem little means of providing a livelihood.

Almost a thousand members of the National Association of Manufacturers, representing great industries in every section of the country, have sent written expressions of their desire to participate in a practical way in the economic rehabilitation of men injured in the war.

That disabled soldiers and sailors have an inalienable right to maintain their positions in their communities with self-respect and independence is unquestioned, and any suggestion that the situation be handled through charitable organizations shows a shocking disregard of the rights and feelings of those who have made supreme sacrifices for their country; to force them to become public charges is obviously as unfair to them as it is to the community.

The consensus of opinion among manufacturers so far questioned seems to be that the fairest way of helping wounded men is by helping them to help themselves, and they unanimously pledge their coöperation.

So far as the employment of disabled men is concerned, a safe generalization is that occupations needing strength and endurance rather than skill are for the most part closed to such workers. The various lines of the iron and steel industry come under this category, and as a Pennsylvania iron and steel company writes: "Our operations would afford a poor place for the employment of men crippled in the present war, as the work is dangerous, and unless a man is able to take care of himself, he is at a serious disadvantage." (*Journal of Commerce*, September 18, 1917, p. 5)

River Barges Moved by Artificial Wave

With the Ohio River at summer stage, thousands of tons of coal were brought to Cincinnati harbor from the upper river districts recently on the crest of an artificial "flood wave." The experiment was made under the direction of Colonel Beach of the United States engineers of that district.

By allowing the pool waters in tributary streams to be released, through lowering the dams, Colonel Beach created an unnatural "wave," which, entering the Ohio, gave a stage high enough to float down the loaded barges. The opening of the dams was carefully timed, and as each new supply of water swept into the parent river, the stage was maintained and the barges reached Cincinnati safely.

So successful was the trial that a conference of coal shippers was called at once at Marietta, Ohio, and arrangements were made to use the "artificial flood" at regular intervals during the low river stages. Colonel Beach explains that this new method will release thousands of coal cars and help to no small degree in lessening the demands on the railroads. (*Christian Science Monitor*, September 11, 1917, p. 5)

Possible Use for Waste Timber

By using timber heretofore used only for firewood and considered worthless for any other purpose, a new industry is being started in Mississippi, and its rapid growth gives promise of its attaining considerable magnitude and influence in the state.

Refuse wood is being cut into blocks 2½ ft. long and from six inches to more than two feet in width and thickness. White oak and hickory blocks are then shipped to factories for making wagon and buggy spokes, while red-oak and water-oak blocks go to furniture factories to make small articles of furniture.

Several cars already shipped North have found ready markets, and this, with the fact that the waste wood supply is unlimited in this section of the state, has made investors believe that the industry will be a permanent one. (*Christian Science Monitor*, September 11, 1917, p. 7)

Research Progress in Britain

The report of the Advisory Council of the Privy Council Committee on Scientific and Industrial Research for 1916-17 has recently been published. The report is prefaced by a report of the Privy Council Committee, in which is a recommendation that the sum of £1,000,000, handed over by the government to the imperial trust for the encouragement of scientific and industrial research, should be spent in the form of grants in aid to firms in an industry undertaking research, and who may combine to conduct such research on a coöperative basis.

The report of the Advisory Council is divided into two parts. Part I describes the steps taken to deal with the problem of industrial research where practicable on the coöperative basis, and by the department itself where independent state action is required. Substantial progress, the report states, has been made towards establishing a national research association in connection with the great staple industry in cotton, and a scheme of procedure has been worked out in considerable detail. Woolen and worsted manufacturers in Great Britain are following suit, and a provisional committee has been appointed to draft the constitution for a research association. Irish flax spinners and weavers, it is stated, have also decided to take the same step.

"There are also a number of industries," the report continues, "which are so circumstanced that their firms are unable to combine in this way. In some cases the leading firms fully realize the value of science and of combined attack, but they cannot as yet carry the industry with them. For example, the papermakers are urging the council to establish a state laboratory, to the initial and maintenance cost of which they are anxious to contribute.

"The Council note that there are important fields which research associations cannot expect to cover, one of these being research into fuel. Here they consider it simpler and more just that all should contribute through the taxes to the cost of the research. A fuel-research board has, therefore, been formed by the Council. This board has presented its first report, in which are outlined its proposals for taking stock of the coal resources of each district and for classifying, according to their qualities, the seams which are being worked or which might, in certain circumstances, be worked, and ascertaining broadly the industrial uses to which the different kinds of coal are being put." (*Christian Science Monitor*, October 5, 1917, p. 3)

Six-Hour Day for British Labor

That the study of labor conditions, as developed by the war, had demonstrated the advisability of a six-hour working day was the statement of Lord Leverhulme, president of the Welsh National Eisteddfod, made in an address at the annual meeting of that body. Lord Leverhulme is chairman of Lever Bros., Ltd., the soap manufacturers. In his address he also discussed the financial conditions growing out of the war. In part, he said:

"We have learned much the last three years on the subject of fatigue, overwork, and excessively long working hours. We have proved conclusively that prolonged hours of toil, with resulting excessive fatigue, produce after a certain point actually reduced results in quantity, quality, and value than can be produced in fewer hours when there is an entire absence of overstrain or fatigue. Fortunately, however, this logical effect of overlong hours of continuous work does not apply, except to a very limited extent, in the case of machinery and mechanical utilities.

"Therefore, we shall require an enormous increased output of goods to replenish stocks that have been allowed to run down both for our home and export trade, and as we have the machinery available, and which hitherto in most industries has only been run 48 hours per week, a solution of this one of our difficulties can be best and most readily found by working our machinery for more hours and our men and women for fewer hours. We must have a six-hour working day for men and women, and by means of six-hour shifts for men and women we must work our machinery 12, 18, or 24 hours per day.

"In considering the six-hour working day and its advantages for increased output with lessened overstrain and avoidance of overfatigue, we must not overlook the great assistance it will be in solving the problem of education. Our men and women working in factories and mines and allied occupations, including clerical work—in fact, any form of work that is from its very nature mechanical, arduous, or monotonous—have been employed during such hours each day that from mere lack of time and opportunity they can never receive proper education, and are consequently undereducated. If to these conditions of hours occupied in daily labor you also take into consideration, as unhappily must often be the case, to arrive at its true bearings on the problem of education, that our workers are often also underfed, underhoused and overcrowded in insanity kill-joy homes, how can we wonder at what is called 'labor unrest'?" (*Journal of Commerce*, October 2, 1917, p. 5)

A German Appreciation of Enemy Aircraft

A number of French and British aeroplanes which have fallen into German hands have been exhibited at the Berlin Zoological Gardens. The exhibition contained 31 machines, most of them complete, but a few with the motors removed. Of these 15 were British, 15 French, and one Russian. There were also exhibited a number of engines, some more or less damaged. Three of the machines were hydroaeroplanes.

Nine of the machines were single-seaters and 22 double. Five were monoplanes and 26 biplanes. Nine had stationary motors and 13 revolving ones, while two had two motors each. In seven machines the engine was behind the pilot, and in 22 in front, while in two it was at the side. Among the makers represented were the Franco-British Aviation Company (1 machine); Deperdussin (1); Nieuport (5); Morane-Saulnier (3); Farman Bros. (1); Caudron (2); Voisin (1); Blériot (1); Ferner Vickers (2); Martinsyde (1); Sopwith (1); and Avro (1), with six of the British Experimental Co. and four of the Fighting Experimental Co.

The general comment made on these machines in an article in the *Zeitschrift des Vereines deutscher Ingenieure* is that they are not nearly so well finished as the German machines, nor so comfortable for the pilot, and the arrangement of the levers and instruments is criticized as unpractical. It is admitted that the short life of the machines may be a justification for not spending too much time on their finish; on the other hand, it is argued that the permission for poor finish may be an inducement to pay insufficient attention to the vital parts of the machine. Surprise is expressed that the Allies are still building machines with the engine behind the pilot, although the utility of such machines is admitted as giving a free field for vision for navigation as well as for the use of the machine gun.

The machines are divided by the enemy critics as being built on two different principles. In one class it is said that [illegible] aimed at with the sacrifice of non-resistance to [illegible], but it is remarked that if such machines are to be serviceable they must have a comparatively small pressure on the planes, that is, they must have a great plane area for a given weight. They are considered to have powerful engines in proportion to their weight, but as the engine power is practically only of importance in its relation to the load to be carried, the machines are none the less regarded as efficient. Into this category are put the machines of Voisin, Farman, Caudron, Fighting Experimental, and Vickers, all with motors behind or with two motors. In the other class the principal endeavor is said to have been to reduce the air resistance to the minimum possible; the machines are therefore heavier, but permit of a greater load per square foot of plane surface.

The Voisin machine, with its tangle of wire stays, is picked out as the extreme of the first type, and as a contrast the British Experimental is named as the best representative of the second type. In the latter machine the air resistance has been reduced to a minimum, the body of the machine being so narrow that openings have to be cut into the side to give the pilot elbow room. It is also mentioned that even the wire stays are of a lentil-shaped cross-section to reduce the resistance to the air. Other criticism and comparison are withheld, except for the remark that for German machines the second type has always been followed. Similar requirements are believed to be fulfilled by the first class, but the means by which they are arrived at are criticized as primitive.

In conclusion, it is pointed out that the exhibition must in no wise be considered as representing the present state of the art of building aircraft among the Allies, the latest machines not being exhibited. (*Times Engineering Supplement*, August 31, 1917.)

Chemistry and Finance

At a meeting of the New York section of the American Chemical Society on September 28, 1917, the subject of Chemistry and Finance was taken up, with particular reference to the true relation of banking to chemistry. The subject is an interesting one and suggestive of the connection between engineering developments and finance. It is well known how in Germany the close coöperation between the engineer, in particular, the inventor, and the banker, has helped the progress of industry in that country.

The two addresses made at the meeting, one by Dr. A. D. Little, Mem.Am.Soc.M.E., of Boston, Mass., representing the chemist's side of the question, and the other, by Mr. G. A. O'Reilly of the Irving National Bank of New York, showing the banker's point of view, comprehensively presented the situation as it is in this country.

The basic idea in Dr. Little's address was that the time has come for chemists and bankers to find a common language and establish a mutual understanding. Some bankers are finding it worth while to study Spanish, because it leads them into a new financial world. It is in the power of chemistry to open up a new universe of finance.

The speaker pointed out, however, that the chemist has not learned the proper formula for presentation of his projects, especially large ones, to bankers. In the case of a chemical [illegible], especially where new processes are involved, a generous allowance must be made for unforeseen expenditures. Chemical investments in their various stages are undoubtedly speculative, and often highly so in character.

The banker's viewpoint was expressed by G. A. O'Reilly, who stated that the point of contact of the theories of banking and the practice of chemistry is a subject which, it is feared, has not claimed the attention of banking circles in the past to the extent to which its merits would appear to entitle it. However, these are not normal conditions in the least, and questions are handled in a way different from that of pre-war days.

The true relation of banking to chemistry is to found only in the very simple and easily understood theory of practical business. The situation is not difficult unless we are unreasonably disposed to make it so.

For a complete text of both addresses the reader is referred to *Metallurgical and Chemical Engineering* for October 15, 1917.

This Month's Abstracts

An interesting discussion on the fatigue of brasses, especially under alternating stresses, is presented in an abstract of a paper by Dr. R. Archer Haigh before the Institute of Metals. One of the interesting conclusions to which the author comes is that the nature of elongation produced in copper is the same, no matter whether produced by a pulsating or steady stress. It also appears that the value of the ratio between the limiting maximum stress for 1,000,000 cycles and the ultimate tensile stress of the metal is highest for those metals which show considerable reduction of area at fracture in the tensile strength test.

In the section Fuel are presented, in the form of a table, some of the data of tests of a powdered-coal-fuel installation for steam generation on a Western railroad, showing that it is fully possible to burn powdered fuel commercially.

Fred B. Seely, in a Bulletin of the Engineering Experiment Station of the University of Illinois, presents data of a very interesting investigation on the effect of mouthpieces on the flow of water through a submerged short pipe.

That a short stroke is conducive to an increased life of a die is the claim made by E. F. Creager, who supports it by data of his particular experience. He also gives some valuable pointers on the design of presses and describes the little-known devices for oiling the steel strip before punching.

In the section Mechanics attention is called to the abstract of an article by W. M. Wallace on the critical speeds of loaded shafts, in which is discussed the case of a shaft carrying two symmetrically disposed similar cast-iron disk loads.

From data given out by the Society of Automotive Engineers are reproduced a brief description and illustration of the United States military truck, commonly known as the Liberty truck. The history of this engineering achievement was fully told in the daily press. Data contained in the present abstract will give an idea of the simplicity and expediency of the general features of its design.

In the section Pumps are given two abstracts dealing with air pumps. We have reference to tests carried out at the Carnegie Institute of Technology on a small Roots pump, with the view of determining the quantity of air which such a pump can handle. The second article gives some data of tests of a Breguet condenser pump previously described in the Engineering Survey.

The stresses in digester shells have been investigated by H. O. Keay, Mem.Am.Soc.M.E. These stresses are of interest because, in the case of a digester in addition to the pure steam stresses, the effect of the heavy masonry present has also to be considered.

REVIEW OF ENGINEERING PERIODICALS

SUBJECTS OF THIS MONTH'S ABSTRACTS

Engineering Materials

STRUCTURE OF CAST IRON IN METAL MOLDS, Edwin F. Cone

A discussion of the structure of cast iron in metal molds as compared with that in sand molds.

That there must be a decided difference between the microstructure of cast iron cast in sand molds and cast in a metal mold, especially a rapidly revolving one, is evident. This matter becomes of particular importance as it has been demonstrated that it is possible to make cast-iron pipe in rapidly revolving molds.

Metal-mold pipe is manufactured by pouring hot metal into a rapidly revolving mold and removing the casting as soon as it has become solid. Under these conditions the crystal formation proceeds in a different manner from that in sand-cast pipe where the crystals are given time to develop slowly.

An examination of samples of the two types of pipe have shown that in the case of the chilled pipe the sample does not represent the chill, but only the average of nearly the entire metal section. Comparing the machine-cast with the sand-cast pipe samples, it is noticeable that the combined carbon is less, due to the amount of pearlite present caused by the conditions of cooling.

A comparison of the photomicrographs of the two types of metal given in the original article tends to indicate the superiority of machine-cast metal from the point of view of crystalline structure. The crystals are smaller and more closely knitted together, while the graphite is in smaller flakes and not in long plates. (*The Iron Age*, vol. 100, no. 12, September 20, 1917, pp. 656-658, 18 figs., *ec*)

EXPERIMENTS ON THE FATIGUE OF BRASSES, Dr. R. Archer Haigh

Description of an extensive series of experiments the purpose of which was to ascertain the effects of annealing, using stresses alternating between equal intensities of direct pull and push; to ascertain the relation between the limiting range of stress required to produce fatigue and the ratio between the maximum and minimum stresses; to study the phenomena of elongation under stresses greater than the fatigue limit but less than the ultimate tensile strength of the material; and, finally, to study the influence upon the endurance of the metal under the alternating stresses of corrosive reagents in contact with the metal.

The paper describes the method of testing and the machine used. The brasses used in these experiments were obtained from commercial supplies and not specially manufactured for the purpose.

The data are given in the form of tables and curves. The most interesting part of the investigation refers to the alternating-stress tests.

It was found that under alternating stresses varying between

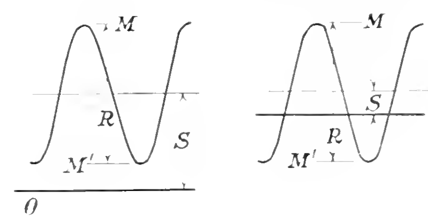


FIG. 1 DIAGRAM OF STRESSES IN A SPECIMEN TESTED IN AN ALTERNATING STRESS-TESTING MACHINE

equal intensities of pull and push with a frequency of 2000 per min., the behavior of these brasses was very similar to that of mild steel tested in the same manner. The limiting fatigue stresses were, however, somewhat lower and the results, in general, somewhat more consistent between different specimens of the same sample; likewise, the fractures were, as a

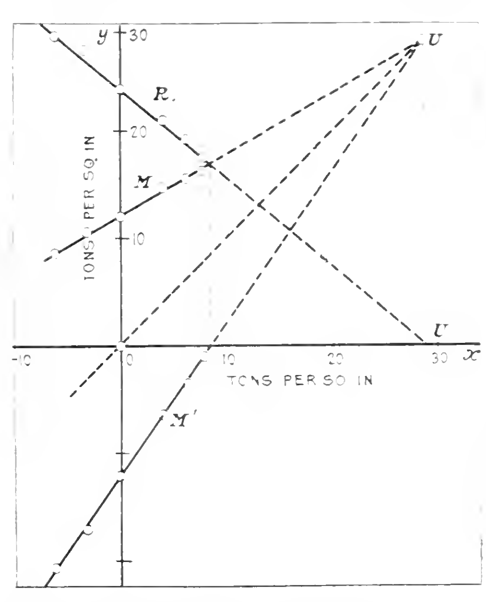


FIG. 2 FATIGUE LIMITS UNDER UNEQUAL PULL AND PUSH

[illegible] more regular in profile. One of the interesting features observed in considering the microstructure of brasses was that the cracks produced in brasses of sound structure showed the "branch" that are commonly observed in mild steel. Further, it was found that under test conditions the growth of the crack was exceedingly rapid. That this is not so in practice may be due to the variability of the stresses at work.

Among other things it has been found that there is no direct proportionality between the limiting fatigue and the primary elastic range in tension and compression. On the whole, the most regular ratio of comparison appears to be the ratio between the limiting fatigue stress and the ultimate strength of the metal. Further, the use of this ratio has the advantage of conveying useful information without implying the existence of any definite physical relation between the two quantities.

The experiments are claimed to illustrate, although they cannot prove, a simple working rule which seems to have few exceptions, namely, that the value of the ratio between the limiting maximum stress for 1,000,000 cycles and the ultimate tensile strength of the metal is highest for those metals which show considerable reduction of area at fracture in the tensile-strength test. It is not intended to imply, however, that a physical connection exists between the two, except in so far as both may be dependent on the same characteristics of the micro- and submicro-structure.

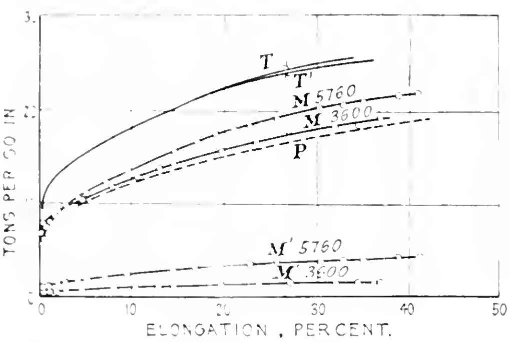


Fig. 3 Ductile Elongation of Brass Wire Under Alternating Stresses

A series of tests was made to ascertain the relation between the limiting fatigue range and the ratio between the unequal maximum intensities of direct pull and push. The curves obtained, as, for example, in Fig. 2, were found to be asymptotic to values which may be regarded as nearly equal to the fatigue limits below which fatigue would not occur after an infinite number of repetitions of stress. In Fig. 2 the abscissæ give the mean stress, and the ordinates for graph R the limiting fatigue ranges, and for graphs M and M' the maximum intensities of pull and push. It appears that plotted in this manner the stresses obey the linear law which may be expressed as

$$R = R_0 - k\,S$$

$$M \text{ or } M' = (S \pm \tfrac{1}{2} R) = S \pm \tfrac{1}{2}(R_0 - k\,S)$$

The graphs M and M' represent here the limiting conditions of stress above which fatigue occurs by the production of a brittle fracture, but when the range of stress is greater than that represented and is combined with considerable steady pull or push, failure may also occur by the gradual elongation or compression of specimen. The same material was tested under pulsating stresses with frequencies of 5700 cycles and 3600 cycles per min. Here again the yield point was observed to be somewhat indefinite, but above the yield point elongation was produced at definite stresses lying within limits of measurement.

In Fig. 3 the maximum and minimum intensities M and M' are plotted on the base of elongation used for the tensile tests, Fig. 1. Comparing the curves, it seems at first sight that the change in frequency has produced considerable effect, but the difference between the maxima for the two frequencies may be attributed to the differences betwen the two minima employed. By varying the minimum while the test was in progress, it was found that any given increment to M' required a corresponding but similar increment to M to produce elongation. Careful measurements showed that increment to M was from one-half to one-third of that to M'. Assuming either of these values, one may deduce from M and M' the value of an "equivalent" pulsating stress which with zero as the minimum of its cycle would produce the same elongation. The approximate locus of this "equivalent" pulsating stress is represented in the diagram by the curve P, somewhat below M. The ordinates of P are nearly alike for tests with the different frequencies and are approximately two-thirds of those of the curves representing the tensile tests.

Similar tests have been carried out on soft copper wire. It was found that although the yield point under pulsating stress is nearly equal to that under steady tension, further elongation is produced with considerably less increase of load than in an ordinary tensile test; also that the ultimate elongation produced in copper is considerably greater under pulsating stress (46 per cent) than under steady stress on the same material (34 per cent).

Further experiments have shown that the nature of the elongations is the same no matter whether produced by a pulsating or steady stress. Another interesting fact which has been brought out by the tests is that although some 500,000 cycles of stress were imposed on individual specimens in the course of the elongation tests, no examples of brittle fatigue were found, except in rare instances at the end attachments. It may be inferred that if the range of stress is less than the maximum tension (80 to 90 per cent) the fatigue limit lies above the yield point for pulsating stress. In practice the actual range at particular points in a complex structure may, however, be greater than the mean range is generally estimated, so that fatigue may occur although the estimated range is well below the maximum tension.

An interesting series of tests was carried out for the purpose of ascertaining whether fatigue was accelerated by the presence of different corrosive fluids in contact with the metal during the test. On the whole, it was found that no appreciable acceleration of fatigue had been produced by any of the corrosive reagents employed. On the other hand, it is believed that fatigue may vary readily in parts that have suffered appreciable corrosion prior to the application of the stresses that effect the failure. The phenomena occurring in specimens tested under alternating stresses may differ, however, from those of normal corrosion, in that they occur only locally and with much greater rapidity. Chemical action is certainly accelerated by strain in the crystals even below the elastic limit: and the elongation of stress facilitates the formation of crevices and progressive corrosion throughout the mass. It appears also that the atmosphere as well as fluid reagents may act chemically upon the metal. (Paper read before the Institute of Metals, September 19, 1917, abstracted from a reprint in *The Engineer*, vol. 104, no. 2699, September 21, 1917, pp. 315-319, 23 figs. *eA*)

Fuel

PULVERIZED FUEL IN A POWER PLANT ON THE MISSOURI, KANSAS & TEXAS RAILWAY, R. H. Collins and Joseph Harrington, Mem.Am.Soc.M.E.

Description of a plant burning pulverized coal under boilers and of tests thereon, the latter including data on the method used in weighing coal which are of interest.

The data of the tests are given in the form of tables. Of particular interest is the heat balance. The boilers were found to be quite efficient under the conditions of the test, and the furnace and grate extremely so (Table 1), no loss being shown as due to combustible in the ash. The ashpit in this case had a sloping bottom and was visible throughout its extent from the door in the basement. The ash mostly fused and ran down the bottom in molten streams. Practically no dust in the ashpit was encountered, while under the ordinary operating conditions in this plant with the same fuel and operating at times at low ratings there is produced a mixture of fine sandy-looking ash and melted slag.

TABLE 1 DATA OF TESTS OF A POWDERED-COAL-FUEL INSTALLATION FOR STEAM GENERATION ON THE M. K. & T. RR.

FURNACE AND GRATE LOSSES	B.t.u	Per cent	B.t.u.	Per cent	B.t.u	Per cent
Heat loss due to combustible in ash..	0	0.00	0	0.00	0	0.00
Heat absorbed by excess air up to temp. steam..............	50	0.57	100	0.8[illegible]	67	0.53
Heat loss due to production of CO	73	0.86	44	0.37	0	0.00
Heat available for boiler....	7707	87.03	10821	89.68	11548	91.75
Furnace and grate efficiency.......		98.40	.....	98.69	.....	99.44
BOILER LOSSES						
Heat loss due to theo. gas. moist. and H. above temp. steam	465	5.25	438	3.64	675	5.36
Heat loss due to air leakage through setting......................	120	1.36	29	0.24	52	0.41
Heat loss due to radiation and unaccounted for..................	2049	24.27	3362	27.89	2056	16.33
Boiler efficiency...................	....	65.82	......	64.61	.....	75.90
Combined efficiency........	..	57.32	......	58.00	....	69.64
Ratio: Comb. effy. to highest theo. efficiency.......................	..	64.80	....	63.90	.....	75.49

During the tests there was a light gray haze apparent at the top of the slag. A sample of this dust was obtained from the breeching. Analysis showed that there was 2 per cent of combustible matter in the fine dust, which showed that the loss in this item was exceedingly small.

Another matter worthy of attention is the item of heat absorbed by excess air. The CO_2 content in the flue gases could without the slightest difficulty be carried up to 16 per cent, readings frequently going to 17 per cent and but few readings being less than 15 per cent. It was found that the CO loss was in direct proportion to the length of the flame, which indicates some relation between the proportion of volatile matter in the fuel and the CO loss.

The furnace conditions in this case were as nearly ideal as one could imagine. The unaccounted-for loss in this test is also the least and the furnace efficiency the greatest.

The question of control of the furnace temperature and consequent fusing of the brick walls has been hitherto a mooted point in connection with the burning of powdered coal under steam boilers. In this instance careful measurements checked in several ways have shown that the temperature of the furnace was between 2300 and 2400 deg. fahr., under which conditions brickwork may be maintained indefinitely, and which is above the fusing point of the ash from a great many coals. Actually, there was no apparent fusing of the brickwork, which might occur if the ash had a fluxing effect thereon. The furnace has been in constant service for nine or ten months and the interior seems to be in perfectly good shape.

On the whole, the writer believes that these tests give promise of a future for powdered coal in steam generation which is indeed bright. It is possible to burn in this way qualities of coal which are not ordinarily classed as of commercial value. Moreover, it is entirely possible to provide space adequate for the complete combustion of fuel in this form and control the temperature of the furnace properly. (*General Electric Review*, vol. 20, no. 10, October 1917, pp. 768-777, 3 figs., *de*)

Hydraulics

THE EFFECT OF MOUTHPIECES ON THE FLOW OF WATER THROUGH A SUBMERGED SHORT PIPE, Fred B. Seely

Data of experiments on the flow of water through a submerged short pipe with and without entrance and discharge mouthpieces of a variety of angles and lengths. This investigation treats of the loss of head which occurs when a stream contracts or expands under differing conditions of flow and emphasizes the marked effect that turbulence of flow may have upon the amount of head lost. The discussions have a direct bearing upon various problems in hydraulic practice which involve the contraction and expansion of stream in flowing through passages.

Comparatively little experimental work has been done to determine the value of conical mouthpieces of various angles and lengths in reducing the lost head at the entrance to and discharge from a submerged pipe, particularly for mouthpieces of the sizes and proportions comparable with those met in engineering practice.

The loss of head due to the contraction and expansion of a stream may be of considerable importance in a variety of hydraulic problems: for example, the passages through a large valve, the passages through locomotive water columns, the draft tube to a turbine, the connection from a centrifugal pump to a main, the venturi meter, the suction and discharge pipes of dredges and the guide vanes and runner of a turbine.

Losses due to this cause are difficult to estimate and easy to overlook. Even where such losses are, in themselves, of little consequence as compared with other quantities involved, they may have a considerable influence upon subsequent losses on account of the turbulent motion started by the contraction or expansion, and the writer cites several instances where this apparently takes place.

In the present investigation the values of the coefficients of discharge for the short pipe with inward-projecting entrance (no mouthpiece attached) were determined with special care since the effect of attaching the mouthpiece could not otherwise be found. The values found for c are slightly larger than those generally given in textbooks, while the values for m are considerably smaller. This may, however, depend on various concomitant factors.

To illustrate the method of handling the various important

problems of this investigation an abstract will be given of the part relating to entrance mouthpieces. From Fig. 4 it will be seen that entrance mouthpieces having angles of from 10 deg. to 30 deg. (20 deg. to 60 deg. total angle of convergence) give practically the same discharge, while all the entrance mouthpieces having angles of from 5 deg. to 60 deg. give only about 5 per cent range in the rate of discharge. In other words, the lost head at the entrance to an inward-projecting short pipe may be reduced from 0.62 of the velocity head in the pipe to 0.18 of the velocity head by a conical mouthpiece having an angle ranging from 10 to 30 deg.

It has also been found that no advantage results from increasing the length of the entrance mouthpiece beyond that corresponding to an area ratio of from 1 to 2. The lost

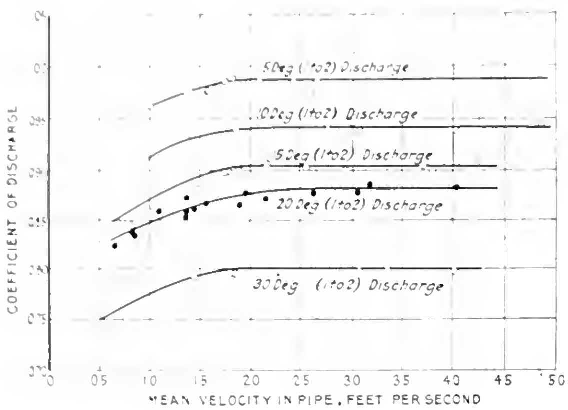


FIG. 4 RELATION BETWEEN COEFFICIENT OF DISCHARGE FOR A SHORT PIPE WITH MOUTHPIECE AND THE MEAN VELOCITY IN THE PIPE

head at the entrance to a mouthpiece is sometimes considered the same as would occur at the entrance to an inward-projecting pipe of the same area as that of the mouthpiece, that is, the lost head is found by multiplying the velocity head at entrance to the mouthpiece by the coefficient for an inward-projecting pipe. The writer does not approve of such a method, since the entrance mouthpiece having an area ratio of 1 to 3 gives almost the same lost head as one with an area ratio of 1 to 2, while the velocity head at entrance to the former mouthpiece would, of course, be only one-ninth of that of the latter. It is not clear just what effect straight throat or pipe has when added to an entrance mouthpiece.

Owing to lack of space only the most important conclusions of the present investigation can be reproduced here.

a As applying to conditions likely to be met in engineering practice, the value for the head lost at the entrance to an inward-projecting pipe (i. e., without entrance mouthpiece and not flush with wall of the reservoir) is 0.62 of the velocity head in the pipe ($0.62v^2/2g$) instead of $0.93v^2/2g$, as usually assumed. To put it in another form, the coefficient of discharge for a submerged short pipe with an inward-projecting entrance is 0.785 instead of 0.72, as given in nearly all books on hydraulics. Further, the lost head at the entrance to a pipe having a flush or square entrance is 0.56 of the velocity head in the pipe ($0.56v^2/2g$) instead of [illegible], as usually assumed. In other words, the coefficient of discharge for a submerged short pipe with a flush entrance is [illegible] instead of 0.82 as given by nearly all authorities.

b The loss of head resulting from the flow of water through a submerged short pipe when a conical mouthpiece is attached to the entrance end may be as low as 0.165 of the velocity head in the pipe ($0.165v^2/2g$) if the mouthpiece has a total angle of convergence between 30 to 60 deg. and an area of ratio of end sections between 1 to 2 and 1 to 4 or somewhat greater. In other words, the coefficient of discharge for a submerged short pipe with an entrance mouthpiece as specified above is 0.915.

c The loss of head which occurs when water flows through a submerged short pipe having an entrance mouthpiece varies but little with the angle of the mouthpiece if the total angle of convergence is between 20 and 90 deg. and if the area ratio is between 1 to 2 and 1 to 4 or somewhat more. The loss of head for any mouthpiece within this range would be approximately 0.20 of the velocity head in the pipe ($0.20v^2/2g$). There is, therefore, little advantage to be gained by making an entrance mouthpiece longer than that corresponding to an area ratio of 1 to 2. Thus, an extrance mouthpiece with a total angle of convergence of 90 deg. and the length of which is only 0.2 of the diameter of the pipe gives approximately $0.20v^2/2g$ for the loss of head.

d The amount of velocity head recovered by a conical mouthpiece when attached to the discharge end of a submerged short pipe depends largely upon the angle of divergence of the mouthpiece, but comparatively little upon the length of the mouthpiece. This is true for lengths greater than that corresponding to an area ratio of 1 to 2 and for total angles of divergence of 10 deg. or more. The amount of velocity head recovered decreases rather rapidly as the angle of divergence increases from a total angle of 10 to 40 deg. At or near 40 deg. the amount of velocity head recovered rather abruptly falls to approximately zero.

e A conical discharge mouthpiece having a total angle of divergence of 10 deg. and an area ratio of 1 to 2, when attached to a submerged short pipe, will recover 0.435 of the velocity head in the pipe, which is 58 per cent of the theoretical amount possible of recovery.

f The amount of velocity head recovered by a diverging or discharge mouthpiece when attached to a submerged short pipe is considerably more when a converging or entrance mouthpiece is also attached than it is when the entrance end of the short pipe is simply inward-projecting (no mouthpiece attached). This excess in the velocity head recovered diminishes rather rapidly as the angle of discharge mouthpiece increases, and it becomes zero for a discharge mouthpiece having a total angle of divergence of approximately 40 deg. This increase in the velocity head recovered is probably due to the effect of smooth flow in the pipe as the water approaches the discharge mouthpiece. The smooth flow allows the mouthpiece to recover more of the velocity head in the pipe than when a more turbulent flow exists; this increase amounts to as much as 33 per cent in the case of the discharge mouthpiece having a total angle of divergence of 10 deg. and an area ratio of 1 to 2. (*University of Illinois Bulletin,* vol. 14, no. 35, April 30, 1917, 48 pp., 14 figs., *eA*)

Internal-Combustion Engineering

VICKERS SYSTEM OF SOLID INJECTION FOR DIESEL ENGINES

It has been mentioned in the engineering papers that Vickers, Ltd., of Barrow, have been using solid injection of fuel with their four-cycle type submarine Diesel engines. This system enables them to dispense with high-pressure injection air, but has the disadvantage of giving a higher fuel consumption, sometimes as high as 10 per cent in excess of that required with good air-injection systems.

In view of the secrecy hitherto maintained about this system, the following data taken from a British patent are of interest:

The fuel is delivered by a pump *M* (Fig. 5) giving constant fuel pressure, and the power of the engine is controlled by varying the period of opening of the injection valve *G* by an adjustable lever *J* operated by a cam *H*, the shape of which is so related to path given to the end of the lever by the adjustment that for all adjustments and consequent variations in engine power the valve is timed to open at the correct point at which injection should take place. Independent timing means are therefore dispensed with, the cam being formed to give the proper timing for the operation of the valve for all variations in the period of opening.

The pump is of a larger capacity than is required by the engine, and surplus fuel is discharged through the adjustable relief valve. The control of the suction of the pump, however, allows the output of the pump to be regulated as the power of the engine is varied. Excess fuel is always delivered by the pump, so that the pressure to which the relief valve is adjusted is maintained. But the excess over that required by the engine is kept approximately constant, thus assisting the

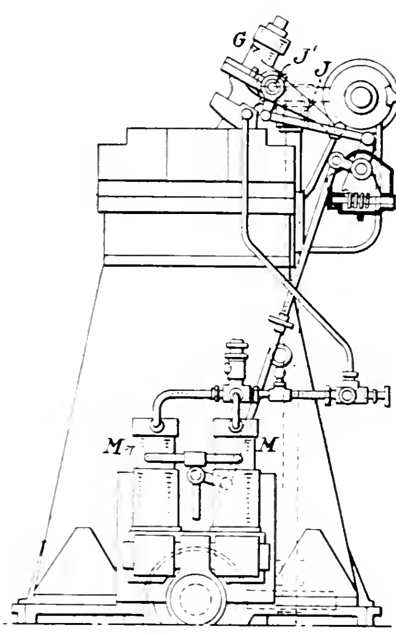


Fig. 5 Vickers Method of Solid Injection of Fuel for Diesel Engines

relief valve to maintain a steady pressure. This connection to the fuel pump is particularly desirable for constant-speed engines; for example, those driving dynamos, in which the surplus to be passed by the relief valve would otherwise be greatly increased while running at light loads. (*Motorship*, vol. 2, no. 10, October 10, 1917, p. 13, 1 fig., *d*)

Machine Shop

Relation of Press Stroke to the Life of a Die. E. F. Creager

The writer attempts to answer the question as to whether a short stroke that is less than standard increases the life of punch and die. He made some experiments and found that decreasing the stroke of the press increases the life of punch and die.

The work the writer was engaged in was that of punching armature laminations. With a "solid" type of punch and die made from the best steel available, the production between grinds was on an average of from 12,000 to 15,000 blanks, both figures with the standard $2\frac{1}{2}$- and 3-in. strokes. Next the same punch and die set was transferred to a press with a $1\frac{1}{2}$-in. stroke and immediately it gave 40,000 blanks before the fin was as bad as it was in the longer-stroke press at 12,000 to 15,000 pieces. At the same time it was found possible to double the output from the same set of dies while maintaining a higher standard of product.

This is a very important saving, considering the fact that it takes from 67 to 76 hours to make the punch, while the completed die mounted for the press takes 270 hours. There are also other savings from the longer life of the punch and die besides those mentioned above.

The article also discusses some of the details of press con-

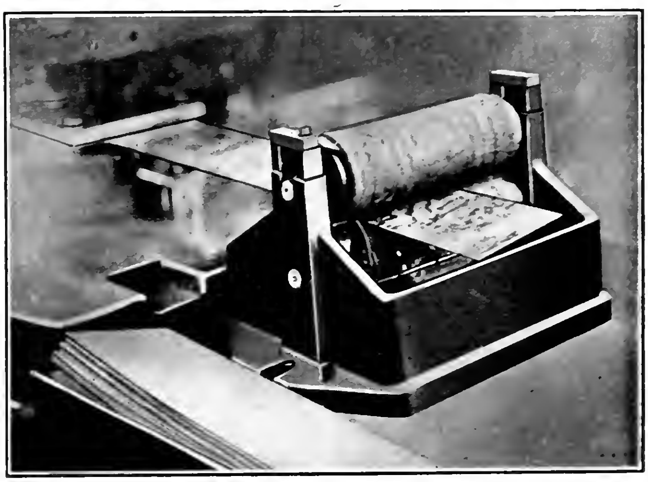


Fig. 6 Steel-Strip Oiling Device

struction. For example, the fact is mentioned that it would not cost much to secure the key in the brake wheel, and still the writer has seen at least two accidents caused by the key dropping out and allowing the release to strike the stop pin hard enough to break it off and permit the press to repeat. The proper way is to drill and tap the brake wheel over the key and countersink the key slightly, then use two headless set screws, one acting as a lock.

The writer also thinks that the many unnecessary bends on the pedal rod in some presses and its general flimsiness in others are the wrong way to economize. All presses should be supplied with the non-repeat trip that can be used or not, as desired, and all presses should be guarded at the crankshaft where it approaches the cam.

Fig. 6 shows a simple, little-known device for oiling the strip before punching. Formerly three men with brushes did this work. Now one operator does it with no decrease of speed, no increase of cost, and a saving of approximately 60 per cent of oil.

The writer also recommends a motor-driven shear roll grinder to grind the cutters in position.

It will greatly reduce the twist in the sheet and facilitate handling in the press, if care is used in setting the cutters for depth so that they will shear instead of tear. Cutters ground in position will last five times as long between grinds and the total life will be at least as much longer. (*American Machinist*, vol. 47, no. 12, September 20, 1917, pp. 485-487, 7 figs., *dp*)

Mechanics

On the Whirling Speeds of Loaded Shafts, W. M. Wallace

Details of experiments arranged for the purpose of examining (1) the accuracy of various simple methods of determining the whirling speed of a shaft of variable sections, and (2) the effect of radial clearance at the bearings on the whirling speed.

A previous article (*The Engineer*, June 16 and 23, 1916, compare The Journal, August 1916, p. 673) indicated a graphic method of estimating the whirling speed of a symmetrical shaft loaded at the middle with a single disk load. In this simple case there was, of course, no appreciable gyroscopic action on the shaft. In the present case the test was made with two similar cast iron disk loads, fixed symmetrically on the shaft in the positions shown in Fig. 7. The shaft was supported at the sections *A*, *A* by simple cast iron bearings, so arranged that the surface of contact of shaft and bearing was limited to a ring of 1/4 in. breadth, and, as the shaft was a nice turning fit in this ring, the positions of the nodes were known almost to one-eighth of an inch.

In Fig. 7 the bending-moment diagram for the loaded shaft is shown by *a b c d*, and the diagram reduced to suit the similar section of the shaft in *a e f g h l m n r d*: the deflection diagram (only half of which is shown) is *p e t*.

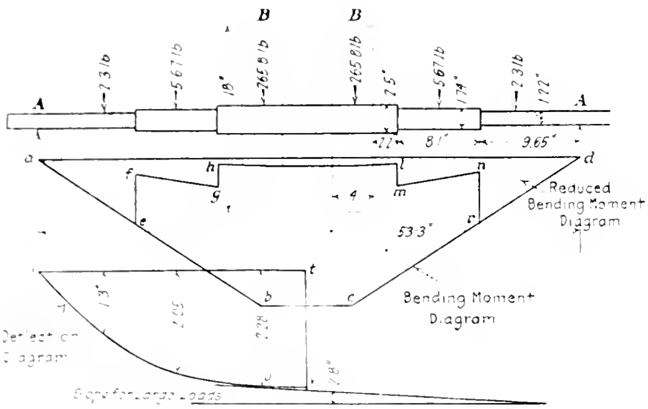


FIG. 7 BENDING-MOMENT AND DEFLECTION DIAGRAMS OF A SYMMETRICAL SHAFT OF VARIABLE SECTION, FREELY SUPPORTED ON RING BEARINGS AND LOADED WITH TWO CAST-IRON DISKS *B B*

The writer makes the calculation in detail, and shows that when working with four-figure logarithmic tables no appreciable difference is seen in the results, as far as gyroscopic action is concerned.

When this shaft was actually running, it commenced to whirl at 663.6 r.p.m., and continued until a speed of 680 r.p.m. was reached; the maximum whirl appears to have occurred at a speed of 677 r.p.m. The calculations carried through by the author indicate that the whirling speed, with gyroscopic action neglected, should have occurred at 687.5 r.p.m., or about 1.5 per cent above the speed actually found by experiment. This difference may be due to experimental error, or, more probably, to the slight difference in diameter of shaft and bearing, a difference which must always occur where a shaft turns freely in its bearing.

The writer checks these figures by a rapid approximate method, using the deflection tables for a uniform shaft, previously described in *The Engineer*, and finds a value for the whirling speed for the shaft of variable section shown above of 665 r.p.m. Since, however, this method is known to tend to give results on the high side, it appears that the correct theoretical whirling speed is about what the graphical method indicates, or 688 r.p.m.

An interesting feature of these experiments, both with and without bearing clearance, was the difficulty experienced in obtaining a true whirl of the shaft. Under the action of hammer blows along the line *X-X*, Fig. 8, the cast-iron stands which are fixed at the base to a massive iron bed yield slightly, with the result that on speeding up the shaft horizontally, vibrations first made their appearance, which died down as the speed was increased, to be succeeded by vertical vibrations. This experience suggests the possibility that as soon as it is unlikely that the clearance and yield of bearings is rarely the same in these two directions, the shafts of most machines do not whirl at any speed, especially if the noise produced is considerable.

A series of tests was also carried out in order to determine the effect of radial clearance by the bearings on the whirling speed. To do this the shaft was dismounted and the ends turned down at the sections of support *A*, as shown in Fig. 9, so as to form a diametral clearance of 0.044 in.

A simple theory offered in *The Engineer*, September 1, 1916, anticipated that the clearance would lower the whirling speed and increase the range of speeds over which whirling would occur.

Figs. 10 and 11 may be used to explain the leading lines of this theory. Here the exceptionally thin shaft is shown whirling with the radial clearance β at the bearings. The deflection of the shaft at any given point being y, the potential or strain energy stored in the shaft is proportional to y, but the radius of the circle of whirl described by the shaft at this point being

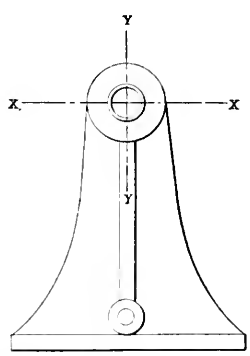


FIG. 8 BEARING FOR SHAFT SHOWN IN FIG. 7

$y+\beta$, it follows that the kinetic energy of motion is proportional to $(y+\beta)^2$; that is, instead of using the summation of Wy^2 in the denominator of the experiment for N, it is necessary to use the summation of $W(y+\beta)^2$. This, of course, results in a lower value of the whirling speed being obtained.

The writer points out that not only are the magnitudes of the out-of-balance force on the shaft important in affecting the speeds and the amplitudes of vibrations or whirl, but that their disposition on the shaft is also of importance. In most cases in practice, it is a single force situated near the middle of the shaft, a case for which the simple theory indicated above is applicable; still, it is easy to conceive a case in which the clearance effect would only be realized upon end of the bearing.

The writer further claims that the more one studies the actual behavior of shafts, the more one realizes how inadequate, even misleading, is the usual mathematical treatment of the problem.

The calculation given by the writer indicates that disturbances should begin at 531.1 r.p.m. On actually running the shaft, horizontal disturbances commenced at about 500 r.p.m. There is reason to believe that this very low speed was due to the yield of the bearings in a horizontal direction. The hammer blows along the line X-X, Fig. 8, have a considerable leverage over the bases of the supports; whereas, the forces along the line Y-Y have no such leverage.

The vibrations in a vertical direction commenced and finished at speeds which depended upon whether the speed of rotation was being increased or decreased. On being increased they commenced at 650 r.p.m. and ceased at 680 r.p.m. On coming down they commenced at 650 r.p.m. and ceased at 570 r.p.m. From this data it appears that 570 r.p.m. is the lowest speed at which the vertical forces can maintain (not originate) a rhythmic lifting of the shaft through the clearance distance; that when a disturbance has once been set up it is continued to speeds far beyond those which can be established when the speed variation is in the opposite direction. There is no true whirl, because the maximum vertical disturbance does not occur with the maximum horizontal disturbance.

The writer emphasizes the fact that there is what one might call a certain difference in conception between the mathematical view of critical speeds and what is found in actual practice. The usual mathematical solution gives one the impression that there are certain speeds at which the shaft is in a state of instability so highly sensitive that any slight lateral disturbance would cause a catastrophe. This hypersensitive state exists only in the minds of the mathematicians. Actually, there is a certain range of speed over which the shaft is most

Fig. 9

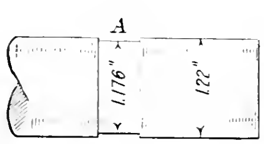
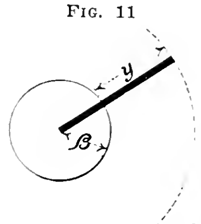


Fig. 11



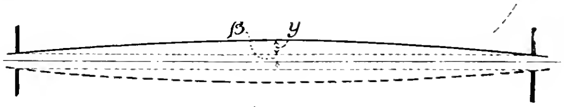


Fig. 10

Fig. 9 End of Shaft of Fig. 7 Turned Down at the Sections of Support A A to Test the Effect of Bearing Clearance

Fig. 10 Illustration of Influence of the Radial Clearance β on the Radius of Whirl

Fig. 11 End View of Shaft, Showing Clearance β

sensitive to out-of-balance force, but by reducing the out-of-balance force sufficiently it is possible to run a shaft quite safely at any speed. (*The Engineer,* vol. 124, no. 3221, pp. 246-247, 7 figs., *et*)

Disk-Wheel Stress Determination, S. H. Weaver, Mem. Am.Soc.M.E.

Reproduction of the paper presented by the writer at the Spring Meeting of The American Society of Mechanical Engineers in May 1917.

In addition to the data presented in the paper before this Society are given several charts for facilitating the derivation of tangential stresses as given in Equations 5a and 5b in the paper. (*General Electric Review,* vol. 20, no. 10, pp. 791-799, illustrated. The charts are on pp. 794-798. *tA*)

Motor Trucks

The Building of the U. S. Military Truck

An announcement was made October 8 to the effect that the first Liberty motor truck for the U. S. Army had been completed at Lima, Ohio.

The Liberty motor truck was built in great secrecy. A building without windows and lighted only by skylights housed the truck during the three weeks of its construction. The plant was closely guarded by armed men night and day.

The parts were manufactured elsewhere and as each part was completed it was dispatched to Lima in charge of an army representative, who kept factory officials informed of his progress by telegraph. No one company knows the complete design, or what other companies in various parts of the country made other parts.

In view of this statement officially given out to the daily press, the following data published by the Society of Automotive Engineers become of interest.

The standardized military truck for the U. S. Army was

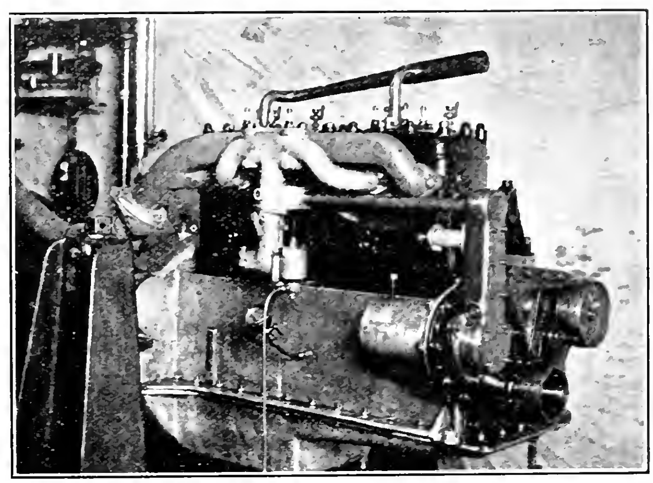


Fig. 12 Liberty Truck Engine

built under the supervision of the Quartermaster Department, Col. Chauncey B. Baker and other officers, with the collaboration of engineers of the various companies.

As regards the engine, it was at first intended to have two types of engines, class A and class B, but it was found that a consistent design of the latter would only be 120 lb. heavier than the design suggested for the former. It was therefore decided to standardize one model for use on both sizes of military truck, the only difference in the two engines being in the bore. It will thus be possible to decrease greatly the number of repair parts needed for the two engines.

The fuel tank will be located on the dash, with provision for a surplus under the seat.

As regards the lubrication system, it was found that the amount of oil passing per unit of time is the determining factor and that this is practically equal in a number of systems operating at widely different pressures. It has been decided to adopt the full-pressure feed with the relief valve at the end of the system. In order to always have the oil in the best possible condition, a method of cleaning it has been developed consisting of passing the oil through a large screen and in having three settling chambers.

The intake and exhaust manifolds of the engine are designed so that heavy gasoline will be thoroughly vaporized. In fact,

it is said that the engine could be operated on kerosene with only minor changes in manifold design.

The transmission is of the four-speed horizontal type and located amidships. Four universal joints will be used in the drive, two between the clutch and transmission and two between the transmission and rear axle. In the design of transmission special care has been taken to secure maximum accessibility and ease of replacement. For instance, only 5/8-in. plugs are used for fastening the covers and bearing retainers. On the right-hand side a handhole has been supplied for inspection purposes.

The truck will have two independent ignition systems for two separate sets of spark plugs. The ignition will be controlled by one switch, so that both ignition systems are either in the "on" or "off" position. A special switch has been designed which carries the lighting and ignition switches and also the ammeter and cowl lamp. The circuit breaker is to be mounted on the back of this switch. The generator is of the third brush type, normally giving eight amperes at 750 r.p.m. It is driven by an Oldham coupling.

As regards the rear axle on class B truck, it will be of the worm-gear type on account of the great manufacturing capacity available for producing the sizes of axle necessary for the heavy service. The class A truck will be equipped with an internal-gear axle. The worm-gear axle has been refined and simplified. For instance, only two sizes of roller bearings will be used instead of the five ordinarily required for the full-floating type of axle. The dry plate at the end of the axle is held by bolts instead of studs, as is the usual practice.

As regards production, it is understood that no employee will be engaged without the full approval of the Quartermaster General's Department after consideration of statements as to nationality and former connections. The men who will handle the production work are really drafted for the national service just as much as those who have joined the National Army. But they will carry the work on in the same manner and by the same methods which made them successful in private business.

In working out the design of the Liberty motor truck the Quartermaster Department had the great advantage of the most hearty coöperation on the part of private companies and the Society of Automotive Engineers.

Two experimental units have been completed, and since formally delivered to the Secretary of War in Washington.

For further details so far published in connection with the design of the Liberty motor truck, the readers are referred to the *Journal of the Society of Automotive Engineers*, vol. 1, no. 3, September, 1917, pp. 173-177.

Pumps

TESTS OF A ROTARY AIR PUMP

Data of tests carried out by Professor Trinks of the Carnegie Institute of Technology on a small Roots pump.

The purpose of the tests was to determine how much air the pump could handle. The air admitted to the pump was caused to pass, previous to entering it, through two tanks, which makes a somewhat cumbersome but necessary arrangement. The reason for this procedure is as follows: If the air going through the pump had been admitted directly through the nozzle at the pump inlet, the pulsation at the pump would have caused the nozzle to show a greater quantity of air flowing than actually did flow. The tanks themselves and the thin rubber diaphragm provided in one of them entirely eliminated these vibrations.

In order to duplicate as far as possible the conditions existing in heating service, the pump in the test was supplied with a small amount of water for sealing purposes. At first the action of the pump was found to be very erratic as it would ultimately hold and lose the vacuum, but it was later found that the trouble lay in the surging back and forth of the sealing water. A check valve was placed in the suction line near the pump and the trouble immediately disappeared. This surging never occurs in practice, because a check valve is usually present.

The more water was admitted the higher was the vacuum which could be maintained by the pump.

Fig. 13 indicates the quantity of air determined by the vacuum which can be maintained by the pump. It expresses

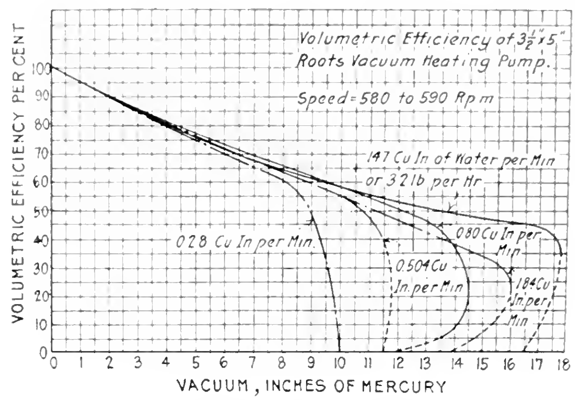


FIG. 13 QUANTITY OF AIR HANDLED BY SMALL ROOTS PUMP DETERMINED BY THE VACUUM ON THE PUMP

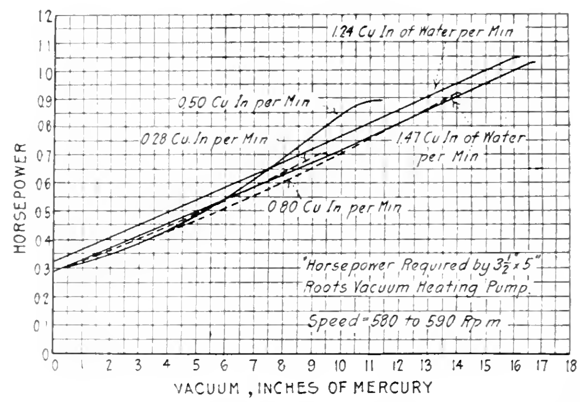


FIG. 14 POWER CONSUMPTION OF A SMALL ROOTS PUMP UNDER VARYING CONDITIONS

the volumetric efficiency of the pump as a function of the vacuum (hence of the quantity of sealing water). By volumetric efficiency is meant the ratio in per cent of the quantity of air actually delivered to the quantity which would be delivered under ideal conditions.

Fig. 14 shows the power consumption of the pump under different conditions, again as a function of the vacuum. It appears that the power varies in a straight line with the vacuum. An operator can considerably increase the power consumption by tightening the stuffing boxes. (*American Gas Engineering Journal*, vol. 107, no. 14/3109, October 6, 1917, pp. 301-302, 3 figs. *e*)

Recent Developments in Air-Pump Design, E. Jones

Discussion of the merits of some of the more recent developments in design of air pumps used as auxiliaries to steam machinery.

The writer discusses the comparative merits of the five standard types of condensers, namely, evaporative, ejector, barometric, jet and surface, with particular reference to the latter two. In this connection he gives a table (Table 2) showing the relative costs and requirements of barometric, jet and surface condensers. The conditions which have been assumed are the same for each case, namely, steam quantity, 40,000 lb. per hour; vacuum with barometer at 30 in., 28½ in.; cooling water at 60 deg. fahr.; and for prime mover a high-pressure steam turbine. Under the present abnormal conditions surface condensers are in a particularly unfortunate position, owing to the cost of the materials used for tubes and tube plates, which is approximately 27½ per cent of the value of the whole equipment.

Of the particular designs discussed by the writer, the Breguet condenser is of special interest. It was introduced

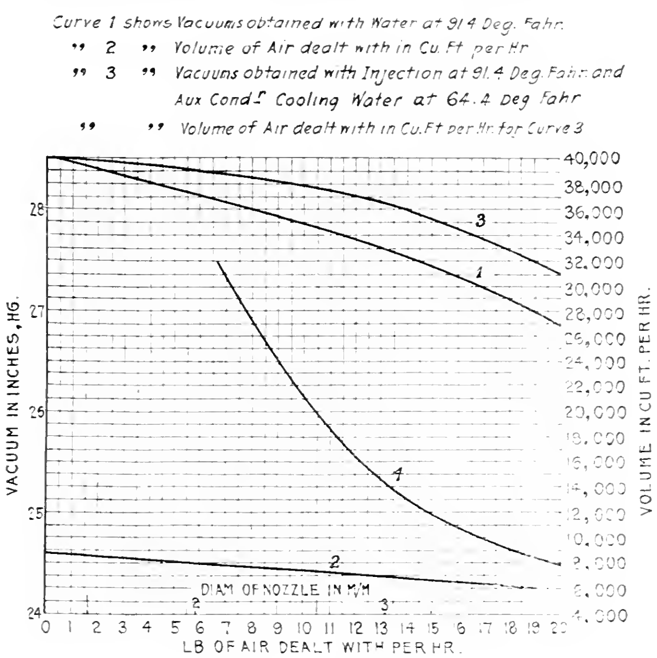


Fig. 15 Breguet Ejectair Theoretical Vacuum at 91.4 Deg. Fahr.

just before the war, and is now said to be extensively applied in the French navy. A description of it was given in The Journal, 1914, p. 0183. These "ejectairs," as they are called, are designed for working with steam pressures at 55 lb. per sq. in. or above, and with the special arrangements of nozzles lower pressures can be used in the primary ejector.

The curves, Fig 15, show the performance of an ejectair. Steam to the ejectors had an absolute pressure of 125 lb. per sq. in., and the steam consumption is given at 194 lb. per hour, of which 129 lb. are recoverable. The apparatus worked in conjunction with a small jet condenser, dealing with 94 gal. of injection water per min. Curve 1 gives the vacuums obtained with water leaving the condenser at a temperature of 91.4 deg. fahr. (33 deg. cent.), and the auxiliary condenser out of action; curve 2 the volume of air dealt with in cubic feet per hour; curve 3 the vacuums obtained with given air leaks, and the water leaving the main condenser as for cooling water at 66.2 deg. fahr. (18 deg. cent.); and curve 4 the vol-

TABLE 2 RELATIVE COST AND REQUIREMENTS OF BAROMETRIC, LOW-LEVEL JET AND SURFACE CONDENSERS

Type of Plant	Consisting of	Approximate Net Weight of Apparatus	Horsepower Required to Drive Condenser and Auxiliaries	Present-Day Costs	Equivalent Ratio
		Tons	B h p	£	
Barometric	Condenser, staging, air pump, injection pump, driving motor, switchgear, air and tail piping, main exhaust piping and sluice valve, auto-exhaust valve. Complete erection. ..	40	86	2700	1.286
Low-level jet	Condenser, water extraction and air pumps, driving motor, switchgear, main sluice valve, adapting and expansion pieces, auto-exhaust valve. Complete erection	22	87	2100	1.00
Surface	Condenser, rotary air pump, extraction pump and circulating pump mounted on common bedplate with driving motor and switchgear. Necessary interconnecting pipes, main exhaust-steam sluice valve, expansion piece, automatic atmospheric valve. Complete erection.	30	78	3300	1.571

umes of air dealt with under the same conditions. It was calculated that the air coming in with the injection water and at leaky joints amounted to 1.102 lb. per hour, or 0.5 kg. (*Engineering*, vol. 104, no. 2697, September 7, 1917, pp. 263-265, 9 figs., first installment of a serial, *d*)

Railroad Engineering

The Shrinkage Allowance for Locomotive Tires, E. L. Ahrons

The writer compares the methods of determining shrinkage allowance on a large English main line with that adopted by the American Master Mechanics' Association and the one adopted by the Lancashire & Yorkshire Railway in England.

In the diagram, Fig. 16, the graphs give the immediate shrinkages for wheel centers of different diameters; A A being the curve for the large English railway, B B the American Master Mechanics' Association standard and C C that of the Lancashire & Yorkshire Railway.

The standard practice of the Great Northern was to allow a shrinkage of 1 in 800. Stress-strain diagrams made from tests of class C—British standard—tire steel of 50 to 55 tons ultimate tensile strength, showed that the elastic limit was reached with an extension of about 0.2 per cent, at 26.5 tons per sq. in. Therefore, an extension of 0.1 per cent, or 1 in 1000, results in a stress on the material of the tire of 13.25 tons per sq. in. The modulus of elasticity of this tire steel will therefore be 13,250.

The diameter of the wheel center was 74 in., and that of the tread of the tire, after shrinkage, where the measurement was taken, was 80 in., the tire being 3 in. thick. It was found that the outside perimeter had extended 0.232 in. after shrinkage on, with an allowance of 1 in 800 on the inside, i. e., on the diameter of the wheel center. The outer circumference, after shrinking, being 251.33 in., the original length of the circumference was therefore 251.098 in., and the strain e = 0.232/251.098. The stress in the outer fiber of the tire = 13.250 e = 12.242 tons per sq. in.

Treating the tire as a ring of rectangular section, and using

[illegible] in thick cylinders, and [illegible] 12.242 [illegible]

[illegible] of the tire [illegible] between tire and wheel center, [illegible] the hoop tension P and the radial stress [illegible] P [illegible] Q [illegible] P [illegible] Q [illegible] con[illegible], and since there is no radial pressure on the outside of the tire [illegible] 0, and therefore P [illegible] Q [illegible] P [illegible] 12.242 tons per sq. in.

On the inner fiber of the tire the usual form of Lamé's expression is

$$P_1 \quad Q_1 \frac{R \quad R^2}{R \quad R_1^2} \qquad \ldots\ldots\ldots\ldots [1]$$

in which R_2 and R_1 are the outer and the inner radii of the tire and P is the apparent hoop tension, neglecting the effect of lateral contraction (Poisson's ratio).

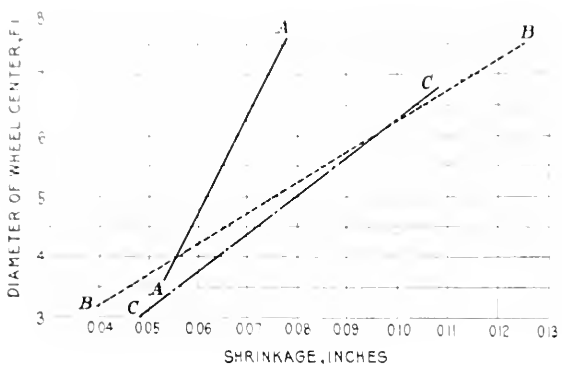


FIG. 16 COMPARISON OF THREE STANDARDS OF SHRINKAGE OF LOCOMOTIVE TIRES

Taking the effect of lateral construction into account, the stress equivalent to the greater strain is

$$P_1 = Q_1 \frac{R_2^2 + R_1^2}{R_2^2 - R_1^2} + \frac{1}{m} \qquad \ldots\ldots\ldots\ldots [2]$$

in which m may be taken as 3.5, an average value for steel.

The thickness of the tire is nominally 3 in., but as the outside tread is turned to 80 in. diameter ($R_2 = 40$), the actual thickness is very slightly greater, since R_1 is slightly less than 37 in. after shrinkage by an amount depending upon the contraction of the wheel center.

Neglecting for the moment the contraction of the wheel center, the value of P_1, the stress on the inner fiber of the tire, becomes from Equation [2] 13.138 Q_1, and since from [1] $Q_1 = 12.242 - P_1$, the value of P_1 becomes 13.25 tons per sq. in.

The strain on the inside layer of the tire, or the stress (13.25 tons) divided by the modulus of elasticity (13.250), is .001, i.e., the actual or terminal shrinkage is 1 in 1000.

If the wheel center be supposed to have contracted 0.02 in. in the diameter, Equation [2] gives $P_1 = 13.094\ Q_1$, from which $P = 13.255$ tons per sq. in. The effect of the contraction on the stress in the tire may, for ordinary cast-steel wheel centers, be neglected.

The difference between the effective or real shrinkage allowance of the tire and nominal allowance is of interest. In the case cited by the writer this difference amounted to 0.0185 in., which may be taken as the actual contraction of the 74-in. wheel.

It may be of interest to investigate experimentally the question of the amounts of contraction of wheel centers for different diameters. While from the above figures it appears that the maximum stress on the inner fiber of the tire is 13.25 tons per sq. in., it is half the elastic limit of the steel. It may happen that an occasional tire is gaged too tightly, in which case the nominal shrinkage will be considerably higher. The above stress in the tire is static and it is probable that additional alternating dynamic loads may, in time, produce the results of repeated stresses and ultimately cause fracture of apparently sound tire which has been shrunk on under the maximum hoop tension considerably less than the ordinary elastic limit of the material, which would explain certain cases of fracture. (*The Engineer*, vol. 124, no. 3222, September 28, 1917, p. 263, 2 figs., *cp*)

Steam Engineering

INVESTIGATION OF STRESSES IN DIGESTER SHELLS, H. O. Keay, Mem.Am.Soc.M.E.

In the design of sulphite-digester shells it has long been the practice to calculate the stresses by means of conventional formulæ for cylindrical pressure vessels, without any apparent consideration whatever of the possible action of the masonry lining. Where such a lining reaches a thickness of 7 in. or more, however, there is present a circular arch of considerable strength. This investigation was undertaken with the view to demonstrating that under certain circumstances such linings impose a heavy tensile stress upon the shells of digesters.

To settle the question of influence of temperature of the lining upon shell stresses, Prof. A. P. Mills and the author of the present article were requested two years ago by the Laurentide Co., Ltd., of Grand' Mère, P. Q., Canada, and the International Paper Company, to conduct a joint investigation of the behavior of the shell of a digester under working conditions.

The paper gives a detailed account of the methods of investigation used in the present case and presents the data in the form of curves.

Had no extraneous stresses been encountered, calculation shows that the magnitude of the value of the circumferential stresses (upper curve, Fig. 17) would have been approximately double those of the longitudinal stress (lower curve); but actually such is not the case, nor do the curves return to the base line of zero stress even when the digester has been cooled down to room temperature. Further, the difference between the maximum and minimum of neither the circumferential- nor the longitudinal-stress curve is as great as the calculated values corresponding with the known maximum internal pressure.

This can be accounted for in only one way, namely, that subsequent to the lining of the digester, compression had accumulated in this lining, reacting as a residual tensile stress in the plate. The effect of internal pressure and the elastic extension of the steel shell tend to relieve the compression in the lining and its consequent reaction on the shell. So, at the point of maximum internal pressure the resultant stress is necessarily less than the sum of the residual stress and that which would have been produced by hydrostatic pressure alone.

The residual circumferential stress is shown to be about 5000 lb. per sq. in. of the solid plate, and the maximum circumferential stress in the final cook reaches a value of 13,000 lb. per sq. in. with a corresponding longitudinal stress of 10,400 lb. per sq. in. Since the strength of the longitudinal

seam expressed in terms of the strength of the gross section of the uncut plate is 85.42 per cent, and that of the girth seam 67.19 per cent, the corresponding maximum circumferential stress becomes $13{,}000/0.8542 = 15{,}220$ lb. per sq. in. and the maximum longitudinal stress $10{,}400/0.6719 = 15{,}480$ lb. per sq. in. The higher stresses encountered in making the first cook after the digester had been cooled down emphasize the necessity for extreme care in bringing the digester up to working temperature and pressure in similar circumstances.

A series of tests was also run on new digesters selected at the Laurentide Company's sulphite plant for the purpose of determining the strength of the longitudinal seams. These tests gave results fairly consistent with the results of the tests referred to above. The behavior of the digester shells was quite similar, although in the former instance the lining cement was gaged with the sodium silicate at 5 deg. B., while in the latter case the cement was gaged with a similar solution at approximately 36 deg. B., a circumstance which appears to indicate that if the silicate has an influence in producing permanent expansion of the lining, an excess over a certain amount has little or no effect. (*Paper,* vol. 21, no. 4, October 3, 1917, pp. 14, 16, 18, 20, 22, 24 and 26, 10 figs., *e*)

New Boilers for Ashley Street Station

Data of an additional boiler installation for driving the new 25,000-kva. turbines now being installed in the Ashley Street Station of the Union Electric Light and Power Company, St. Louis, Missouri, and to increase the general steam capacity by about 60,000 kw. to take care of the growing business of the plant.

To do this the 28 Scotch marine and small water-tube boilers located on the first floor of a double-deck boiler plant will be replaced by 24 of the new type of Edge Moor boilers.

The Scotch marine boilers with internally fired furnaces did not prove successful, owing to their being ill-suited to the burning of low-grade Western coals which must be used in the St. Louis district.

The new boilers are equipped with underfed stokers. The installation of such stokers in a power station which must rely on low-grade Illinois coal was a new and somewhat radical departure, but after six months of operation the success of the venture was proved beyond a doubt. Boiler ratings up to 200 per cent are being carried continuously with an over-all boiler and furnace efficiency of 70.5 per cent.

Precision "Three-in-One" air gages are used for indicating draft pressures in the blowers, furnaces, and uptakes. The average draft in the uptake is $1\frac{1}{4}$ in. of water, with that in the furnace slightly below atmospheric pressure, while the available force of the air blast is 4 in. With this equipment it is impossible to obtain ratings in excess of 300 per cent for periods of one hour or slightly longer. On the economizers are "Tycos" double-pen recording thermometers for incoming and outgoing water temperatures. Each boiler is also equipped with a General Electric indicating flow meter calibrated to read directly in hundreds of boiler hp.

Edge Moor boilers are used. They are built up with the side-wall construction shown in Fig. 18. These walls, which have the usual firebrick lining 9 in. thick opposite the furnace proper, are backed up with hollow building tile 8 in. thick bonded in with common red brick. On the outside of the tile is placed 2 in. of air-cell covering securely fastened and cemented in place, then covered with canvas. On the outside of the building tile and beneath the 2-in. covering is placed a coating of "boiler seal," the object of this being to stop up cracks and prevent air leakage through the setting. Six months' operation of the boilers has proved that these settings are entirely satisfactory. (*Power,* vol. 40, no. 15, October 9, 1917, pp. 480-484, 10 figs., *d*)

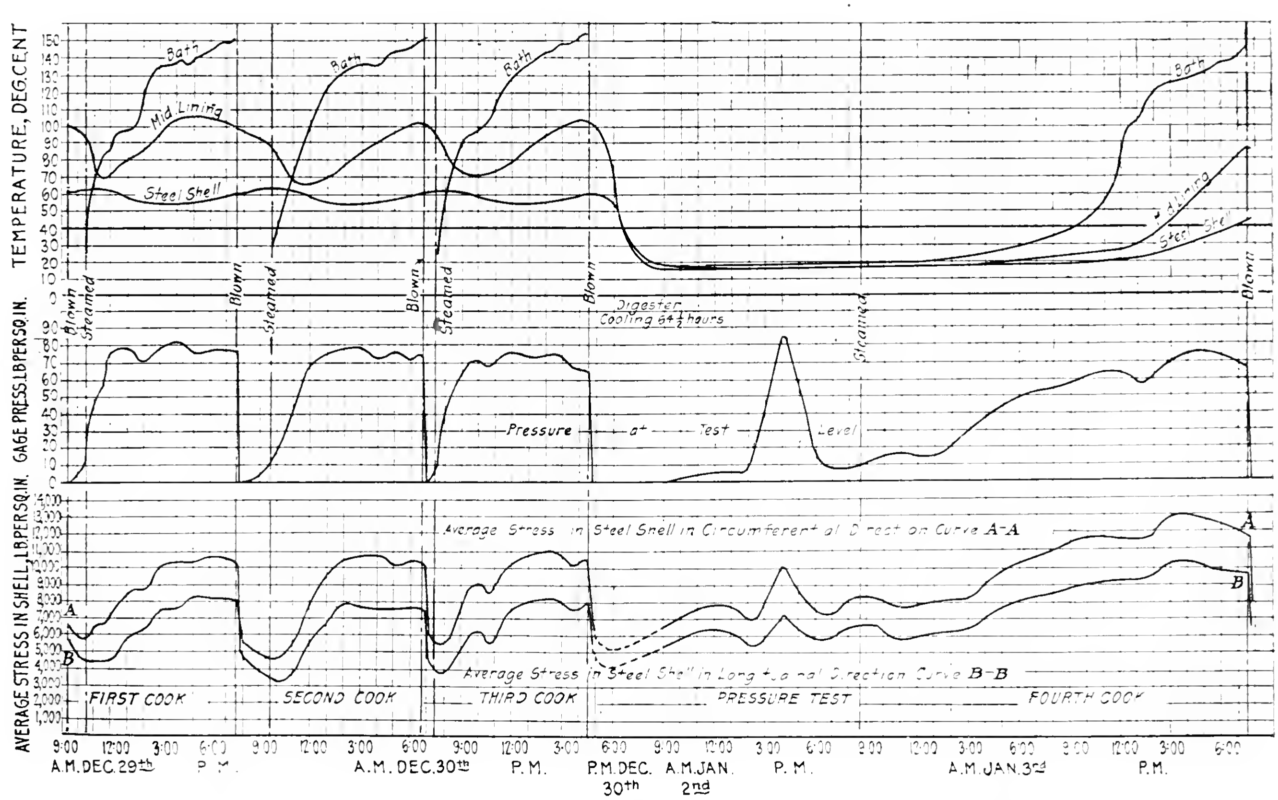


Fig 17 Data of Tests of a Digester Shell for Circumferential and Longitudinal Stresses

Varia

Female Labor's Place in the Automotive Industry, Allen Sinsheimer

Discussion of the probability of increase of female labor in industry, based on the experience of England. The author lays great emphasis on the fact that if female labor is employed, proper conditions should be provided, especially with respect to food

By comparing the increase in the number of women employed in gainful occupations in the United Kingdom with

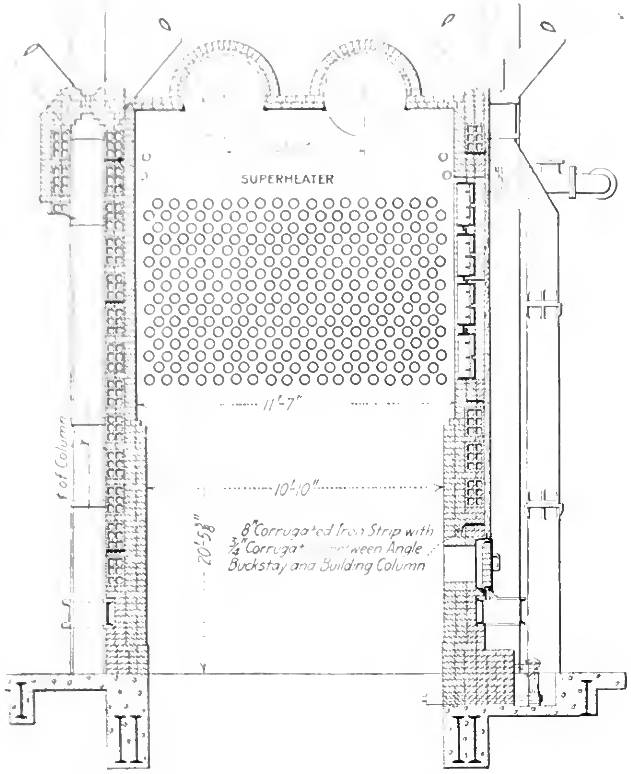


Fig. 18 Wall Construction of Boiler Setting

that now employed in America, the writer comes to the conclusion that one may expect an access of more than 2,000,000 into the industry. This condition will create many problems peculiar to female labor and involving such things as illiteracy and lack of knowledge of English; hours of labor; rates of wages and earnings; efficiency of female labor; labor conditions affecting health; housing and safety; industrial canteens; restrooms and matrons; state legislation affecting female labor; feminine temperament; employment of mothers; time keeping and labor turnover; physical capacity.

As regards the knowledge of English, the writer tells of the so-called Sicher plan, which includes a school incorporated with daily work where three-quarters of a hour of daily instruction is given without interruption in factory work. The schoolroom is set aside in a quiet out-of-the-way corner of the factory. The school has the coöperation of the Board of Education. The total cost of 35 weeks' instruction per girl is $16.80 for the firm and $14.80 for the city. It was found that for 32 weeks preceding the opening of the school the wages of the girls who later became pupils averaged 19.5 cents per hour, while that which the literate girls received was 23.2 per hour.

As regards the hours of labor, experiments in this country with female labor confirmed the experience in England, namely, that short hour shifts are preferable to long-hour shifts. The Miller Rubber Company, of Akron, Ohio, experimenting by reducing the hours of labor from ten to eight, discovered that female labor earnings of 16.4 cents per hour increased to 21.5 per hour in six months, that production increased from 82 per cent to 107 per cent and attendance by 10 per cent in the same period.

As regards efficiency, inquiry among manufacturers in this country shows that female labor applied to certain light machine work and to work where deftness of hand is required is more productive than male labor. The Link-Belt Company of Indianapolis finds women more efficient and productive than men when assembling small links into chains and handling packing for heat-treating purposes. The same experience is reported by several other large concerns, among them the International Harvester Company and the Westinghouse Electric Company.

On the other hand, some manufacturers find that women at machine work require more supervision than men, because when a machine breaks down they are unable to repair it, or because the women are unable to handle the large and heavy output resulting from their productive effort.

Conditions of labor affecting health are of particular importance where female workers are employed. Sanitary washrooms and cloakrooms are essential. Chairs should be provided wherever possible. Provision for meals should allow three-quarters of an hour to one hour, and the interval between meals should not exceed four hours. The housing problem also becomes very important.

The temperament of female labor affects production. Women are less inclined to become labor machines than men. Female supervisors are more efficient than men when handling female labor, because of their ability to gain the workers' confidence, to learn their grievances, to determine home troubles, or discover any factors which prevent them from attaining a normal productive output. On the other hand, the general impression is that women are less inclined to change their positions than men.

The physical capacity of women differs from that of men and they are particularly liable to injury through lifting weights or by long standing. Chief among the slight ailments to which the employers will do well to direct their attention are disturbances of digestion due to unsuitable food, irregular and hurried meals, fatigue, anemia, headache, nervous exhaustion, muscular pain, and weakness and derangement of special physiological functions. English manufacturers have found it profitable to employ women doctors to examine applicants for work. It was found that prolonged standing may be the cause of permanent and serious injury to women, and where standing is unavoidable they make the hours and spells of employment short and provide seats for frequent intervals of rest.

Experiments in the motor plants of the United States show that as test drivers women are more careful than men and that they drive more responsibly through city streets. A number of concerns have found that on assembling, inspection and light machine work women may be employed with excellent results. The Dayton Engineering Company, employing several hundred women workers, has installed a factory school for the girls where they are taught light machine work, receiving the guaranteed day rate while studying.

The writer proceeds to quote the views of Samuel Gompers, President of the American Federation of Labor, on female labor. An interesting part of this is the quotation from the

report of an inquiry carried out by the Federation of Metal Workers of Germany in war times.

From this report it appears that women are often engaged in work which is entirely too strenuous for them and sometimes suffer from the consequences. Thus, the women complain very much of abdominal pains caused by frequently having to lift, without any tackle, sheets weighing 52 lb. In the foundry they have, for instance, to push the casting pans about, work that overtaxes their strength. One woman sustained a rupture of the groin through performing this work. At steam hammers women have to draw bomb castings (weighing about 88 lb.) in a state of incandescence from the furnace to the hammer. It appears that a continuous effort is made in Germany to employ women at the hardest and most dangerous jobs: at steam hammers, shaping machines, core making, pneumatic lifts, transporting heavy cores, casting with pans and with hand ladles. One result of the hard work in one establishment is that out of 42 women nearly one-third have been disabled by disease.

Of the women employed in the metal trades 79 per cent work from 11 to 13 hours per day, with much overtime and Sunday work.

As regards wages, the treatment does not appear to be fair. Thus, in one establishment it is the custom that piece-work wages must not exceed the average time wages by more than 75 per cent. Should a woman through diligence and skill earn a larger sum, the piece-work rate was reduced in her case. The inquiries showed that only 9 per cent of the women were paid at rates corresponding to those paid to men for identical work. (*The Automobile and Automotive Industries,* Nos. 13 and 14, September 27 and October 4, 1917, pp. 525-531 and 592-593, illustrated.)

The Growth of Mining and Metal Industries in France

BEFORE the war, France was already considered by experts as the richest country of the world in iron ore, after the United States. Besides the basins of Lorraine, which produce three billion tons of ore, she possesses the basin of Normandy, which, in an area of 40,000 square kilometers, contains, according to a recent estimate, nearly a billion tons of a superior quality of ore yielding 50 per cent of iron. In 1914, 21 grants in mining districts, producing 1,152,000 tons a year, already existed in the departments of the Orne, Manche and Calvados, which yielded 648,000 tons with six grants only under exploitation. About the middle of 1916, a large society, entirely French, the Société Normande de Métallurgie, was founded, with a capital of 40 million francs, by Messrs. Schneider and Co., the great Creusot manufacturers, the Société des Aciéries de la Marine et Homécourt, and several shareholders belonging to the metallurgic world. This new society leased the foundries and fittings previously organized, or provided for, by the Société des Hauts-Fourneaux de Caen, formed in 1892, and in July 1916 started the works afresh. They are situated at Mondeville-Colombelle near Caen, and stand over 400 hectares (about 2½ acres), 200 of which are on the plateau and 200 in the valley of the Orne. About thirty kilometers distant is the Soumont mine, capable of yielding even now 4000 tons of iron ore a month, and which, in the near future, will have a far larger output.

The establishments of the Société Normande de Métallurgie comprise gas and coke furnaces, large steel works, a flattening mill, smelting works and blast furnaces. Three stations, and a railway line 33 km. long, facilitate the transport service. The line was made by a branch society and runs between the above foundries and the Soumont mines. At present there are 4 batteries of 42 furnaces each, producing 1000 tons of coke a day. In January 1918 two other batteries, now under construction, will be in working order and will bring the output up to 1500 tons a day, or 500,000 tons a year. The coke, collected by an ingenious system of inclined planes and chains, after being sorted out, is sent in trucks to Government metal works. Gas undergoes a series of processes for the purpose of extracting the secondary products obtained by the distillation of coal such as tar, phenol, benzine, toluol, naphthalin, sulphate of ammonia, used in the manufacture of explosives and for dyeing purposes, and which, prior to the war, were almost exclusively produced by Germany.

The blast furnaces, the first of which has been recently inaugurated, are in themselves 29 meters high, but with their basements tower 45 meters above the foundry ground plot. They can produce 400 tons a day, which is the largest output obtained in Europe up till the present day. To each is affixed a battery of 5 metal cylinders, or "Cowpers," 7 meters in diameter, for heating the air for the combustion of coke, and the reaction of carbon on the oxides of the ore, which is the source of production for cast iron. Three of these gigantic blast furnaces will be ready in the autumn of 1918, and the whole installation, when completed, will allow of an output of 450,000 tons of cast iron a year. The steel works, properly so-called, contain 4 converters of 30 tons, and 5 Martin furnaces of 30 tons, allowing of an output of 275,000 tons of Thomas steel and 125,000 tons of Martin steel every year. The flattening mill can pass 500,000 tons of ingots a year, and is supplied with several reversible trains for the production of all small samples. The Société already possesses stocks of iron ore sufficient to insure the supplies for its factories without any difficulty. It has had a large water tower, 66 meters in height, built in the neighborhood, with two reservoirs and a canal to the Orne, so that 10,000 cubic meters of water could be supplied hourly. A vast hall 200 meters long contains the electric machinery for distributing motive force, two turbo alternating generators of 3000 kilowatts, one of 5000, six gas alternating generators of 6000 hp., and three of 3000 hp. A private harbor has been built on the Orne canal, and it is now ready for vessels of 2000 tons, and will soon be open to boats of 8000 tons' burden.

The preceding facts show how the Société Normande has been able to create in the midst of war one of the most important metallurgic centers in the whole of France. The mining industry of the entire region has followed its example. At present 30 fresh grants have been made for exploiting of the layers of iron in Normandy, Brittany and Anjou. On the other hand, the French Government is preparing to work the Littry coal fields, situated between Saint-Lô and Bayeux. Lastly, owing to many recent improvements, trade with Caen harbor is increasing every day. From 890,000 tons in 1910, it rose to 1,126,000 in 1913.—Paris Chamber of Commerce Bulletin, September 1917.

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

SELECTED TITLES OF ENGINEERING ARTICLES

AERONAUTICS

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Possibilities of Rapid Growth in Airplane Work, Fred H. Colvin. American Machinist, vol. 47, no. 15, October 11, 1917, pp. 629-630, 1 fig., 3 tables.

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The 260-hp. Mercedes Engine. The Automobile and Automotive Industries, vol. 37, no. 14, October 4, 1917 (part 3), pp. 585-586, 3 figs.

Development and Progress in Aviation Engines, Henry Souther. Journal of the Franklin Institute, vol. 184, no. 4, October 1917, pp. 509-526, 16 figs.

CONVENTIONS

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St. Louis Meeting of the American Institute of Mining Engineers. Metallurgical and Chemical Engineering, vol. 17, no. 8, October 15, 1917, pp. 455-457.

Spirit of Service Pervades Foundry Meeting. The Foundry, vol. 45, no. 10, whole no. 302, October 1917, pp. 411-420, illustrated.

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The Formation of Tri-Calcic Aluminate, Edward D. Campbell. The Journal of Industrial and Engineering Chemistry, vol. 9, no. 10, October 1, 1917, pp. 943-946, 2 figs.

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Physico-Chemical Properties of Chrome-Nickel Steels, Herbert J. French. Metallurgical and Chemical Engineering, vol. 17, no. 8, October 15, 1917, pp. 473-476, 10 figs., 5 tables.

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*Structure of Cast Iron in Metal Molds, Edwin F. Cone. The Iron Age, vol. 100, no. 12, September 20, 1917, pp. 656-658, illustrated.

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*An Investigation of Stresses in Digester Shells, H. O. Keay. Paper, vol. 21, no. 4, October 3, 1917, pp. 14-26, 10 figs.

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Strut Charts, H. M. Buckwald. Aviation, vol. 3, no. 5, October 1, 1917, p. 305.

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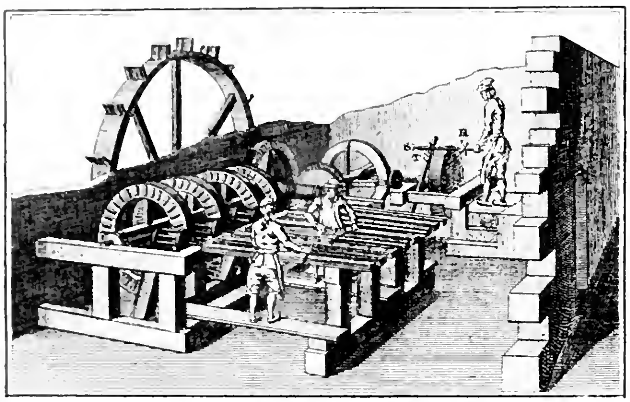
LIBRARY NOTES

From the Libraries of the Four Founder Societies and the United Engineering Society, in the Engineering Societies Building, New York City

Diderot's Encyclopedia

THE United Engineering Society Library has been fortunate in securing a well preserved copy of the famous French "Encyclopedie" edited by Denis Diderot (Encyclopédie, ou Dictionnaire Raisonné des Sciences, des Arts et des Métiers, par une société de gens de Lettres. Mis en Ordre & publié par M. Diderot; & quant a la Partie Mathématique, par M. d'Alembert . . . 3rd éd. Geneve, Pellet, 1777-1779. 36v., fronts. ports. tables. With 3v. of copper plates.) The Encyclopedia Britannica characterizes this work as one of "greatest and most remarkable enterprises of the 18th century." The germ of the "Dictionnaire" originated in a plan to translate from English into French, Ephraim Chambers' "Cyclopædia," or an Universal Dictionary of Art and Sciences, containing an Explication of the Terms and an Account of the Things Signified thereby in the Several Arts,



How They Made Munitions in Diderot's Time

The old encyclopedia contains many such illustrations of interest

and the several Sciences, Human and Divine." (London, 1728. 2v.)

After much quarreling between the publisher and those who had undertaken the translation, it was abandoned. An original French work was then planned and Diderot engaged as editor. "Instead of a mere reproduction of Chambers, he persuaded the bookseller to enter upon a new work, which should collect under one roof all the active writers, all the new ideas, all the new knowledge, that were then moving the cultivated class to its depths."

No other encyclopedia, it is safe to say, ever had so stormy, so romantic, and eventful a career. The work was by no means a piece of closet scholarship. Into it was poured the spirit of the democratic and scientific movement just preceding the French Revolution. The encyclopedia burns with the desire of the men of that time to conquer nature. It is aflame with the passion for experiment and exploration. Needless to say, it met with the violent opposition of the powerful ecclesiastics and the despotic French court, who instinctively felt this work to be a menace to blind faith in the traditional explanations of natural phenomena and a challenge of the unthinking worship of autocratic authority. Rousseau wrote the articles on music. Montesquieu, Turgot, and Voltaire were among the more than twenty contributors. Such a galaxy of free spirits did not inspire the trust of the then tottering French feudalism. In 1749 Diderot was imprisoned at Vincennes in close confinement for twenty-eight days, and cooped up in the castle an additional three months and ten days. The first two volumes of the encyclopedia were suppressed "as being dangerous to the king's authority and religion." The plates were ordered seized but could not be found. After work had been resumed, the Parliament of Paris, in 1759, stopped the sale of the Encyclopédie and ordered all copies to be burned. In 1766 Lebreton, the publisher, was forced to show his subscription list and was put in the Bastille for eight days. The famous beauty, Madame de Pompadour, who had befriended the undertaking from the first, pleaded for the lifting of the ban upon it, saying to the king that she could "know no longer how her rouge and silk stockings were made. The duc de la Vallière regretted that the king had confiscated their encyclopedias, which could decide everything. The king said he had been told that the work was dangerous, but as he wished to judge for himself, he sent for a copy. Three servants with difficulty brought in the 21 volumes. The company found everything they looked for, and the king allowed the confiscated copies to be returned." Lebreton, the publisher, set up the copy exactly as it came from the editor, but after final revision secretly removed all parts he felt too bold. It was thus that this great scientific work fared.

Diderot was the contributor of articles on philosophy, the arts and trades. "He passed whole days in workshops, and began by examining a machine carefully, then he had it taken apart and put together again, then he watched it at work, and lastly worked it himself. He thus learned to use such complicated machines as the 'stocking- and cut-velvet looms." The copper plates of this set are most excellent. They are valuable as records of the early history of the machinery from which the factory system of today has been developed. The whole work illumines the dawn of the modern world, the age of engineering.

Engineers of today are so busy making history, that they have little time to write it. But there are those who take a deep interest in tracing the development of their various professions. The United Engineering Society Library exists primarily as a working tool for the man in active practice. However, through the generosity of its friends, its has received some rare collections of books, such as the Wheeler and Raymond gifts, and is yearly becoming stronger in source material on engineering history. The "Encyclopédie" of Diderot is regarded as a noteworthy addition.

F. V. A.

For all fuller account see the Encyclopædia Britannica under "Encyclopædia" and "Diderot, Denis," from which articles the above account was compiled.

The addition to the Engineering Societies Building is now completed and the Library restored to its normal condition.

U. E. S. Accessions

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Handbook of Clearing and Grubbing; Methods and Cost. By Halbert Powers Gillette. Clark Book Co., Inc., *New York, 1917.* Cloth, 5 x 7 in., 240 pp., 67 figs. $2.50. Gift of the publisher.

Historia del Ferrocarril de la Sabana por el Socio de numero senor doctor don Alfredo Ortega. July 19, 1917. *Bogota, 1917* Gift of Sociedad Colombiana de Ingenieros.

History of Transportation in the United States before 1860. Prepared under the direction of Balthasar Henry Meyer by Caroline E. MacGill and a staff of collaborators. Carnegie Institution. *Washington, 1917.* Paper, 7x10 in., 678 pp., 6 maps. $6.50. Gift of the publisher.

Institution of Mechanical Engineers. Proceedings. January-May 1917. *London, 1917.* Purchase.

The Iron Ores of Lake Superior; Containing Some Facts of Interest Relating to Mining and Shipping of the Ore and Location of Principal Mines. By Crowell & Murray. 3d ed. with original maps of the ranges. The Penton Press Co., *Cleveland, 1917.* Cloth. 6 x 9 in., 316 pp., 7 figs., 13 maps. Gift of the authors.

Is Civilization a Disease? By Stanton Coit. Houghton Mifflin Co., *Boston and New York, 1917.* Cloth, 5 x 7 in., 136 pp. Gift of the University of California Press.

Leavenworth-Smithville Folio, Missouri-Kansas. (U. S. Geological Survey. Folio No. 206). *Washington, 1917.* Purchase.

McGraw Electric Railway List, August 1917. *New York, 1917.* Purchase.

Mining of Thin Coal Seams as Applied to the Eastern Coal-Fields of Canada. (Canada. Mines Department. No. 432). *Ottawa, 1917.* Purchase.

Modern Machine Shop; Construction, Equipment and Management. A Comprehensive and Practical Treatise on the Economical Building, the Efficient Equipment and Successful Management of the Modern Machine Shop and Manufacturing Establishment. By Oscar E. Perrigo. 2d ed., revised and enlarged. The Norman W. Henley Publishing Co., *New York, 1917.* Cloth, 6 x 9 in., 384 pp., 219 figs. $5. Gift of the publisher.

Official Automobile Blue Book, 1917; Standard Road Guide of America. Volume A, New York City and the Metropolitan District Embracing a Radius of 100 Miles from Columbus Circle. The Automobile Blue Book Publishing Co., *New York, Chicago, San Francisco* (copyright, *1917*). Leather, 5 x 9 in., 624 pp., illustrated, 1 map. $3. Gift of the publisher.

New York City. Department of Water Supply, Gas and Electricity. Annual Report 1908, 1915-1916. Gift of Department.

Ohio State University. Report of the Board of Trustees. 46th, 1916. *Columbus, 1916.* Gift of Ohio State University.

Opérations Minières dans la Province de Québec, rapport sur les l'année 1916. *Québec, 1917.* Purchase.

Organisation Physiologique du Travail. Par Jules Amar. Préface de Henry Le Chatelier. H. Dunod et E. Pinat, *Paris, 1917.* Paper, 7 x 10 in., 374 pp., 134 figs. 18 francs. Gift of the publisher.

Organization, Purpose and Methods of Underwriters' Laboratories. *Chicago, 1917.* Gift of J. I. Banash.

Parallel Tables of Slopes and Rises; In Combination with Diagrams of Slopes and Rises and Other Tables for Bridge and Structural Engineers, Draftsmen, Checkers, Templet Makers, Builders, and Vocational Schools. By Constantine K. Smoley. McGraw-Hill Book Co., Inc., *New York, 1917.* Leather, 5 x 7 in., 330 pp., 41 figs. $4. Gift of the publisher.

Plattsburg Training Camp, New York. Topographical map. *1917.* Purchase.

Practical Wireless Telegraphy; A Complete Text-Book for Students of Radio Communication. By Elmer E. Bucher. Wireless Press, Inc., *New York* (copyright *1917*). Cloth, 6 x 9 in., 322 pp., 323 figs. $1.50. Gift of the publisher.

The Principles of Iron Founding. By Richard Moldenke. McGraw-Hill Book Co., Inc., *New York, 1917.* Cloth, 6 x 9 in., 517 pp., 45 figs. $4. Gift of the publisher.

Production of Explosives in the United States during the Calendar Year 1916. (U. S. Bureau of Mines. Technical Paper 175). *Washington, 1917.* Purchase.

Publishers' Trade List Annual, 1917. *New York, 1917.* Purchase.

Railroad Construction; Theory and Practice. A Text-Book for the Use of Students in Colleges and Technical Schools, and a Hand-Book for the Use of Engineers in Field and Office. By Walter Loring Webb. 6th ed. rev. and enl. John Wiley & Sons, Inc., *New York, 1917.* Cloth, 4 x 7 in., 831 pp., 218 figs. $4. Gift of the publisher.

Researches of the Department of Terrestrial Magnetism, Volume III. Ocean Magnetic Observations 1905-1916; and Reports on Special Researches. By L. A. Bauer with the collaboration of W. J. Peters, J. A. Fleming, J. P. Ault, and W. F. G. Swann. Carnegie Institution of Washington, *Washington, 1917.* Paper, 9 x 11 in., 447 pp. $10. Gift of Carnegie Institution.

Results of Magnetic Observations Made by the United States Coast and Geodetic Survey in 1916. (U. S. Coast and Geodetic Survey. Special publication No. 42). *Washington, 1917.* Purchase.

Shape Book; Containing Profiles, Tables and Data Appertaining to the Shapes, Plates, Bars, Rails and Track Accessories Manufactured by the Carnegie Steel Company. The Carnegie Steel Co., *Pittsburgh* (copyright *1917*). Leather, 5 x 8 in., 352 pp., 270 figs. $1. Gift of the Carnegie Steel Co.

Standard Table of Electrochemical Equivalents and Their Derivatives, with Explanatory Text on Electrochemical Calculations, Solutions of Typical Practical Examples and Introductory Notes on Electrochemistry. By Carl Hering and Frederick H. Getman. D. Van Nostrand Co., *New York, 1917.* Leather, 4 x 7 in., 130 pp., 8 figs. $2. Gift of the publisher.

Société Technique de l'Industrie du Gaz en France. Compte-Rendu du Trente-Neuvième Congress, June 1912. *Paris, 1912.*

——— ——— Compte Rendu de l'Assemblée Générale du June 9, 1916. Rapport de Gestion du Comité pour l'exercice 1915. Rapport des Travaux du Comité du 1 Juillet au 31 Mai 1916. *Paris, 1916.* Gift of George G. Ramsdell.

Spokane Public Library. Annual Report, 1916. *Spokane, 1916.* Gift of Spokane Public Library.

Text-Book of the Materials of Engineering. By Herbert F. Moore. McGraw-Hill Book Co., Inc., *New York, 1917.* Cloth, 6 x 9 in., 204 pp., 70 figs. $2. Gift of the publisher.

A Text-Book on Roofs and Bridges; Part II, Graphic Statics. By Mansfield Merriman and Henry S. Jacoby. 4th ed., revised and enlarged. John Wiley & Sons, Inc., *New York, 1917.* Cloth, 6 x 9 in., 291 pp., 162 figs. $2.50. Gift of the publisher.

Theory and Calculations of Electrical Apparatus. By Charles Proteus Steinmetz. McGraw-Hill Book Co., Inc., *New York, 1917.* Cloth, 6 x 9 in., 480 pp., 227 figs. $4. Gift of the publisher.

Timber Framing. By Henry D. Dewell. Dewey Publishing Co., *San Francisco, 1917.* Cloth, 6 x 9 in., 275 pp., 112 figs. $2. Gift of the *Mining and Scientific Press.*

U. S. Navy Department. General Specifications for Inspection of Material. *Washington, 1917.* Gift of U. S. Bureau of Steam Engineering.

Utilization of Pyrite Occurring in Illinois Bituminous Coal. University of Illinois Bulletin, vol. 14, no. 51, August 20, 1917. By E. A. Holbrook. University of Illinois, *Urbana, 1917.* Paper, 6 x 9 in., 46 pp., 14 figs. $0.20. Gift of the publisher.

Wet Thiogen Process for Recovering Sulphur from Sulphur Dioxide in Smelter Gases. A critical study. (U. S. Bureau of Mines. Bulletin 133.) *Washington, 1917.* Purchase.

What a Geologist Can Do in War. Prepared by R. A. F. Penrose, Jr., for the Geological Committee of the National Research Council. J. B. Lippincott Co., *Philadelphia, 1917.* Cloth, 4 x 6 in., 28 pp. Gift of the author.

Gift of the Chilean Nitrate Commission

Foods for Plants. Ed. 11. New York, n. d.
Nitrate Industry. By Señor Enrique Cuevas.
Views of the Chilean Nitrate Works and Ports.

A. S. M. E. Accessions

Carnegie Endowment for International Peace. Year Book 1917. *Washington, 1917.* Gift of S. N. D. North.

Cincinnati, Ohio, Water Works Department. Annual Report 1916. *Cincinnati, 1917.* Gift of Water Works Department.

Engineers' Society of Milwaukee. Final Report on Milwaukee River Investigation. Aug. 1, 1917.

Laboratory Course of Practical Electricity. By M. J. Archbold. Macmillan Co., *New York, 1916.*

Measurement of the Human Factor in Industry. By Frank B. and Lillian M. Gilbreth. Presented at the National Conference of the Western Efficiency Society, May 22-25, 1917.

New Jersey. Board of Public Utility Commissioners. Statistics of Public Utilities, 1915. *Union Hill, N. J., 1917.* Gift of New Jersey Board of Public Utilities.

Theoretical Depreciation. A discussion of the subject with an analysis of a paper by Dr. Weber, Statistician of the Public Service Commission for the First District, State of New York, entitled "Accounting for Depreciation," presented for the consideration of the Public Service Commission by the Consolidated Gas Co., of New York, St. Louis, N. d. Gift of James E. Allison.

"The Times," What the Course of, Shall Be. Letter of Gen. Otis to Mr. and Mrs. Chandler—their statement.

TRADE CATALOGUES

Link Belt Company, Chicago, Ill.
Book No. 246. Electric Hoists.
Book No. 342. Casings and Lubrication for Link Belt silent chain drives.

The Francke Company, New Brunswick, N. J.
Bulletin No. 23. Flexible Couplings. *Jan. 1917.*

Union Iron Works, Erie, Pa.
Water Tube Boilers. Descriptive pamphlet.

McEwen Brothers, Wellsville, N. Y.
Bulletin on High-Compression Oil Engines, 16 pp.

PERSONALS

IN these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by November 10 in order to appear in the December issue.

CHANGES OF POSITION

B. DENVER COPPAGE has resigned as chief engineer of The Pusey and Jones Company, Wilmington, Del., and is now experimental engineer on the staff of E. I. du Pont de Nemours and Company, of the same city.

CHENOWETH HOUSUM has left the employ of the Allis-Chalmers Manufacturing Company, Milwaukee, Wis., to enter the Government service on certain special development work.

JOAQUIN R. MASFERRER has resigned his position with the South Porto Rico Sugar Company, as assistant steam engineer of their electric plant at the Guanica Centrale, and has accepted the position of assistant mechanical engineer with the Haytian American Sugar Corporation, of Port-au-Prince, Hayti.

RAYMOND T. BELL, formerly engineer of tools and methods, Wahl Adding Machine Company, Chicago, Ill., has become identified with the Teetor Adding Machine Company, Des Moines, Iowa.

HAROLD A. RICHMOND, president of the American Emery Wheel Works, Providence, R. I., has become associated with the General Abrasive Company, Inc., Niagara Falls, N. Y.

PAUL D. HAWKINS has become affiliated with Lybrand Ross Brothers and Montgomery, New York. He was, until recently, connected with the Newton Gas and Electric Company, Newton, N. J.

JULIUS G. BERGER, industrial power engineer, Public Service Corporation, Trenton, N. J., has assumed the duties of chief engineer of the William Gordon Corporation, Philadelphia, Pa.

JACOB GINSBURG, formerly associated with the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., has accepted the position of mechanical engineer with the Lehigh Portland Cement Company, Iola, Kan.

CLAYTON A. HOOVER, formerly accountant and auditor with the Southwark Foundry and Machine Company, Philadelphia, Pa., has entered the employ of the Vim Motor Truck Company, of the same city, in the capacity of treasurer.

DANIEL T. MACLEOD, president of the Hamilton By-Products Company, New York, has assumed the position of vice-president of the Elkhorn Piney Coal Mining Company, Milwaukee, Wis.

ARTHUR F. CARY has accepted the position of mechanical engineer with the Stanley Motor Carriage Company, Newton, Mass. He was, until recently, superintendent of trade school of the Massachusetts Reformatory, Watertown, Mass.

BENJAMIN G. DENLINGER, formerly mechanical foreman of the Astoria Light, Heat and Power Company, Long Island City, N. Y., has entered the service of the Keller Mechanical Engraving Company, Brooklyn, N. Y.

FREDERICK R. SHANLEY, efficiency engineer with L. V. Estes, Inc., Chicago, Ill., has become identified with the Northwestern Knitting Company, Minneapolis, Minn.

FREDERICK J. BRENGEL, assistant superintendent, manufacturing department of the Safety Car Heating and Lighting Company, Jersey City, N. J., has assumed the position of superintendent of the Bailey Meter Company, Boston, Mass.

A. F. VAN DEINSE, until recently associated with the Springfield Gas and Electric Company, Springfield, Mo., in the capacity of general manager, has become affiliated with the Federal Light and Traction Company, New York.

HERBERT L. WHITTEMORE has resigned from the associate professorship of mechanics at the University of Oklahoma, Norman, Okla., and accepted a position with the Bureau of Standards, Washington, D. C.

P. J. BELL has resigned his position as manager of the San Carlos Milling Company, Ltd., effective July 1, and has accepted a position with Welch, Fairchild and Company, Inc., of Manila, P. I.

JOHN R. DUPRIEST, formerly head of the mechanical engineering department of the University of Idaho, Moscow, Idaho, has become professor of steam and gas engine design at Rensselaer Polytechnic Institute, Troy, N. Y.

CHARLES G. ROBINSON, formerly engineer with the Wheeling Steel Casting Company, Wheeling, W. Va., has assumed the duties of president of The Ohio Mold and Foundry Company, Cincinnati, Ohio.

IRA DYE, until recently erecting engineer with Henry R. Worthington, Harrison, N. J., has been appointed night superintendent of the Weir Frog Company's plant at East Norwood, Ohio.

J. E. GIBSON has accepted the position of manager of the water department under the Commissioners of Public Works, Charleston, S. C. He was formerly connected with the American Pipe and Construction Company, Philadelphia, Pa., in the capacity of principal assistant engineer.

DONALD B. PRENTICE, instructor of mechanical engineering, Sheffield Scientific School, Yale University, New Haven, Conn., has accepted the position of assistant professor of mechanical engineering at Lafayette College, Easton, Pa.

CHARLES A. HAYNES has resigned his position as superintendent of Unger Brothers, of Newark, N. J., to accept a similar position with the Mohegan Tube Works, Brooklyn, N. Y.

WILLIAM N. STEVENS, formerly identified with the Cincinnati Milling Company, has entered the service of the Gisholt Machine Company, Madison, Wis.

ARTHUR H. AAGAARD, formerly instructor of steam and gas engineering, College of Mechanics and Engineering, University of Wisconsin, Madison, Wis., has accepted a position at Rice Institute, Houston, Tex.

ROBERT M. MATTHEW, until recently connected with the Ohio Tool Company, Charleston, W. Va., in the capacity of machine-shop foreman, has assumed the position of assistant superintendent of the Whitaker Manufacturing Company, of Chicago, Ill.

CHARLES MAAK, until recently in the employ of the Metals Production Equipment Company, Springfield, Mass., as assistant chief engineer, has become affiliated with the Quigley Furnace Specialties Company, New York.

AUBREY I. BROWN has accepted the position of assistant professor of mechanical engineering, Pennsylvania State College, State College, Pa. He was formerly on the faculty of Ohio State University, Columbus, Ohio, as instructor of mechanical engineering.

MARK A. E[illegible], formerly head of the [illegible] inspection with the Bosch Magneto Company, Plainfield, N. J., is now connected with the United States Signal Corps, as inspector of [illegible] planes and aeroplane engines.

HENRY L. U[illegible], engineer of the [illegible] Consolidated Gas Company of New York, has [illegible] with the B[illegible] Hayward Company, [illegible], Md.

FRANK J. BA[illegible], formerly sales engineer with Manning, Maxwell and Moore, New York, has [illegible] assistant works manager of the Putnam Machine Company, Fitchburg, Mass.

A. C. TOWNSEND, who has been connected with the Green Fuel Economizer Company in various capacities for the past twelve years, has resigned his position as assistant to general manager and is now associated with H. R. G[illegible], sales agent for power-plant equipment and the Moore Steam Turbine Corporation.

FRANK A. BROWNE, formerly manager of the Iroquois Works of the Barber Asphalt Paving Company, Buffalo, N. Y., is now connected

with the [illegible] Shipping Board, Washington, D. C., in the capacity of general purchasing officer.

[illegible] I. Pettersen, formerly connected with De Camp and Sloan Manufacturing Company, Newark, N. J., has accepted a position in the engineering department of the Hopkins and Allen Arms Company, Norwich, Conn.

Earl L. Consoliver, formerly in the employ of the American Auto [illegible] College, Omaha, Neb., has accepted the position of instructor in mechanical drawing and machine design in the Extension Division of the University of Wisconsin, Madison, Wis.

Clifford P. Staudinger, formerly assistant designer for the A. S. Heinrich Corporation, has taken a position in the experimental department of the Curtiss Engineering Corporation.

Arthur S. Lewis has resigned his position as travelling mechanical engineer and eastern representative with the Chicago-Cleveland Car Roofing Company, New York, to join the sales force of Flint and Chester, Inc., New York. As assistant to the president, Mr. Lewis will have charge of sales to railroads and other large corporations.

Clyde H. McClintock has severed his connections with the Denver Tramway Company, Denver, Colo., and is now associated with the Trinidad Electric Transportation Railway and Gas Company, Trinidad, Col., as construction engineer.

R. F. Peters, until recently senior mechanical engineer, valuation division of the Interstate Commerce Commission, Kansas City, Mo., has become identified with the St. Louis-San Francisco Railway Company, Springfield, Mo., as mechanical engineer.

ANNOUNCEMENTS

Major Francis B. Longley has been detailed as engineer officer in charge of the engineering department of the Signal Corps Aviation School, San Diego, Cal.

Porter H. Adams, recently chief engineer of the Basle-Adams Engineering Company, Boston, Mass., is now in the naval service of the United States, stationed at Rockland, Me.

Robert P. Lay, formerly assistant inspection engineer with the Curtiss Aeroplane and Motor Corporation, Buffalo, N. Y., is now assistant engineer in the motor experimental division of the same company, located at the Churchill Street plant, Buffalo, in charge of the design of all new motors developed by the company.

James Brakes, Jr., has accepted a position as testing engineer for the Kimberly-Clark Company, Neenah, Wis.

C. W. E. Clarke has gone to France on Governmental work in connection with the war.

R. Sanford Riley, president of the Riley Stoker Company, Ltd., has been elected president of the Murphy Iron Works, and in order to take care of the increased volume of business in the Riley underfeed stokers, additional manufacturing facilities have been arranged at the Detroit plant of the latter company. There will be no change in its management or policy.

Samuel S. Williams has enlisted in the Signal Service of the United States Army and is stationed at Atlanta, Ga.

James Allentuch announces that his name has been legally changed to James Allen-Tuch.

Commander H. I. Cone, U. S. N., marine superintendent, Panama Canal, has been detached from the Panama service and is now stationed at Washington, D. C., in the Navy Department.

Harry T. Anderson has become identified with the Dusenberg Motors Corporation, Elizabeth, N. J.

Major W. B. Gregory, of New Orleans, La., Engineers Officers' Reserve Corps, is now with the American Expeditionary Forces in France, reporting direct to General Pershing.

Lee L. Walker has been commissioned First Lieutenant, Ordnance Officers' Reserve Corps, and has been assigned to active duty in the carriage division.

Victor Schleyer has become affiliated with the Lea Courtenay Company, Newark, N. J., in the capacity of chief engineer.

Melbert W. Taber has been transferred from the position of Detroit district manager of the Asbestos Protected Metal Company, to that of factory manager of the company's plant at Ambridge, Pa.

Francis M. Bond was commissioned a Captain in the Ordnance Officers' Reserve Corps on June 26, 1917, spending about two months at the Frankford Arsenal and about one month at the Rock Island Arsenal training for inspection of ordnance materials. At present, Captain Bond is detailed to the plant of the Wagner Electric Manufacturing Company, of St. Louis, Mo., as inspector of ordnance in charge of the inspection and acceptance of materials on contract for the War Department.

Thomas J. Love, assistant mechanical engineer with the Dodge Sales and Engineering Company, New York, has become resident representative of the same company, at Indianapolis, Ind.

G. G. Schmidt announces the opening of the fifth annual season of The New York School of Heating and Ventilating, World Building, New York, of which he is secretary.

Paul M. Chamberlain has received a commission as Major, Ordnance Section, Officers' Reserve Corps.

D. P. Gaillard has been commissioned as First Lieutenant, Ordnance Officers' Reserve Corps, and is at present assigned to Division T (Nitrate Division), office of the Chief of Ordnance, Washington, D. C.

Lyman H. Miller, assistant superintendent of the American Steel and Wire Company, New Haven, Conn., has recently been elected president of the New Haven Safety Local Council of the National Safety Council, for the year 1917-1918.

Dean E. Foster, associate professor of mechanical engineering, University of Missouri, Columbia, Mo., is at present on leave of absence and is employed by Cosden and Company, refiners, as mechanical engineer on the design and construction of their Tulsa, Okla., 44-million-dollar refinery.

Albert H. Gfröhrer has been commissioned as First Lieutenant, Officers' Reserve Corps, Ordnance Division, War Department, Washington, D. C.

John M. Toppin has resigned his position of general manager with the Rhodes Manufacturing Company, Hartford, Conn.

Major-General George W. Goethals has been elected president of the Wright-Martin Aircraft Corporation, whose main plant is located at New Brunswick, N. J.

Philip F. Miller has entered upon duty as First Lieutenant, U.S.R., in the Field Artillery Section of the Carriage Division of the Ordnance Department, Washington, D. C.

W. Dean Burton has resigned as mechanical engineer with the McKeen Motor Car Company, Omaha, Neb., to become associated with the U. S. Signal Service, Fort Omaha, Neb., in the capacity of aeronautical mechanical engineer.

A. B. Christen has been commissioned as First Lieutenant, Signal Corps, and will leave shortly for France.

Eugene L. Brown, Jr., has resigned his position with the Illinois Stoker Company, Alton, Ill., to accept a commission as First Lieutenant in the Engineer Officers' Reserve Corps.

Fred W. Brown has been commissioned as Captain in the Ordnance Section of the Officers' Reserve Corps.

Frank B. Gilbreth, consulting management engineer, of Providence, R. I., has been commissioned a Major in the Ordnance Department of the United States Army and is to have charge of some features of construction work of the railroad which the United States is to build in France.

Henry L. Doherty, president of the Doherty Operating Company, New York, is the subject of a biographical sketch in the October number of the *American Magazine*.

APPOINTMENTS

Arthur A. Misch, of Cleveland, O., has been appointed First Lieutenant in the Ordnance Department of the Officers' Reserve Corps.

Robert E. Jackson, formerly assistant superintendent of the Edison Laboratories, Orange, N. J., has been appointed superintendent of the laboratories, effective October 1.

George H. Shenberger has been appointed works and safety engineer for the Goulds Manufacturing Company, Seneca Falls, N. Y.

Christian Girl, president of the Standard Parts Company, Cleveland, O., has been appointed by the Government to supervise the construction of the 40,000 Liberty trucks that are to be built for the War Department. He will remain at the head of the Standard Parts Company, but has been given a leave of absence in order to devote his time to Government service.

William A. Blackburn has been appointed manager of manufacturing at the Cadillac Motor Car Company, of Detroit, Mich., superseding George H. Layng, who has recently become associated with the Lincoln Manufacturing Company, of Detroit, Mich. Mr. Blackburn was formerly connected with the Cadillac Motor Car Company in the capacity of general foreman.

Walter D. Fuller has been appointed secretary of The Curtis Publishing Company, Philadelphia, Pa. He was formerly comptroller of the same company.

George E. Pellissier, consulting engineer of Springfield, Mass., has been appointed assistant general manager of the Holyoke, Mass., Street Railway.

AUTHORS

Allen F. Brewer is the author of an article bearing on Overhead Charges as Applied to Appraisal Reports, published in *Industrial Management* for September, 1917.

H. L. Gantt presented a paper on the Economic Position of the Engineer before the October 22 meeting of the Engineers' Club of Trenton.

John T. Faig addressed the Engineers' Club of Dayton, October 2, on The Economical Use of Coal by Communities.

C. E. Knoeppel, of New York, addressed the October 10 meeting of the New England Foundrymen's Association, Boston, Mass., on The Importance of Foundry Costs.

C. B. Auel has contributed an article on the Utilization of Factory Wastes to the October issue of *Industrial Management*.

Richard H. Rice is the author of The Large Turbo-Generator which appears in the October number of the *General Electric Review*.

Dexter S. Kimball has contributed an article entitled Labor-Maintenance Service as a Factor in Management, to the October issue of *Industrial Management*.

J. W. Ledoux has contributed an article on Purposes Which Should Govern Water-Works Valuations to the October 4 issue of *Engineering News-Record*.

John Hunter is the author of an article on New Boilers for Ashley Street Station which is published in the October 9 issue of *Power*.

C. B. Lord is the author of Athletics for the Working Force, which appears in the October issue of *Industrial Management*.

Roy H. Smith has contributed an article on the Cold-Heading of Wire to the October number of *Machinery*.

Holden A. Evans has contributed an article on Eliminating Unproductive Time to the October issue of *Industrial Management*.

THE NEW BOOKS

ALL books received by The Journal will be listed under this heading, generally accompanied by brief descriptive notes. Works of special importance to mechanical engineers will be commented on at length by members and others peculiarly qualified by reason of their experience and training.

Steam Turbines

Steam Turbines. By Wm. J. Goudie, M.I.M.E., M.I.E.S., Scotland, Reader in Theory and Practice of Heat Engines, University of London. Longmans, Green & Co., New York, 1917. Cloth, 6x9 in., x+519 pp., 230 illustrations. $4.

As stated in the author's preface, the book is primarily designed for the use of engineering students, but from the extensive analyses and the quantity of advanced data and methods of calculation it contains, it will be of considerable use to designing engineers. It will also be very suitable for students and from this point of view is much better for classroom use than Stodola, which is altogether too heavy for anybody but experienced designers, very cumbersome in the classroom and without examples, although it has been considered the standard reference work for many years. Compared with other books now on the market, it will fill a much needed place, in that it is less informal and somewhat more convenient in its treatment than Martin's book and much more thorough in detail than Roe's or Thomas's works on the subject. These latter two books, however, were only intended for classroom use, the former for short courses, such, for instance, as two hours' lecture work a week for a class of senior students covering the course in one term.

The arrangement of the chapters is somewhat unusual. Immediately after the first chapter, Classification of Steam Turbines, follows the description of commercial types. The usual arrangement is to discuss the design of the turbine, as given in Chapters 7 to 15, and then consider the commercial types as examples of the procedure. It seems as if the usual practice were more desirable; what was probably in the author's mind was to teach the student what the commercial types were, using his memory faculty first, following it with the analyses of the commercial types, and using his reasoning faculty after he had become familiar with what the turbine is. However, the writer has found it better, in general, to exercise the memory faculty of the second- or third-year student by general descriptive courses of power machinery, and to handle the design of steam turbines only with fourth-year students, which would render the usual arrangement of design material first and descriptive material afterwards a better one.

In Chapter 7 the material on supersaturated steam is the first that the reviewer has seen which properly elaborates this subject. Information on this peculiar phenomenon has been very scarce. Chapter 10 on mechanical losses and their prevention is also very well worked out and gives some interesting diagrams in connection with the formulæ. Chapters 13, 14 and 15, on the provisional determination of general proportions, help to emphasize the important point in turbine design, namely, that the complete design is practically never worked out at the first trial. Each adjustment of any single dimension in the nozzles and blading affects so many other variables, which in turn react upon the first, that the computations must be completely revamped in order to make the necessary and complete corrections. With the exception of Martin's book, practically no other text has called sufficient attention to this feature.

The description of the Ljungström turbine in Chapter 3 and the design in Chapter 15 are the first published material that the writer has seen fully covering this interesting and novel type of machine. It is to be remembered in working out turbine designs that the number of examples is usually less than in textbooks generally, on account of the length of

[illegible] class of fourth year [illegible] one year, three hours' lecture [illegible], it was found [illegible] the impulse or reaction [illegible]. Most of the examples in this [illegible] nozzle, bucket, or complete [illegible] only. This is very desirable from a practical point of view.

Naturally, a good deal of the material is worked up from previous books on the subject, but there is quite a little new matter, particularly in the sections on provisional design. [illegible] book is the one which it resembles the most, but it carries the design more logically to its conclusion. It covers the field about as completely as any turbine book which has been published up to the present time, and should be a very valuable addition to any engineer's library.

R. J. S. PIGOTT.

Mechanical Equipment of Buildings. Vol. II, Power Plants and Refrigeration. By Louis Allen Harding, B.S., M.E., and Arthur Cutts Willard, S.B. John Wiley & Sons, Inc., New York, 1917. First Edition. Flexible binding, 7x9¼ in., 766 pp., profusely illustrated. $5 net.

An almost ideal book for the mechanical engineer for use as reference is the work under consideration. It cannot be considered an entirely original book, but it is made up of a collection of valuable data that are badly needed and ordinarily hard to find. The information contained is also well assembled and indexed.

To the designing engineer the book is almost indispensable. To the power-plant engineer it is also of great value, and the refrigerating engineer, even if the refrigeration section is somewhat limited, will find that the remainder of the contents on steam-power plant proper is well adapted to his uses.

The first chapter is devoted to physical units and heat, and is valuable especially to the student. This is followed by a section on water, steam and air, dealing with formulæ for measurement, designing of piping, and with the fundamental laws of hydraulics, thermodynamics and pneumatics.

Chapter III takes up fuels and combustion, giving valuable information in small space and including tables of analyses and heating values of various fuels, and also an analysis of fuels and flue gases. The rather complete chapter on boilers and rules for construction which follows contains a number of valuable tables of detail dimensions of various standard boilers, in addition to construction formulæ, and is well supplemented with illustrations and explanations. Following this is a short chapter dealing with mechanical stokers that could well be somewhat more complete.

The next chapter is on superheaters and economizers, giving also manufacturers' tables of tests on performance under various conditions. The part devoted to superheaters is very short, thus throwing the book somewhat out of balance.

The section devoted to the theory, design and construction of chimneys for power boilers is interesting and complete in outline. It not only includes the methods of determining the proper dimensions of breechings and stacks, but also construction data of steel, brick and concrete chimneys, and a complete set of specifications. It is followed by a number of pages on mechanical draft, including tables and curves of forced-draft fan performance, and a chapter on feedwater heaters and purifiers, also a collection of data on feedwater treatment.

The space devoted to steam engines and steam turbines is almost a book by itself, well filled with data in a concentrated form. The chapter on pumps is also an extensive one, and contains some novel information.

The next eighty pages cover quite well the steam condenser and cooling ponds and towers, giving results of tests under various conditions. These data are entirely conservative, and most of them, as throughout the book, have been obtained from responsible manufacturers. A psychrometric chart and tables are also included.

The chapters on pipe fittings, valves, coverings and accessories and power-plant piping are well filled with selected data, and embody specifications for piping under various steam pressures.

The section on the arrangement of steam-power plants is well illustrated with plan and cross-sectional views of representative power plants, and is followed by data on coal- and ash-handling machinery well adapted for medium- and large-size plants.

The cost of steam- and gas-power equipment is treated in a separate chapter containing complete lists of power-plant equipment adapted for small and large plants, together with equations for determining the costs of various sizes.

The information on isolated plants is very valuable to the operating engineers of hotels and other large buildings, also to the electric or heating-plant central-station engineering departments.

The remainder of the book is devoted to refrigeration, but the information given, while very valuable, is not entirely of a novel nature. Illustrations on the construction of cold-storage walls are shown, followed by considerable matter on the heat transmission of piping, Goodenough's tables on saturated and superheated ammonia, and a number of well-arranged pages on the ammonia condenser.

Very interesting and practical material is included in the chapter on the absorption machine, and the subject is treated in an entirely new way. The valuable tables of the York Mfg. Co. and a number of other ice-machinery manufacturers are included.

The book, as a whole, presents well-assembled and properly condensed information in a readily accessible form. The examples found in the various chapters are also of value in helping the engineer to follow easily the calculations of various problems.

VICTOR J. AZBE.

Military Preparedness and the Engineer. A Handbook for the Civilian Engineer. By Ernest F. Robinson, Assoc. M. Am.Soc.C.E., Captain, New York Corps of Engineers, National Guard. Clark Book Co., New York, 1917. Second Edition. Cloth, 4½ x 6½ in., 361 pp., 132 illustrations. $2 net.

This book has been written for the information of civilian engineers desirous of serving their country in the field in time of war, and the author has aimed to present to such men as accurate an idea as possible of the salient points of military engineering. The publication is based on a series of lectures delivered before prominent engineering societies during the past two years, and in the present edition has been brought down to date by the inclusion of new material from many different sources. Much relating to field fortifications has been obtained directly from participants in the European struggle, and is descriptive of types now in actual use. Contents: How to Obtain a Military Training; The National Guard; Military Organization; Military Administration; Engineer Troops in the Field; Fire Action; Field Fortifications; Obstacles; Siege Works; Demolitions; Military Bridges; Topographical Sketching; Wire Entanglements; Organization of Captured Positions; Engineers in Field Service; Sanitation; Equipment Data.

The Thirty-Eighth Annual Meeting of The American Society of Mechanical Engineers will be held in the Engineering Societies Building, New York, December 4 to 7. The program of the meeting, giving details of professional sessions, committee meetings, sections conferences, titles of addresses, titles and authors of papers, etc., is given on pages 1004 and 1005.

Publication of the papers was commenced in the October issue and has been continued in the successive issues; publication in The Journal is in comprehensive abstract form and simultaneously the papers are being printed in extenso in pamphlet form and copies may be obtained gratis by members on request. Contributed discussion of the Annual Meeting papers is solicited and will be presented at the meeting and subsequently published in The Journal. A full account of the Annual Meeting will be presented in the January Issue.

THE COOLING OF WATER FOR POWER-PLANT PURPOSES

By C. C. THOMAS, BALTIMORE, MD.

Member of the Society

THE purpose of the work here described was to ascertain the conditions governing the cooling of water by means of spray ponds. This involved determining the efficiency of the cooling process under varying conditions of pressure at the spray nozzles, the temperature of water to be cooled, the power applied to the pumps, the height of sprays above the pond, etc. The work has resulted in a large collection of data, part of which is presented here, and also in the development of the new form of spraying device described.

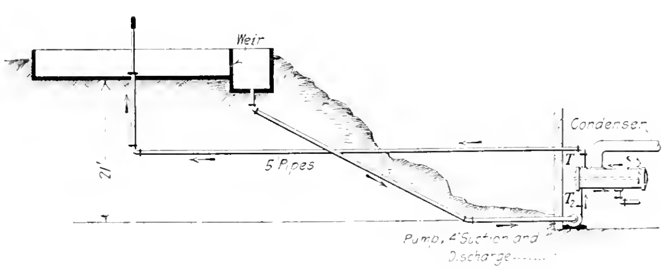


Fig. 1 Cooling System Used in the Experiments

EXPERIMENTAL WORK

The experiments were made on the pond shown in Fig. 1, which is part of the power plant and laboratory equipment of The Johns Hopkins University, Department of Engineering. The pond is 35 ft. in diameter and 4 ft. deep and was designed with special reference to experimental work, as well as to cool the condensing water for a 50-kw. Buckeyemobile fitted with a surface condenser. The water is ordinarily sprayed through one spray head, or nozzle, of the new type described in this paper, but some of the tests were made with nozzles of other types. A motor-driven centrifugal pump with 4-in. suction and discharge sends the water through the condenser tubes and to the spray head, as shown in Fig. 1.

The pressure at the spray head or other type of nozzle was in all cases measured by a mercury column connected to the entrance of the spraying device, and the recorded pressures are for that point. Wind velocity was measured by a standard anemometer, and the humidity by a wet-and-dry-bulb sling psychrometer. The amount of water circulated was measured by a 10-in. weir fitted with a micrometer hook gage.

About six hundred tests have been made, mostly with the new type of spray head shown in Figs. 2, 3, and 4, but tests Nos. 11 to 18, 86 to 91, and many others not reported here, were made with three sizes (3-in., 2-in., and 1-in.) of nozzle having spiral cores, as shown in Fig. 5. Data representative of the tests are given in an appendix.

It was desired to ascertain, among other things, the effect of placing a wire fly-screen cylinder about the spray head, and many of the tests were so made, as shown in the appendix.

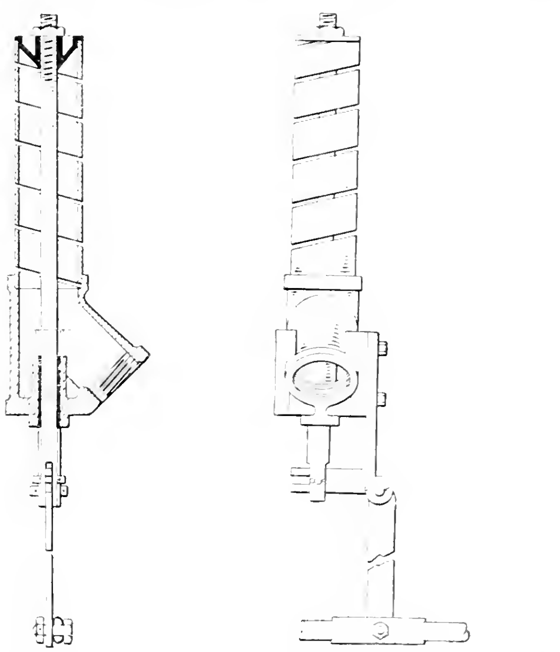


Fig. 2 Thomas Adjustable Spray Head, Closed and Open

THE AUTHOR'S ADJUSTABLE SPRAY HEAD

The adjustable spray head is shown in Figs. 2 and 3. It consists of a cast-iron supporting base containing the water-entry opening and carrying a $3\frac{1}{4}$-in. outside-diameter bronze tube in which is cut a spiral opening of coarse pitch. This opening is cut with a tool placed at an angle of about 60 deg. with the axis of the tube, so that the water is thrown upward at this angle. The spiral tube is held between the base and

For presentation at the Annual Meeting, December, 1917, of The American Society of Mechanical Engineers, 29 West 39th Street, New York. The paper is here printed in abstract form, and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

a cap which fits the top by means of a central bronze stem which passes down through a close-clearance bushing in the base. This stem is movable and is operated by a bell crank having an extended vertical arm giving accurate control of the position of the stem. The result of the motion is either to increase or decrease the fineness of the film of water as it leaves the spray head. When the head is in operation the water is discharged in a continuous sheet in a direction which

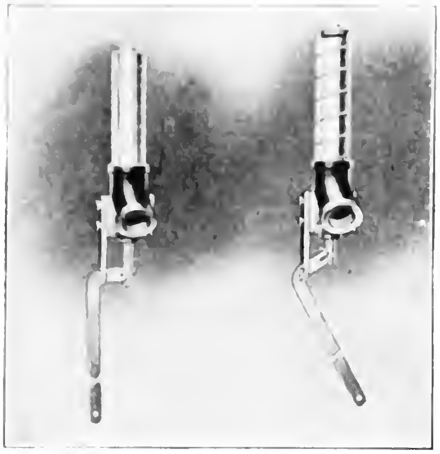


FIG. 3 SECTION AND ELEVATION OF THOMAS ADJUSTABLE SPRAY HEAD

is inclined upward, due to the angle of the spiral opening. As the water film spreads it becomes thinner, on account of its increasing diameter, until a point is reached where the surface tension is overcome and the sheet of water breaks into either a uniformly fine spray, a mist, or a large number of small drops, depending upon the size of opening to which the spray head has been adjusted. This principle of spraying a liquid as the result of the spreading of a film of water until it breaks into mist, or spray, or fine drops, is particularly applicable to low-pressure work, and it will be noticed that the pressures used in the experiments described are relatively low, being in general from 5 to 8 in. of mercury. A pressure of 10 in. gives an exceedingly fine spray, and in general 8 in. at the spray head is ample. Of course, the higher the pressure, the more extensive is the cooling, and this is true with all forms of nozzle.

EFFICIENCY OF COOLING PONDS AND TOWERS

The efficiency E of a cooling pond or tower may be expressed as the ratio between the cooling actually produced, $T_1 - T_2$, and that which would have resulted from cooling the water down to the dewpoint or wet-bulb temperature T_w. Thus,

$$E = \frac{T_1 - T_2}{T_1 - T_w}$$

T_1 and T_2 being the temperatures of the water before and after cooling, respectively. A perfect atomizing device would be one capable of subdividing the water so that evaporation would take place at T_w, and to an extent such as to lower the temperature of the remaining liquid spray to that temperature.

The curves in Figs. 6 and 7 show variation of efficiency of the adjustable spray head with variation of pressure and with variation of capacity, respectively, for three initial temperatures, namely, for $T_1 = 95$, 105 and 125 deg. fahr. These results were obtained by adjusting the spray head to suit the weather conditions existing at the time. From these curves the cross curves on Fig. 8 were drawn, for use in predicting the cooling range to be expected from a given set of conditions. This may be done as follows:

From these curves the efficiency to be expected for any given initial temperature T_1 and for any given pressure at the nozzle, may be found. If an initial temperature of water, T_1, and an average air temperature, T_a, and humidity be assumed for the locality of the cooling pond, the expected cooling range may be worked out. For example, if $T_1 = 115$ deg. and $T_a = 70$ deg. and if humidity $= 0.55$, then, from a humidity table, $T_a - T_w = 10$ deg. or $T_w = 70 - 10 = 60$ deg., and

$$T_1 - T_w = 115 - 60 = 55 \text{ deg.}$$

Let the pressure at the nozzle be 10 in. mercury. From the curves, the efficiency to be expected in cooling water from 115 deg. by spraying it with 10 in. mercury pressure at the nozzle is

$$\frac{T_1 - T_2}{T_1 - T_w} = 0.70$$

The cooling range will then be

$$T_1 - T_2 = 0.70\ (T_1 - T_w) = 0.70 \times 55 = 38.5 \text{ deg.}$$

FIG. 4 THOMAS ADJUSTABLE SPRAY HEAD IN OPERATION

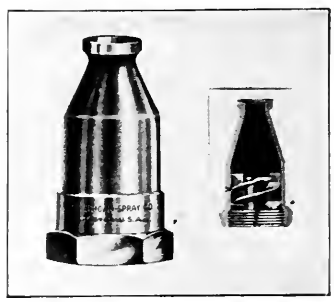


FIG. 5 NON-ADJUSTABLE NOZZLE WITH SPIRAL CORE

It is of interest to observe the wide variation of efficiency shown in Fig. 9 which takes place during a long period of operation when no attempt is made to adjust the spray head so as to obtain uniformly good results. The tests yielding these points cover about a year. The heavy black circles indicate results from the non-adjustable nozzles, while the others refer to the adjustable spray head when operated under widely varying weather conditions, pressures, and temperatures of water, without any attempt to obtain high efficiency. It will be noticed that with the non-adjustable nozzles, such as shown in Fig. 5, the pressures used are high and capacities very low as compared with those for the adjustable spray head.

Fig. 10 shows for a few related tests the variation of cooling range, $T_1 - T_2$, with pressure at the spray head.

A curve was obtained showing better efficiencies with the

water falling upon the bare cement bottom as compared with those resulting when the pond contained its normal amount of water. These results are rather surprising, and it is hoped that further tests may be made to confirm or to controvert them. If a bare pond would serve as well as one containing water, the construction of the pond could be cheapened, since less weight would come upon the foundation and less material would be required for the pond as a whole.

FACTORS INVOLVED IN THE PROBLEM OF COOLING WATER

The loss due to evaporation during a period of eight days is shown in Table 1. These data are not yet complete, but the average evaporation may probably be taken as about 2.25 per cent. This will, of course, vary with weather conditions, initial temperature of water, pressure at the nozzle, and with humidity. A large number of tests made with water at high

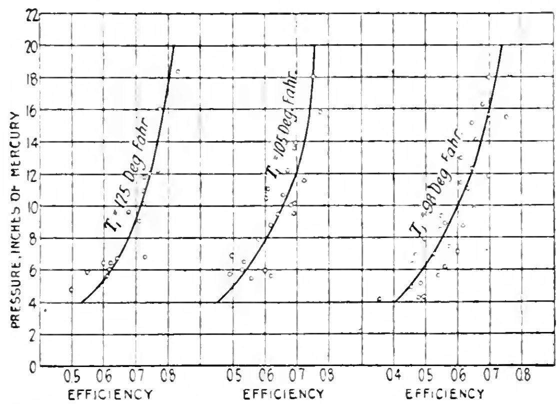


FIG. 6 VARIATION OF EFFICIENCY OF ADJUSTABLE SPRAY HEAD WITH VARIATION OF WATER PRESSURE

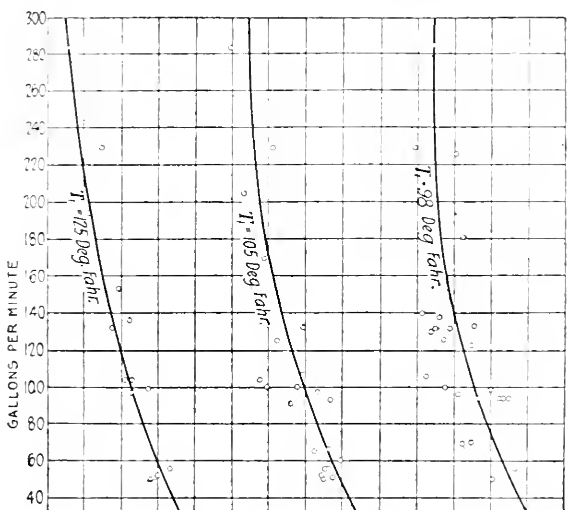


FIG. 7 VARIATION OF EFFICIENCY OF ADJUSTABLE SPRAY HEAD WITH VARIATION OF CAPACITY

and low initial temperatures indicate that 2 to 2.5 per cent per hour represents fairly well the average loss of water, but that it may be as low as 0.30 per cent, and in windy weather as high as 10 or 15 per cent with non-adjustable nozzles.

Extended observations on a pond at Sparrow's Point, Md., for cooling gas-engine-jacket water show the average loss in 24 hours to be 6 in. depth of water. The pond is 60 ft. x 40 ft. and the water circulated amounts to 2000 g.p.m. The loss is therefore about 0.31 per cent per hour.

The upper left hand point in Fig. 11 was obtained from tests on this pond.

The power required to circulate the water is shown in Fig. 12, as watts per gallon per minute per degree of cooling, from varying initial temperatures. In order to test the accuracy of this curve, experiments were made on the pond at Spar-

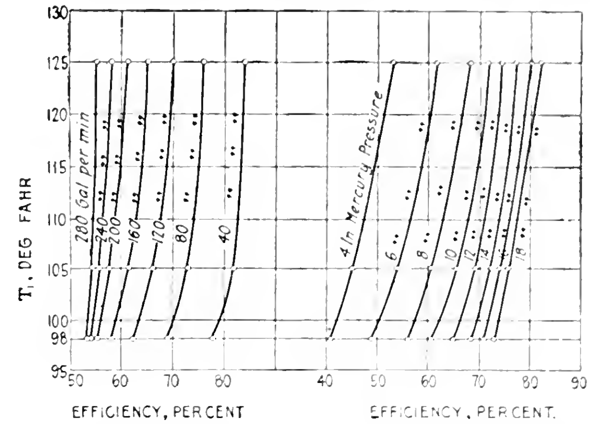


FIG. 8 CURVES FOR PREDICTING COOLING RANGE TO BE EXPECTED FROM A GIVEN SET OF CONDITIONS

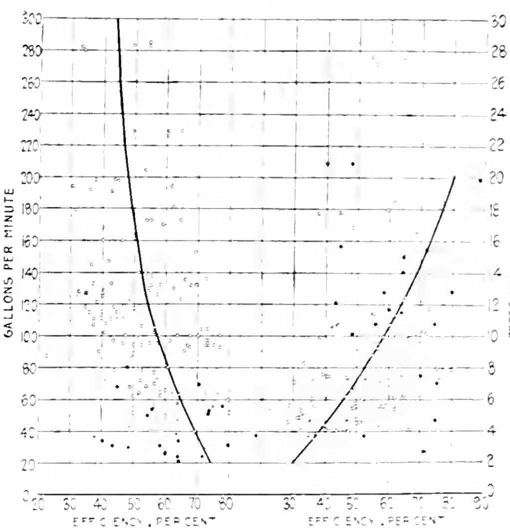


FIG. 9 CURVES SHOWING WIDE VARIATION OF EFFICIENCY WHEN PROPER ADJUSTMENT OF SPRAY HEAD IS NEGLECTED

(Black circles indicate results from non-controlled nozzles)

row's Point, which is equipped with two sets of nozzles, either of which may be used. One set consists of 42 non-adjustable, spiral-core nozzles, and the other set of 12 of the adjustable spray heads described in this paper. The power required with the adjustable spray heads at Sparrow's Point is shown by the point so marked in Fig. 11, the other points being from the Johns Hopkins pond. From this curve the power required to circulate the water in a given case can be estimated, to cover specified temperature and capacity. The power appears to be practically independent of the type of spraying device used. The average power required to drive the pump may be calculated from the following equation representing the curve drawn through the experimentally determined points in Fig. 11:

$$P = \left(\frac{100}{T_1}\right)^{3.25}$$

[illegible] power of the pump motor in watts per gallon per minute per degree Fahrenheit of cooling, and T = initial temperature of the water to be cooled, deg. fahr. (not absolute temperature). The cooling seems to be principally dependent upon the energy put into forcing the water through some suitable [illegible], and given the requisite energy a great variety of forms of nozzle would yield about equally good results. The operating advantages of the adjustable spray head and its large capacity greatly facilitate keeping the heads clean without shutting down to clean them. It also permits

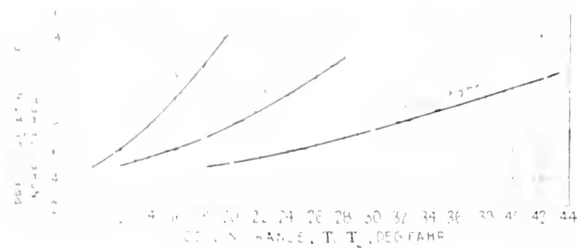


FIG. 10 VARIATION OF COOLING RANGE, $T_1 - T_2$, WITH VARIATION OF PRESSURE AT THE SPRAY HEAD

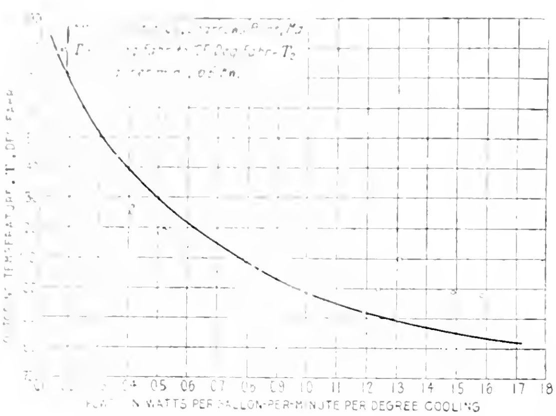


FIG. 11 POWER REQUIRED TO CIRCULATE WATER IN COOLING SYSTEM FROM VARIOUS INITIAL TEMPERATURES

regulation of the spray to suit weather conditions and to minimize loss of water and inconvenience to the nearby buildings due to driftage in windy weather. The amount and cost of piping are comparatively small for the adjustable spray head, since each one will handle from 150 to 250 gal. per min. In general, each adjustable spray head will handle the condensing water for a 50- to 75-kw. plant.

Curves are also shown in the complete paper of the effect of wind velocity upon the cooling range, the effect of spraying upon a series of superposed inclined cement plates, and of the cooling range as affected by the amount of water sprayed by a given adjustable spray head. The factor of height of spray nozzles above the surface of the pond is also considered.

It has been found to be very difficult to take account of all the variables involved in the problem of cooling water, and perhaps no one formula will cover the matter completely. It is hoped that further investigation will serve to define the [illegible] humidity and wind velocity and some of the other [illegible] that this paper may perhaps stimulate others [illegible] complete work than the writer has been able to [illegible].

CONCLUSION

[In his conclusion, the author considers other methods of cooling water, and compares the results with those obtained from spray ponds.

Fig. 12 shows a cooling pond equipped with adjustable spray heads for 2500 kw. capacity of turbines.]

The experimental pond shown in Fig. 1 was built in 1914 for the dual purpose of serving the University power plant and permitting investigation of the problems discussed in this paper. The writer has had much assistance from others, and is particularly indebted to Mr. W. J. Dana, Instructor in Mechanical Engineering, Johns Hopkins University, to Mr. John P. Powell, Superintendent of Gas Engines, Bethlehem Steel Company, Sparrow's Point, Md., and to the C. H. Wheeler Manufacturing Company, Philadelphia.

TABLE 1 TESTS WITH ADJUSTABLE SPRAY HEAD, AT LOW PRESSURE AND AT LOW INITIAL TEMPERATURES, TO ASCERTAIN LOSS OF WATER DUE TO EVAPORATION

Test number	1	2	3	4	5	6	7	8
Date, 1915	9-27	9-28	9-29	10-3	10-4	10-5	10-6	10-8
Duration of test, hours	6½	6½	4½	8	8	8	6	8
Hook-gage zero, ft.	1.422	1.422	1.422	1.422	1.422	1.422	1.411	1.411
Hook gage, first reading, ft	1.593	1.592	1.592	1.577	1.571	1.597	1.598	1.511
Hook gage, last reading, ft	1.567	1.570	1.582	1.571	1.552	1.584	1.545	1.481
Loss on hook gage, ft	0.028	0.022	0.010	0.006	0.019	0.013	0.053	0.030
Pressure at nozzle, in mercury	4.27	6.10	3.00	5.24	6.74	6.23	6.59	5.10
Temperature at inlet, T_1, deg. fahr	86.0	83.5	84.0	73.9	79.6	81.6	70.3	80.0
Temperature from pond, T_2, deg. fahr	80.4	77.8	78.0	70.6	73.6	74.3	64.6	70.2
Cooling range, $T_1 - T_2$, deg. fahr.	5.6	5.7	6.0	3.3	6.0	7.3	5.7	9.8
Dry-bulb temperature, T_d, deg. fahr.	75.8	75.7	76.0	69.6	75.2	73.1	59.4	63.5
Wet-bulb temperature, T_w, deg. fahr.	66.6	68.2	66.0	57.1	62.0	61.9	50.1	56.5
Depression, $T_d - T_w$, deg. fahr.	9.2	7.5	10.0	12.5	13.2	11.2	9.3	7.0
Humidity, per cent.	62	70	60	46	47	53	53	65
Loss of water,[1] per cent per hour	2.49	1.99	1.30	0.483	1.59	0.934	4.99	4.11

[1] Average loss of water (8 days), per cent per hour, 2.23.

The average efficiency for the 8 days covered by the above tests is 32½ per cent, and this will be seen to correspond with the 6-in. pressure curve (extended) in the T_1 and efficiency curves on Fig. 8. With such low initial temperatures and pressures this represents the efficiency and cooling range to be expected.

FIG. 12 COOLING POND WITH ADJUSTABLE SPRAY HEADS FOR STATION OF 2500 KW. CAPACITY

A COMMERCIAL ANALYSIS OF THE SMALL-TURBINE SITUATION

By W. J. A. LONDON, SPRINGFIELD, MASS.

Member of the Society

This paper is devoted to a commercial analysis of the four types of small steam turbines now on the market and used for the driving of auxiliary machinery, dealing principally with non-condensing units.

In these, high thermal efficiency is in many cases unnecessary on account of economic utilization of the exhaust steam, and as economy bears a definite relation to first cost, a highly efficient machine is often a mistaken investment. Moreover, operating conditions are generally such that the designer must sacrifice considerations of efficiency if they interfere in any measure with simplicity and durability.

The theoretical design, according to the author, presents no difficulties, but the mechanical design is what determines success or absolute failure; and some of the problems involved and the methods that have been employed in solving them successfully are indicated.

The average specification calls for very rigid guarantee as to steam consumption, speed regulation and load requirements that, in the opinion of the author, are in most cases unnecessarily severe and merely tend to increase the cost of installation. After an extended survey of the situation, he has been led to formulate a Code of Practice, given in an appendix to the paper. The adoption of this code would, he believes, bring about a reduction in selling prices, eliminate many of the unpleasant experiences which now often arise between manufacturers and customers, and thereby increase the popularity of the turbine-driven unit.

EIGHT years ago the Society was presented with a very valuable and complete paper,[1] by Mr. George A. Orrok, Mem.Am.Soc.M.E., on the small-turbine situation at that time. A great deal of further development has naturally taken place since then, changed operating conditions calling for considerable modifications in design. Increased competition, and a broader conception of the possibilities and limitations of various types, have resulted in a gradual elimination of certain principles of operation and a general trend toward the adoption of one common type.

We have seen during the last six or seven years a very marked tendency toward standardization of type in the larger machines. Practically every builder has resorted to the *composite* type, i.e., multi-velocity staging in the high-pressure element, and pressure staging at the low-pressure end. Even such a zealous advocate of the *pure* type as Parsons himself has now been converted to the advantages of this type, and is building the composite machine.

The same condition exists in the field of small machines, and it is interesting to review the various designs as mentioned by Mr. Orrok in 1909,[1] and to see which have survived the test of time and experience; and among the ones that have survived to note the modifications that have been made to suit present practice.

In the order given we find: (1) *De Laval,* (2) *Terry,* (3) *Sturtevant,* (4) *Bliss,* (5) *Dake,* (6) *Curtis,* (7) *Kerr,* (8) *Wilkinson.* These may be conveniently classed in general types as follows: (*a*) *De Laval;* (*b*) *Terry, Sturtevant* and *Bliss;* (*c*) *Dake;* (*d*) *Curtis;* (*e*) *Kerr;* (*f*) *Wilkinson.*

The Bliss, Dake and Wilkinson are either no longer on the market or are not seriously competitive; Sturtevant and Kerr still manufacture their original types only, with minor modifications; but De Laval and Terry have both recently developed machines on the Curtis principle. As these latter firms are two of the largest manufacturers of small turbines today, it would appear that there are sound reasons why they should depart from their original designs, and this fact is indicative of the general trend toward standardization mentioned above.

Since Mr. Orrok's paper, five new machines have appeared on the market. They are the Westinghouse; the Allis, Chalmers & Wait, reviving the Wilkinson principle as described by Mr. Orrok; the Lee, manufactured by the Witton Co. of New London, Conn., which is a modified Terry machine; the Alberger, an unmodified Curtis—in fact, manufactured under license from the General Electric Co., and hardly to be considered as a separate machine; the "Steam Motor," also a Curtis type, and the Moore, a modification of the Kerr machine. We have, therefore, at the present time the following types to consider: (1) The *Terry,* which includes the Sturtevant and Lee machines; (2) the *Westinghouse,* which includes the Allis, Chalmers and Wait machines; (3) the *Curtis,* which includes the machines manufactured by the G. E. Co., Terry, De Laval, Alberger, The Steam Motors Co., and Moore, and (4) the *Kerr* type, manufactured by the Kerr Turbine Co. and the Moore Co.

The machines in the first three groups employ velocity staging, and in small machines are, for the most part, single-stage, and will be considered as such for comparative purposes. Some of the designs are, of course, arranged for "staging," to improve the economy, but as this does not effect our considerations when comparing the relative merits of the general types, all machines in this class will be assumed to be of the single-stage type. The Kerr machine, primarily based on the pressure-staging principle, must be considered separately as a multi-stage machine.

As the title indicates, this paper is devoted to a purely commercial analysis of the various designs and the situation in general, and will deal particularly with non-condensing units. The thermodynamic features will be barely touched upon, except in cases where they have a direct bearing on the commercial aspect.

[1] Small Steam Turbines, George A. Orrok, Trans. Am.Soc.M.E., vol. 31 (1909), p. 263.

For presentation at the Annual Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York, December 4 to 7, 1917. The paper is here printed in abstract form, and advance copies of the complete paper may be obtained gratis upon application. All papers are subject to revision.

THREE ASPECTS OF THE SITUATION

There are three distinct aspects to this situation, namely:

(1) The type to be employed that will give the necessary competitive efficiency, with the lowest shop cost to the manufacturer, together with a design that will give satisfaction to the customer after installation.

(2) The aspect from the salesman's and customer's point of view. This governs the rating or maximum output of the machine, standardization of specifications, etc., as well as the proper appreciation of efficiency, with its relation to first cost. This latter phase is, perhaps, better explained by stating that in many instances water rate efficiency can be economically sacrificed in favor of first cost, and vice versa.

(3) The policy of the manufacturer who builds one part of the apparatus (such as the turbine) toward the manufacturer of the other (such as the pump), and their united policy toward the customer.

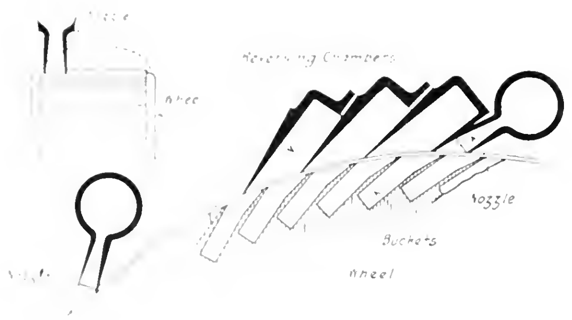


Fig. 1 Terry Type Turbine

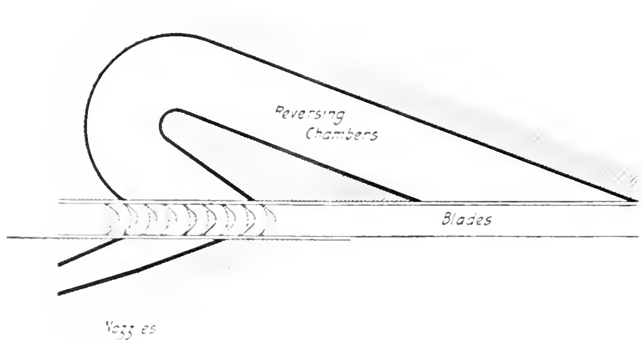


Fig. 2 Westinghouse Turbine

[The paper here enters into a detailed consideration of the three aspects. The introduction to the author's discussion of type for efficiency, being necessarily of a mathematical nature, is not abstracted here, but only his conclusions given. His treatment of the second and third aspects is here given practically in full.]

CONSIDERATION OF TYPE FOR EFFICIENCY

It is now generally acknowledged that from a design standpoint the small machine must be laid down on a totally different basis to the larger machines. The principal reasons for this are:

a High thermal efficiency is in a great many cases unnecessary on account of the economical utilization of exhaust steam; and as economy bears a definite relation to first cost, a highly efficient machine is often a mistaken investment.

b The class of labor employed in the average station to look after auxiliaries is very inferior to that employed on the main engine room floor. These machines, which are called upon for continuous operation, are often located in places where no other well-finished piece of machinery would be expected to run.[1] The designer must therefore consider simplicity and durability first, with as high an efficiency as possible; but he must sacrifice efficiency if in any measure it will interfere with the first essentials mentioned.

While the small-turbine auxiliary has all the appearance of a very elementary and simple engineering proposition, this is by no means the case, as any manufacturer knows; and problems equally complex with those confronting the designer of large machines have had to be solved, and a great many are by no means solved yet. We have only to consider the comparatively few firms that are competing in this line today with the number that have entered it, evidently tempted by the apparent simplicity and big profits, and finding out too late that it is a more difficult proposition than appears on the surface. The theoretical design, that is, the proportions of nozzles, blades, wheels, etc., presents no difficulties, but the *mechanical design* of such parts as the bearings, glands, governor, etc., is what determines success or absolute failure.

It is not within the province of this paper to go into these details any further than to point out in a general way some of the problems that have had to be solved. Among the more important of these are lubrication, packing and regulation.

Forced lubrication being impracticable in small machines for general-auxiliary purposes, the ring-oiled type has been called upon to operate with duties previously considered impossible, and to operate continuously with a bearing-box temperature in the neighborhood of 250 deg. fahr.

Glands or stuffing boxes are sometimes called upon to pack against a back pressure of 120 lb., while 20 and 30 lb. are common. It must be borne in mind that the soft-packing stuffing box as used in reciprocating machines is impracticable in turbine work on account of the high rubbing speeds.

The design of a satisfactory governor, the essential feature of which is simplicity, but, having a characteristic approaching the more elaborate types, has presented many difficulties; so has the governor valve, which must be as small as possible to minimize cutting at light loads, but must not crowd or stick when it is passing the maximum amount of steam required.

The above constitute the essential components governing details of the performance of the turbine itself, but there is one other and a vital factor to be considered, and one that comes directly within the present subject matter—the satisfactory performance of the whole unit. As in all other classes of machinery, certain mechanical troubles will always arise from time to time, but it is safe to say that today the general behavior of a turbine unit will compare very favorably with that of any other piece of apparatus in a power house. But to return to the more general considerations of the unit as a whole, there are some very important factors to be taken into account that are peculiar to this class of apparatus, and which have a direct bearing on the general design.

The most important of these is, of course, the necessity for true alignment. Where the unit is built in one shop the designer has a distinct advantage, inasmuch as he can so design

[1] Several cases are on record where machines have actually run for considerable periods under water without damage.

both ends of the apparatus as to make one rigid unit; but where the two ends of the unit are built by different parties it is a different proposition.

The average so-called flexible coupling will not satisfactorily take care of mis-alignment, the bedplate cannot be commercially designed that will stay true from test floor to foundations, so that no matter what care has been taken in the shops, a realignment after erection becomes an unfortunate necessity in even the smallest units. There is an extensive field for improvement in general design to eliminate this. Various schemes have been advanced recently resulting in a marked improvement in this direction, such as the 3-point support, and the 3-bearing unit with the elimination of the flexible coupling. The latter is practicable where one firm builds the whole unit, but otherwise up to the present it has not worked out very satisfactorily. The main reason for this is best explained in the case of electric-generator units. If the turbine maker takes away one of the generator bearings, in other words, disturbs the assembly of the complete generator as shipped from the manufacturer, he disclaims responsibility for anything that may happen to that part of the apparatus on the road.

In blower work the proposition is more practicable, but only when the unit is lined up by the turbine maker or one equally appreciative of the necessity of accurate workmanship.

To overcome this trouble, the Steam Motors Co. have recently placed on the market a design of machine as shown in Fig. 5. This machine is supplied with only one bearing and solid coupling for connecting to the driven apparatus. By taking a standard pump or blower and removing one bearing and fitting a solid coupling to the shaft, the combination of steam motor and pump becomes a 2-bearing unit, with a very much shorter bedplate and the elimination of any mis-alignment troubles.

In larger machines, one of the most pleasing in effect and at the same time most radical departures made in recent years to overcome the difficulties of mis-alignment, was the introduction by Mr. R. H. Rice, Mem.Am.Soc.M.E., of the General Electric Co., of the so-called rigid-frame design. From Fig. 6 it will be seen that the bedplate has been entirely eliminated, and the whole structure so designed that both ends are bound to stay in line irrespective of foundation conditions, so reducing the personal equation in erection to a minimum. In erecting this machine only one end is anchored, as shown in Fig. 6. The generator end is mounted on a sliding key, allowing free movement endwise, and on a narrow transverse foundation plate on which the generator can rock to compensate for any vertical movement of the turbine due to varying temperature. In effect, the machine rests on its foundations, as shown diagramatically in the figure.

THE SALESMAN'S AND CUSTOMER'S ASPECT

What might be called the truly commercial aspect of this situation, i.e., those phases of vital interest to the salesman and customer, presents many interesting problems. To begin with, we must forget that we are dealing with steam turbines in the sense that we have been accustomed to, when we have only been considering prime movers. For auxiliary purposes the small turbine is becoming the standard method of drive. That means that it is getting into the class of the electric motor. It has already passed the stage of being "built," and is now being successfully manufactured in quantity.

There is, however, still a great deal to be accomplished before the machine can be satisfactorily manufactured to be sold from stock. At first sight it might appear that this is almost out of the question, especially when we see such a diversity of specifications as accompany the average contracts for small turbines today, but when the number of these machines that are now being turned out at the present time and the fact that the market is increasing rapidly are considered, it is surely only a matter of time when some form of standardization will be absolutely necessary. In the electrical industry we have seen the wonderful advantages, both to the manufacturer and customer, of the rules laid down by standardization committees, and we wondered why we had not adopted them

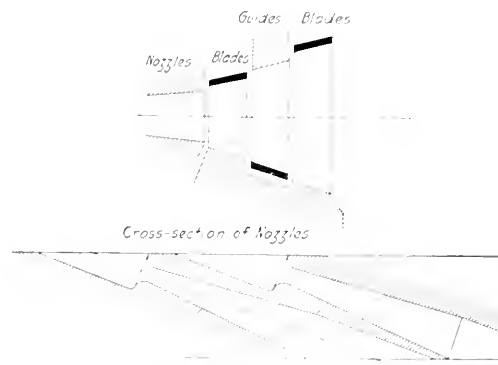


Fig. 3 Curtis Turbine

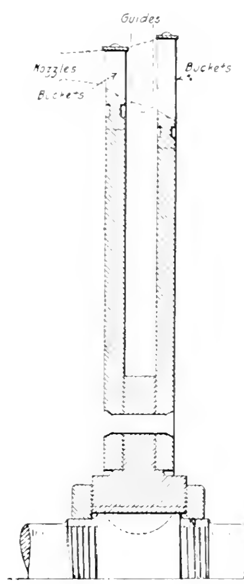


Fig. 4 Kerr Built-Up Wheel

sooner. Perhaps not to the same degree of perfection, but certainly to some extent a standardization of small-turbine specifications is not only possible but quite practicable. As long as the customer calls for something special and everybody is willing to build it, not only does this customer have to pay for it, but the standard machine will cost more on account of the interruption to the manufacturer in putting through lots.

Let us then consider where the possibilities lie in this direction, analyzing the various requirements of the average specification which call for rigid guarantees under the headings: (*a*) steam-consumption guarantees at certain loads with fixed or various steam conditions; (*b*) speed-regulation guarantees,

(c) when connected to electric generators voltage regulation [illegible], and (d) various load requirements and [illegible] steam and back pressure conditions. In addition there is a diversity of requirements as to fittings, such as [illegible] regulator, emergency governor, strainer, etc.

[illegible] (a), this is a much-debated point when discussing small turbines. Granted there was a time when the small turbine was wasteful of steam, that time has nevertheless passed and the builder of small turbines today meets any guarantee he makes, and at the very worst it is questionable whether a small turbine was ever built that consumed steam at a rate comparable with some direct-acting pumps. But there was never any serious criticism raised with such pumps on that score, nor was the manufacturer even asked for a guarantee. The consulting engineer or purchaser feels that he cannot possibly buy a steam turbine, no matter how small, unless he imposes numerous stringent guarantees as regards steam consumption. The fact that an auxiliary rarely operates under

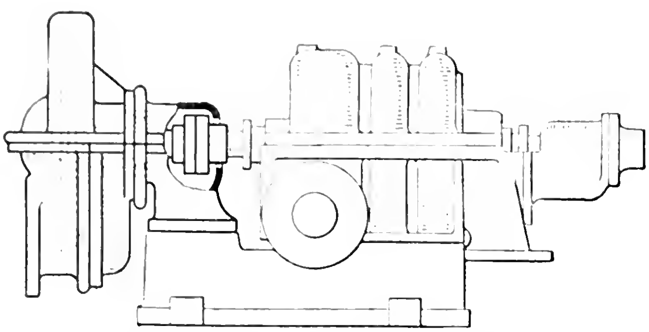


Fig. 5 Pump and Overhung Turbine

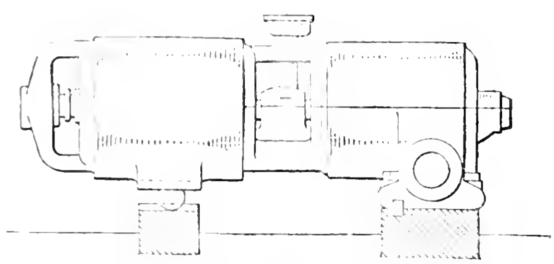


Fig. 6 Rigid-Frame Design Turbine and Pump

the steam conditions as specified, and therefore the guarantees as made bear but little relation to the actual performance, does not enter into his consideration at all.

When a manufacturer advances any argument relative to the unimportance of steam consumption, he is generally misunderstood. The customer feels he is trying to evade any responsibility along these lines and sell an inferior piece of machinery. Let us look at that from another standpoint. The manufacturer today builds one line of machines. There are so many cases where efficiency is of prime importance that the machine as built must be capable of meeting the guarantees as demanded by the market. Furthermore, any machine with a witness-test clause added on cannot be put through the shops independently, but must necessarily be one of a lot of identical machines. If this machine meets its guarantees on test, it is only fair to assume that the others [illegible]. In this connection, a concern which manufactures machines for the U. S. Government under specifications that are most rigid as regards performances on test, yet, with the possible exception of material inspection in some cases, these machines are standard in all respects.

Witness tests are costly. The manufacturer naturally cannot notify the customer exactly when a machine will be ready for the shop tests, and would not want him present then if he did, so that any delay in a busy shop awaiting the customer's convenience and a duplication of the tests must eventually be paid for directly or indirectly by the purchaser.

One more word on the absurd multiplicity of guarantees sometimes called for. It is no exception to find in some propositions, particularly from pump companies, a request for 15 or 20 guarantees under different conditions for a non-condensing machine where the exhaust is to be used in the feedwater heater.

Clause (*b*), speed-regulation guarantee, is necessarily of vital importance in such work as generator drive, but it surely is of no importance whatever when the speed of the turbine is primarily governed by a pressure regulator as in the case of a boiler-feed pump or forced-draft set controlled in a similar manner, yet the manufacturer has to religiously put in his 2 per cent clause.

Even with generator drive, the average clauses are too exacting for the good of the customers. Why need we specify a close speed variation when we already specify a certain variation in voltage? The compensated-wound generator can give flat compounding with a big speed variation, and a reasonably large speed variation means stable governing, whereas a sensitive governor means instability and a tendency to hunt. We have only to look at the average a-c. machine to realize how essential a reasonably wide speed variation is for satisfactory parallel operation.

Again, to obtain close speed variation on test means very delicate fitting and adjustment of the governor valve. The valve must shut absolutely tight, and any valve built this way is subject to cutting in service; whereas, if a wider speed variation had been permissible in the first instance, a more durable valve could have been installed.

Regarding (*c*) load requirements, there is a strong tendency to introduce the *maximum rated* standard into the small-turbine field, and common sense tells us that it is the only proper competitive basis; but is the adoption of this standard commercially practicable under existing conditions? As far as the turbine itself is concerned there is no argument, the output can be accurately estimated; but does the same degree of certainty exist among the pump and blower makers?

With the repeated changes in design, the limited testing facilities in the average pump-maker's plant and the almost impossible proposition of making accurate blower tests on a commercial basis, is it feasible at the present time to order a turbine without an overload margin to take care of errors that are not only excusable but are to be reasonably expected? Experience tells us that a certain leeway *is* necessary. The turbine maker knows this, and often finds that the addition of another jet, over and above that necessary to meet the contract, is a good investment. This principle is not right if we are to have fair competition among turbine makers; it is only natural that the pump maker will favor the type of machine that *he knows* will give him a good big overload. The worst feature of this situation is the fact that in some cases in a cut-price job the pump maker has *relied* on the overload capacity of the turbine to give full load at the pump.[1]

[1] A representative of a pump manufacturer was once frank enough to admit that a certain turbine firm always got the preference because it was more liberal with its overload capacities.

The adoption of the maximum-rating standard by *all* turbine makers and their rigid adherence to it would, in a great measure, solve this whole problem. Granted that allowances are necessary, they should all be made by the pump or blower maker, who should be the best judge as to the leeway advisable, and he should order his turbine accordingly.

The question as to whether the maximum rating will be satisfactory to the customer is another matter to be considered. With the customer educated to the limitations of the turbine there should be no difficulty; but as long as he thinks it can be loaded up to breaking-down point like a motor, there will be dissatisfaction if the machine fails to carry full load when the steam pressure drops. All that is necessary in this case is a clear understanding between the contractor and purchaser as to the conditions *necessary* to obtain full load.

It might be well to bring out here an important point in connection with non-condensing auxiliaries that run at full load continuously. With a condensing machine considerable variations in initial steam pressure can take place without materially affecting the output, but in a non-condensing machine a multiplicity of small deviations from the contract conditions, each insignificant in itself, can have a very marked effect on the output, as will be seen from the following table, which compares the conditions, as they would be specified in an average contract, with conditions that could reasonably be expected in service:[2]

	Steam press., lb.	Quality.	Back press., lb.	Hp.
Specified conditions.........	150	100%	0	100
Operating conditions........	140	98%	2	83

With a view to setting forth how the theories mentioned above can be worked out in practice, a suggested Code of Practice is given in an Appendix.

The question of steam consumption, with its true relation to the overall efficiency of the plant, has lately been receiving much more attention than formerly. In stations and industrial plants where all the exhaust can be utilized, the thermal efficiency of the auxiliaries can vary very considerably without an appreciable effect on the coal pile. Fig. 3 shows what a relatively small effect a very large range in water rate has on the heating value of the exhaust steam.

However, in stations where there are times when all the exhaust cannot be economically utilized, the question of the auxiliary efficiencies becomes of serious importance. To meet this condition a great many radical changes have been made in the general layout of this part of the apparatus, particularly in the introduction of gear-driven pumps, etc., in place of the low-speed, direct-connected type. Any innovation of value here naturally means complications, in the same manner that any marked improvement in the steam consumption of the turbine itself must necessarily be made at a sacrifice of simplicity. Can we afford to do this? Will the little saving that at best can be made commercially in any design of small turbine give the net result required? Is it not better to accept the best efficiency conducive to maximum simplicity and reliability, and be content with that; then, when the point is reached where more exhaust than that supplied by a certain number of auxiliaries is required, to switch over to electrically driven apparatus? The combination steam- and electrically-driven unit meets this situation admirably.

[2] In this connection it might be well to enlarge on one point often overlooked by the manufacturer and customer alike, the necessity for very liberal allowances in machines operating at very low pressures. Operating with atmospheric exhaust an initial drop in steam pressure of 10 lb. from 150 lb. means a reduction of available B.t.u. at the turbine of 3 per cent, whereas the same drop at 60 lb. (common in sugar refinery work) means over 10 per cent. Therefore velocities permissible under the higher pressure must be considerably cut down when it is desired to maintain full load at around 60 or 70 lb.

The ideal way to distribute the units would be to begin with the turbine units in all places that receive the least attention, and such places as boiler-feed pumps, that must not be shut down in case of any electrical disturbance, and keep the electrically driven units on the main engine-room floor as far as possible.

THE MANUFACTURER'S POLICY

Regarding the question of policy between the manufacturer of the respective parts of a complete piece of apparatus and the combined policy of manufacturers toward the customer, the first question that arises is why should there be any difference here from the policy adopted in other branches of the trade. Theoretically, of course, there should be no difference, but many conditions, unfortunately, exist, peculiar to this business, that make this question of policy a very vital one and worthy of serious consideration in any attempt to solve the commercial problem under consideration. When an engine-driven or motor-driven set is sold, the correspondence between the respective manufacturers consists of an interchange of formal orders; but we have a long way to go before we arrive at the same businesslike procedure in connection with turbine units.

These arguments, of course, do not concern the builder of the combined unit, who in this respect will always have a distinct advantage over the other manufacturers.

Any standardization along the lines suggested above will do more than anything else toward clearing the atmosphere of such questions as the limitations of apparatus furnished, the long interchange of correspondence relative to unimportant partial-load performances, and the responsibility for imperfect erection at the customer's plant.

Our one idea in all these considerations is the ultimate reduction of factory costs. Selling costs do not enter into this argument. Factory costs consist of two essential items—manufacturing expenses and overhead. Standardization and the elimination of special machines will help our shop costs or manufacturing expenses. The next question is, What can be done to reduce overhead expenses? To the layman it would appear that the latter should consist of the merest clerical work in such a simple apparatus as a small turbine, but there is today, in addition, a very heavy expenditure that must be borne by all manufacturers alike, and that is the maintenance of a trouble force in the engineering department at the works as well as outside, out of all proportion to the legitimate requirements of the situation. It is here where the question of policy comes in, and it is here where we can look for one of the biggest economies.

There is a deplorable lack of coöperation existing at the present time between the average turbine builder and many of the pump and blower builders. If a unit is reported unsatisfactory for any reason after erection, and the report goes to the pump builder, he will almost invariably assume the said trouble is entirely the fault of the turbine, and call upon the turbine maker to send a man to remedy it before he makes any investigation as to the performance of his own apparatus, and vice versa, if the original report goes to the other party. Even at the station it is common practice for the representative of one end of the apparatus to go out of his way to explain to the customer in detail how the trouble is entirely up to the other end, and this state of affairs is by no means confined to the erecting staff, who cannot always be blamed for taking this attitude, but to the higher officials of the company, who ought to know better. This state of affairs does not help

the customer, but it goes a long way toward making him buy the complete outfit from a firm manufacturing the whole unit. These conditions may, to a certain degree, be expected, but surely it is possible to formulate some definite line of procedure that will, in a great measure, relieve this present unsatisfactory situation.

One of the prominent obstacles to the application of any hard and fast rule is the fact that firms cater to the larger corporations, and feel that it behooves them to go to unjustifiable expense in case of trouble to keep in their good graces for future business. A sound and uniform policy on the part of all manufacturers would put each one in a much stronger position.

A few suggestions as given below present themselves at this time, each one of which, if adopted by one or two individual firms, would probably result in serious disaster, but if conscientiously adopted by all firms would undoubtedly have a mutually beneficial result.

If a turbine is bought by a pump or blower maker, said purchaser must accept the machine on leaving the maker's works as having met all its guarantees (as in the case of reciprocating engines and motors). If, however, subsequent performance warrants a test to determine the performance of the turbine, said test must be arranged for and carried out at the expense of the purchaser. The expenses of a representative of the turbine maker, who must be present, to be included. If the tests show conclusively that the turbine has failed, then all the expenses are automatically transferred to the turbine maker, and he is to be allowed, say, two months to remedy the faults of his apparatus before rejection.

If a test on sight is impossible, the maker can demand that the machine be returned to the works, where a witness test can be made in the presence of the purchaser's representative, the purchaser paying all expenses, including freight, if the machine on test is not at fault, and vice versa, as above.

Neglecting the few instances where both ends of the machine fail, there should be no such thing as dividing the expenses. The machine is right or wrong, and the responsible party should pay all. Cases are on record where a hard and fast rule of this kind would have eliminated years (not months) of controversy over the equitable division of expenses. If the respective parties cannot come to terms, then they should agree to take the decision of an arbitrator mutually agreed upon. As soon as any controversy arises his services should be sought immediately, and not as at present (when this course has been adopted) after months of expensive haggling, with the resulting hard feeling that this invariably creates.

If the customer disputes the performance of the whole outfit, it rests with him to conduct the necessary tests at his own expense, with the same adjustment of costs as above, the makers' engineers to be invited to all such tests.

In all cases of trouble, the customer must first of all see to it that he notifies the right party, i.e., the master contractor. If the turbine breaks down, and the unit is bought from a pump maker, it is primarily the duty of the pump maker to apply the remedy. All dealings with the customer must be through him. Again, if a machine is bought F.O.B. factory from a reputable concern, and trouble is experienced after erection and the services of an expert are requested, the request should be sent by a responsible member of the purchaser's firm, and be considered in the light of a formal order covering said expert's expenses. If the trouble is due to defects in the apparatus, the manufacturer cannot send in a bill and expect any repeat orders.

One of the hardest propositions the manufacturer is confronted with today is to collect for expenses when the trouble has been entirely due to the engineer's absolute neglect of the instruction book furnished with the machine, or other cause for which the manufacturer should in no way be held responsible. If all makers could see their way to adopt a policy of this kind, requests for men by irresponsible under-engineers would rapidly decrease. The fact is that if the engineer knows at the outset that if the trouble is caused by his own negligence and the expense is going to be charged against him, he is naturally going to make sure of his ground before he risks the displeasure of his superiors by showing his incompetence to adjust the machine, or runs up unnecessary bills in his department.

In like manner the subcontractor must expect a formal order from the master contractor for any expert services.

In conclusion, this is not a matter that concerns only the manufacturer from a financial standpoint. It concerns the purchaser, inasmuch as the selling price of the apparatus will be reduced. It also concerns the manufacturer from the standpoint that any advance along the lines suggested cannot have any other effect than to eliminate unpleasant experiences with the customer and thereby increase the popularity of the turbine-driven unit.

The Second Industrial Safety Congress of New York State will be held at Syracuse, N. Y., from December 3 to 6, under the auspices of the State Industrial Commission. Some of the topics to be considered are Safety from an Economic Standpoint as Well as a Humanitarian Proposition, What Part Does Labor Play in the Safety Movement? Disciplining Careless Workmen—How the Employer Feels About It and How the Employee Feels, and Safety Committees, Their Scope and Benefit. The headquarters of the congress will be at the Hotel Onondaga.

Suggestions addressed to owners and managers of power plants for the economical use of coal have been prepared by the Committee on Coal Conservation of the Chamber of Commerce of the United States, which is working in conjunction with the Council of National Defense. The cost of coal for the generation of power, the committee points out, has in many instances not had the same consideration as other costs because coal has been cheap and abundant, so that cheap coal and cheap labor sometimes made it apparently economical in dollars and cents to install and operate an inefficient plant. Coal and labor are now expensive and conditions make it imperative for every owner or manager of a power plant to examine into the cost of the power his establishment uses, the economy with which it is generated and applied and the increase in efficiency that is possible.

Most users of coal can join in promoting efficiency of coal. Railways have made real progress in firing locomotives; they can often go farther. Gas workers can generally effect further saving by using careful technical direction. Manufacturing plants of every degree can show great results in the aggregate.

The Bureau of Mines, on behalf of the Federal Government, has gathered a great deal of information about the use of coal and has expert advice to give regarding means of economy. Several publications, in which the Bureau of Mines has embodied the results of its experiments and made practcal suggestions based upon expert observations and conclusions of its staff and other engineers, are now available and a list can be obtained by application to Director Van H. Manning.

RECENT DEVELOPMENTS IN BALANCING APPARATUS

By N. W. AKIMOFF, PHILADELPHIA, PA.

Member of the Society

Improvements have been made by the author upon the balancing machine described by him in a paper presented before the Society in 1916. They are based mainly on a revision of his former method for securing static balance in a body used as a step in the process of determining its dynamic balance. Two formulae are given to show mathematically the lack of precision in ordinary methods for obtaining such static balance.

The author uses a clamp attached to the body to be balanced, whereby a centrifugal force is introduced when the body is rotated, for the purpose of neutralizing the static or dynamic unbalance of the body. By suitably constraining the motion of the rotating body, either the static or dynamic unbalance, or the combination of both, may be accurately measured through the adjustment of the clamp.

SINCE my paper was presented on the subject of Dynamic Balance,[1] certain improvements have been made in the machine there described; and an entirely new machine based on new methods of balancing has been developed.

The principle of the original machine is indicated in Fig. 1, which shows a lathe bed which takes the form of a beam hinged at one end and supported by a spring at the other. The body to be tested must first be brought into static balance, after which it is rotated in bearings supported by the beam. If the body is dynamically unbalanced its rotation will cause the beam to vibrate in a vertical plane with a period of oscillation equal to the period of rotation of the body.

Suspended from the beam is a second body in the form of a so-called squirrel cage consisting of two circular disks carrying an even number of rods so arranged as to slide in holes in the disks. The cage rotates in unison with the body to be tested and a state of unbalance in this body introduces a centrifugal couple which is neutralized by displacing the rods in the cage until an equal compensating couple has been introduced. The distances that the rods are displaced serve as a measurement of the amount of unbalance to be provided for and counterbalanced in the piece under test.

The improvements upon this original machine, referred to above, are as follows:

a The substitution for the cage of a two-point element consisting of two disks, *A* and *B*, each with a pin projecting from its face, as shown in Fig. 2. The disk *A* is fixed to its shaft and the disk *B* is arranged to slide on the shaft through the use of a feather key *f*. It is clear that when the two disks are in contact they will balance each other; but when separated they will introduce a certain centrifugal couple according to the weight of the pins and the distance between the disks, which latter can be varied while the apparatus is in motion.

b A planetary arrangement by which the relative angular position of the body and the disks (or cage) can be varied while the machine is in operation.

c The application of a principle whereby the disks (or cage) may be arranged to answer the problem of static balance as well as dynamic balance.

The new methods which have been developed and applied in a new type of machine for combination static and dynamic balancing will be referred to later.

STATIC BALANCE

As a result of a great deal of study of the problem of static balance, I have been forced to admit, in common with many other engineers, that too much has been taken for granted in relation to this subject. Static balance is not a trifling problem to be solved easily by placing a rotating body on parallel ways or rollers, as has commonly been supposed. While it is true that static balance can be found without much trouble in the case of bodies of light weight or where the operating speeds are comparatively slow, there are other cases which are much more difficult. For example, consider a gyroscope wheel whose weight is about 50 lb. or so, running at, say, 10,000 r.p.m.; or a turbo-rotor whose weight is 10,000 lb. and whose speed is 3600 r.p.m. Neither of these extreme cases can possibly be handled with any degree of success by placing the bodies on ways; and yet, unless static balance is perfect, no dynamic balancing machine can be expected to give reliable results.

STATIC BALANCE BY MEANS OF PARALLEL WAYS

It may be well to point out that in balancing by the aid of parallel ways there is a limit to the load which can be safely borne by the journals in contact with the ways. A safe load for each journal appears to be 750 lb. per inch of width, per inch diameter of journal.[1] For instance, if the ways are $1\frac{1}{2}$ in. wide and the journal diameter is 10 in., then each side will carry almost 12,000 lb. without any danger of forming permanent flat spots.

It would be of interest if one could estimate the sluggishness of action of a body on the ways under different conditions. The older theories of rolling friction, as proposed by Coulomb, Morin and Dupuit, do not seem to lead to very reliable results. Résal's formula[2] is probably much more reliable and is here reproduced in simplified form (steel on steel):

$$f = 0.056\sqrt{1/(1 + 79/D)}$$

where *f* is the length of the flat contact of shaft with the way and *D* is the diameter of shaft, both in inches. It appears that

[1] New Orleans meeting, 1916; Transactions Am.Soc.M.E., vol. 38, p. 367.

For presentation at the Annual Meeting, December 1917, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 West 39th Street, New York. All papers are subject to revision.

[1] According to the writer's remembrance, this figure was first given him by the engineers of the Standard Roller Bearing Co. many years ago, and has since been revised by him in connection with other practical data which he was able to gather from different sources.

[2] Résal, Traité de Mécanique Générale, T. 11, p. 6.

the weight does not enter into the formula, and in general [illegible] should not be considered as extending to extreme [illegible]. It expresses the average run of things at the [illegible] standard practice.

The diagram in Fig. 3 has been roughly plotted to illustrate the probable magnitude of *residual unbalance* which *may* [illegible] a body that has been brought into apparent balance by [illegible] ways. The chart is based on Kesal's formula, and, as it is intended simply to illustrate the meaning of the formula, values have been exaggerated by plotting shafts of small diameter against weights altogether inconsistent there-

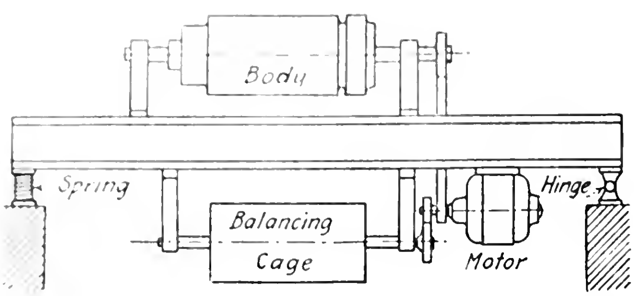


FIG. 1 SQUIRREL-CAGE TYPE OF DYNAMIC BALANCING MACHINE

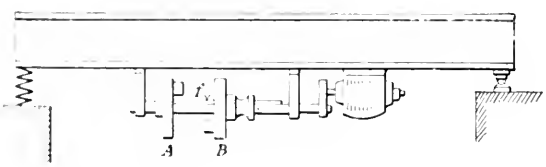


FIG. 2 TWO-POINT BALANCING ELEMENT

with. The chart is easily read. for instance, if a rotor weighs 4000 lb. and diameter of its shaft is 6 in., then the residual unbalance may be as great as 480 ounce-inches, or say, 2½ lb. on a 12-in. radius. It is useless to put a body statically unbalanced to such an extent (or even to 50 per cent of this) on any dynamic balancing machine. Satisfactory results cannot possibly be derived from such tests. An actual case of residual unbalance, typical of many others, is of a shaft having a diameter of $2\frac{3}{32}$ in., a weight of 66 lb. and a residual unbalance of 0.844 ounce-inches. The width of the balancing ways was $\frac{5}{16}$ in. (cast iron chilled and ground).

Considering the phenomenon of rolling friction from the standpoint of higher theories of elasticity (Hertz), the following tentative formula was derived for residual unbalance:

$$M = 0.0004648\, P \sqrt{PD}$$

where M is the residual moment in ounce-inches, P the weight per unit of contact length (that is, per inch of combined width of ways), and D the diameter of shaft in inches (steel on steel). The constant may be considered to be rather tentative, but with the advent of a machine capable of establishing perfect static balance it will not take long to find [illegible] values for it.

[illegible] formula, if an armature weighed 12,000 lb. [illegible] shaft diameter of 8 in., the sluggishness or residual [illegible] ways 1 in. wide, would be:

$$M = 0.0004648 \times 6000 \sqrt{6000 \times 8} = 614 \text{ oz-in.}$$

[illegible] on a 12-in. radius. At 3600 r.p.m. the centrifugal force due to such residual unbalance would be more than 14,000 lb.

USE OF CENTRIFUGAL FORCE IN BALANCING

As previously stated, my earlier machine for dynamic balancing was based on the introduction of *centrifugal couples,* created by the operator to offset the effect of the disturbing centrifugal couple, constituting unbalance in the rotating body. Likewise, a machine for static balancing can be based on the same principle, but long study of the subject has led me to the conclusion that the whole problem of balance, static and dynamic, can be reduced to the principle of a single *centrifugal force* acting on a properly constrained body. Such centrifugal force can be created by the operator, within a rotating body, by such means as, for instance, the clamps of which two designs are here shown (Figs. 4 and 5). As will be explained, such clamps may be used to offset the effect of static or dynamic unbalance in a rotating body, as the case may be, and to record the extent of such unbalance. They should be carefully made and so calibrated that the centrifugal force may be given as a function of some linear dimension, read directly or measured by an accurate scale. The first clamp is easier to make and check for accuracy; while the second design is much handier for quick adjustment on the shaft of a rotating body.

MEANS FOR SECURING STATIC BALANCE

In order to register the effect of static unbalance of a body, or the correction introduced by means of such a clamp as described, the body must be placed in such a condition that its oscillations are emphasized or magnified to an extent that will be visible to the eye; otherwise its unbalance, even if considerable, will not be noticeable and will only result in

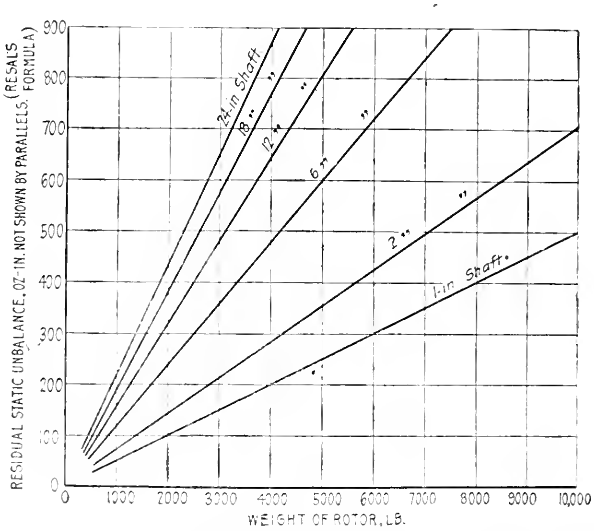


FIG. 3 PROBABLE RESIDUAL UNBALANCE OF BODIES BALANCED ON TESTING WAYS

increased pressure on the bearings. Thus, in a badly unbalanced automobile engine, it is most often possible to pick out a range of speeds where the engine will appear to work smoothly; and many an electric motor with badly unbalanced rotor will apparently run well, simply because its speed may be far away from that which would insure synchronism of the rotation with the oscillation of bearing supports.

Now, suppose we have a frame, suspended as shown in Fig. 9, and capable of a certain period of swinging oscillation. If the body, statically unbalanced, is operated at a speed corresponding to the period of oscillation, the oscilla-

tions of the frame will become violent, and can be readily registered by any suitable dial-gage indicator. Here the body is imposing its own period on the frame, which thus performs what are known as forced vibrations of the same period. Our task is then to adjust the speed of the body so that the period of such forced oscillation will be equal to that of the natural oscillation of the frame and body (at rest).

enough to see that a clamp k can always be so adjusted, both angularly and as regards its off center position, so as to nullify the oscillations of the frame, thereby solving the problem of static balance. No matter how heavy the body, it is always possible to place it into most minute balance by this method, where ordinary parallels would be altogether inoperative.

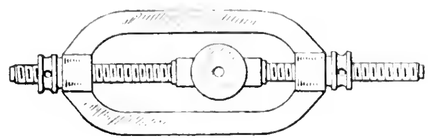


Fig. 4

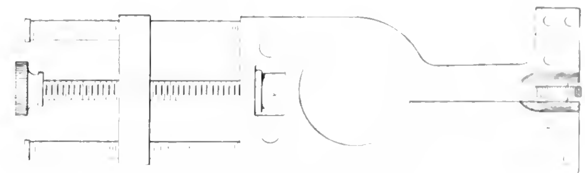


Fig. 5

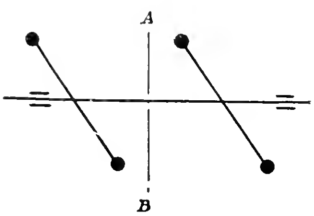


Fig. 6

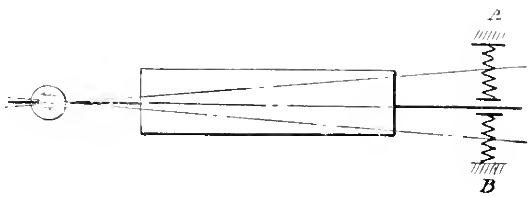


Fig. 7

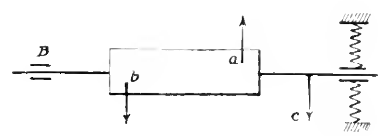


Fig. 8

Figs. 4 and 5, Clamps Used in Securing Static and Dynamic Balance; Fig. 6, Unbalanced Body with Center of Gravity Lying in its Axis; Fig. 7, One Bearing Pivoted and One Floating; Fig. 8, Centrifugal Couple Balanced by a Centrifugal Force.

In Lord Rayleigh's remarkable book[1] a most lucid explanation is given of this phenomenon of "step" or synchronism.

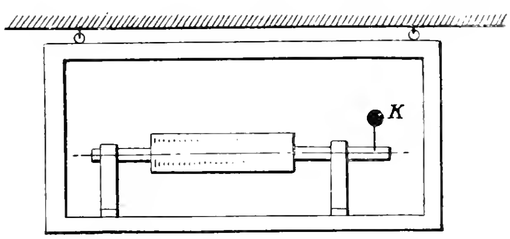


Fig. 9. Body Supported in Swinging Frame for Securing Static Balance

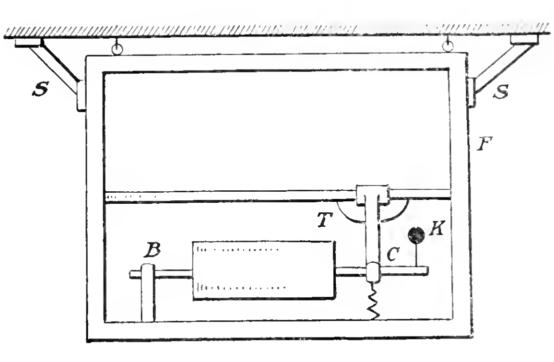


Fig. 10 Body with One Floating Bearing, Supported in Rigid Frame for Securing Dynamic Balance

Lord Kelvin's well-known device called a "vibrometer" is likewise based on this very principle. Of course, it is easy

Dynamic Balance

As regards dynamic balance, due, in a statically balanced body, only to the presence of a centrifugal couple, the following remarks can be made: In the first place the "theory" that this centrifugal couple is due to the fact that the centers of gravity of both halves of the body, cut through its center of gravity, do not lie on the axis of rotation, is radically wrong. Take for instance a skeleton body shown in Fig. 6. Its center of gravity is exactly on the axis of rotation, as also are the individual centers of gravity of each half, to the right and to the left from A to B. Yet such a body would be manifestly out of balance (dynamically). Inversely, a body would readily be imagined to be both in static and dynamic balance, although each of its *halves* were statically out of balance. The only correct way to characterize dynamic balance is to say that the *products of inertia*, containing the axis of rotation, vanish[2]; or, to put it practically, that there is no centrifugal couple in any axial plane.

In the next place, if we constrain (pivot) one end of a rotating body (statically balanced but dynamically out of balance) while the other end is arranged to float in a bearing supported by springs so that it may move, say, in a horizontal plane, Fig. 7, then the oscillations of the body will be angular, as from A to B. Under these conditions the observer will be unable to tell whether the vibrations are due to a *force* (centrifugal) acting somewhere on the body or to a centrifugal couple, unless he knows beforehand that the body is in perfect static balance, under which conditions the vibratory effect can be due only to dynamic unbalance. This being the case, in

[1] Theory of Sound.

[2] Slocum, Theory and Practice of Mechanics, p. 297.

[illegible] of the reaction of the constrained end, it is perfectly possible to balance the effect of a centrifugal couple by means of a centrifugal force. Thus, in Fig. 8, if it is assumed that the dynamic unbalance is due to the couple $a\ b$, it will always be possible to select a centrifugal force c, such that it will quiet the vibrating body, and because of its known distance from the bearing B, establish the exact value, sign and angular position of the disturbing centrifugal couple $a\ b$.

It is thus clearly seen that it is possible to utilize a centrifugal force to good advantage in finding both static and dynamic unbalance of bodies; and combining the principles illustrated in Figs. 7 and 9, we have a combination static and dynamic balancing machine, of which the scheme is as follows:

DESCRIPTION OF IMPROVED BALANCING MACHINE

A frame F, Fig 10, supports the bearings B and C, which carry the body. The frame has a swinging period of its own. The bearing C may either be locked, so that it acts exactly like the rigid bearing B; or else it may be allowed to float in

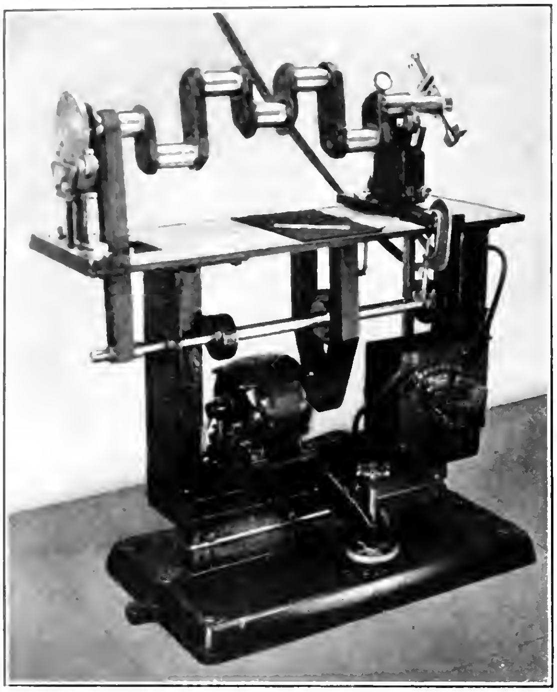


Fig. 11 Combined Static and Dynamic Balancing Machine

a vertical plane, bringing into play certain resistances (springs) opposing its deflection from the neutral (vertical) position. The correcting centrifugal force is indicated by k.

Such a system is known in dynamics as a *system with two degrees of freedom*, in general being capable of two kinds of motion: swinging of the frame, the bearing C being maintained rigid; and swinging of the bearing C, the frame F being maintained rigid by such means as brackets S; while the most general motion consists of a combination of these two motions.

The operation of such a combination machine is very clear. In order to secure static balance we lock the bearing C and unlock the frame supports S. Then, by properly adjusting the magnitude and direction of k we can reduce to zero the bodily oscillations of the frame F, thus establishing the exact value and sign of static unbalance in ounce-inch units. As soon as this has been corrected, we lock the frame F and unlock the bearings C, when the same centrifugal force k, created by a suitable adjustment of the clamp as explained above, can be made to correct the body for dynamic unbalance, as illustrated in Fig. 7. The advantage of basing the results on the centrifugal force instead of on a centrifugal couple is manifest, the former being a *fundamental*, and the latter a *derived*, unit, so that the former is capable of much greater accuracy in adjustment and of more direct application than the latter.

Fig. 11 illustrates a balancing machine built in accordance with the scheme of Fig. 10. The yielding support, clearly shown on the right, has means for easy adjustment of its period, as likewise has the frame itself. The motor is of $\frac{1}{3}$ hp. capacity and operates the body, through a countershaft, by a rubber belt. The balancing clamp is seen on the extreme right of the crankshaft. The oscillations are read by means of ordinary Starrett dial gages, graduated in thousandths of an inch. The precision which can be secured on such a machine is almost uncanny; it enables one to see the sluggishness of the method of balancing on ways and therefore the absolute lack of precision of dynamic balance that might be based on such results. A well-designed clamp is very easily handled and its correct position can be established in a few minutes. Its indications are capable of tabular interpretation, so that the operator has merely to carry out the simple instructions, worked out beforehand. Of course, it is clear that such a machine can be built for any size of body, or for any speed that may be desired.

Two minerals not heretofore known to science have been discovered at Crestmore, Cal., according to a bulletin issued yesterday by Prof. Arthur Eakle, department of geology, University of California. Professor Eakle has christened the discoveries respectively "crestmoreite" and "riversideite." The first is described as a new hydrous basic orthosilicate, containing small amounts of other oxides in place of silica. The latter is a hydrous lime sulphate.—*Minneapolis Morning Tribune,* October 31, 1917, p. 1.

A report on the deterioration in the heating value of coal during storage, covering a five-year period, has just been issued by the Bureau of Mines, Department of the Interior, as Bulletin 136. The tests show that the amount of deterioration has commonly been overestimated. Except for the subbituminous Wyoming coal, no loss was observed in outdoor weathering greater than 1.2 per cent in the first year, or 2.1 per cent in two years. The bulletin, of which the authors are Horace C. Porter and F. K. Ovitz, may be obtained free of charge by addressing the director of the Bureau of Mines, Washington.

Roughly, two pounds of seasoned wood have a fuel value equal to one pound of coal, according to experts of the United States Forest Service. Different kinds of wood have different fuel values, and in general the greater the dry weight of a nonresinous wood the more heat it will give out when burned. For such species as hickory, oak, beech, birch, hard maple, ash, locust, longleaf pine or cherry, which have comparatively high fuel values, one cord, weighing about 4000 lb., is required to equal one ton of coal; it takes a cord and a half (a total weight of 4500 lb.) of shortleaf pine, hemlock, red gum, Douglas fir, sycamore or soft maple, which weighs about 3000 lb. a cord, to equal a ton of coal; while of cedar, redwood, poplar, catalpa, Norway pine, cypress, basswood, spruce and white pine, two cords, weighing about 2000 lb. each, or 4000 lb., are required.—*Power,* November 13, 1917, p. 657.

EXPENSES AND COSTS

By H. L. GANTT, NEW YORK, N. Y.

Member of the Society

In determining the cost of a manufactured article, should we include all the expense incurred while that article is being manufactured, or should we include only those expenses which contribute to its production?

It does not require any knowledge of cost accounting, bookkeeping, or other office art to enable the practical man to say that costs should include only those expenses needed to produce the article in question, and that those people who insist on including in their costs expenses which do not contribute to the production of the article are simply trying to recover from the public through a higher selling price the expenses which they incur through inefficiency and waste.

All cost figures may be divided into three parts:

a Expense for material
b Expense for labor
c Overhead expense, or "burden."

There is no great difficulty about getting the expense for material and the expense for labor, and most concerns get these elements quite accurately, but there is a great variety of opinion as to what the "burden" charge on any particular work should be. This overhead or "burden" may be divided into two parts:

a That which is incurred through simple ownership or rental of the plant and keeping it ready for operation
b That which is incurred by operating the plant, exclusive of direct labor and material.

Analyzing further the meaning of the term "burden," we see that the first part is made up of ownership or rental of a number of machines or work benches, properly housed. The second part consists of the expense of operating the various machines, which consists of such items as power, oil, waste, repairs, etc.

Inasmuch as the rental which we should pay for the plant is made up of the rental of the individual machines and work spaces, we must be able to determine the proper rental for each of these in order to form an intelligent idea of the proper rental for the whole plant. In the same way we can determine the amount of supervision, power, oil, and waste needed to run these machines individually.

Working along these lines, we are able to determine for each machine in the factory both an idle- and an operating-expense rate.

Any article manufactured on a machine should undoubtedly bear the operating-expense rate for the time during which the machine was operated on it.

The expense of maintaining the machine in idleness during the time it was not operated cannot legitimately be charged to the work done while it was operated, and should be put into another account.

We thus see that in every plant there are to be considered two kinds of burden:

a That which produces goods and which can legitimately be charged to the cost of those goods, and
b That which produces nothing, and must be put into some other account.

For presentation at the Annual Meeting, December 1917, of The American Society of Mechanical Engineers, 29 West 39th Street, New York. All papers are subject to revision.

In the past it has been too much the fashion to put these two kinds into one account and make the product bear both. This has led to so much confusion, and is so evidently wrong, that it is not worth discussion.

On the other hand, a careful consideration of the expense incurred while the plant is idle leads to very fruitful results: first, through an attempt to find out why the plant is idle, and then through an attempt to eliminate the causes of idleness, which are lack of work, lack of help, lack of material, repairs, etc.

Without going into the details of those subjects, it may be readily appreciated what advantages will be derived from a careful study of each of these causes.

This general view of the cost question leads to a further simplification of the problem which is worthy of careful consideration.

First, the expense of owning and maintaining a certain machine in idleness properly equipped for efficient operation should be substantially the same in any part of the country where the machine could be bought at substantially the same price.

Second, the amount of power, oil, waste, and repairs, and even supervision, of a certain machine should be substantially the same in any part of the country, if it were engaged upon substantially the same kind of work.

Following these lines of thought, we readily see that a standardization of cost methods and of costs is possible, which was unsuspected a few years ago.

While the writer and those with whom he has been associated have done quite a good deal of work on these lines, and while the results have been satisfactory to a degree that was entirely unanticipated, he does not yet feel that the matter has been developed to such a degree as to warrant detailed publication. The fact, however, that the Federal Government has placed so many contracts on a "cost plus" basis, leads him to set forth these ideas, which are the only ones which seem to him to give promise of avoiding an almost intolerable situation resulting from a complication of interests which is bound to arise in the near future.

It seems to the writer that much of the confusion on the subject of costs in the past has been due to a misconception of the subject. The intimate relation between production and costs has not been sufficiently recognized, for the accountant has looked upon costs as a bookkeeping proposition, whereas, in truth, costs are much more closely connected with engineering and production than with the subjects of bookkeeping and accounting.

If the engineer will recognize this fact and insist that money spent without any corresponding production must be kept separate from that which was productive, either directly or indirectly, many of the apparent contradictions with which we are so frequently faced will be eliminated.

As soon as we establish these methods, the following question is immediately put to us by the accountant and financier, "What are we going to do with this expense of idleness?" they having never before realized that it cost something to be idle.

My frank answer to that is that I do not know. Moreover, I don't care, provided they do not charge it to me in the prod-

[illegible] I may exempt them. My recommendation, however, [illegible] how they can eliminate such expense [illegible] methods.

I am perfectly aware that it is extremely difficult to eliminate [illegible] of such expense, but I am also aware of the fact that it is extremely easy to eliminate a large proportion of it. The solution of this problem is one of the economic questions which the war will shortly force to our attention, and I insist that it is primarily a question to be solved by engineers rather than by financiers.

APPARATUS FOR COOLING, DRYING AND PURIFYING AIR

By W. J. BALDWIN, NEW YORK, N. Y.

Member of the Society

This paper describes an apparatus for purifying air and regulating its temperature and humidity by mechanical means. In principle it consists of the use of a cold spray for the purification process, after which the excess moisture, together with particles of dust, excess CO_2, etc., are separated from the air by centrifugal action. In one of its original forms the device was applied to the porthole of a ship for the purpose of drawing into the cabin large quantities of air but excluding rain or spray. It has also been used to remove CO_2 from vitiated air, as in the compartments of a submarine, and for removing particles of dust from the gases of combustion in a chimney.

THE necessity for removing dust and other impurities from the air needs no amplification from me, as we all recognize the advantages of pure air and nearly all strive in every way to obtain it.

The ordinary meaning of the term pure air, however, should be amplified, and when it appears in a contract it should mean more than that the air should not be fouled by the human breath and by exhalations from the human body. The engineer must not be content when making an examination within an enclosed structure simply to report that the air is maintained at some common standard of purity of contamination, expressed by the number of times the CO_2 within the room is in excess of the standard, good or bad, found to exist outside the enclosure. Such a standard gives only an approximate idea of the condition of the air within the enclosed space, and it is the roughest approximation under the common acceptance of the term.

Presumably there is no pure air near the surface of the ground, nor in the atmosphere of cities. The best we have exists at the tops of mountains, or on the ocean, but even this we are unable to standardize.

Air with about two parts of CO_2 in 10,000 is considered good, no matter where we find it; but in cities where much coal is burned the proportion is higher, and may rise to as high as 10 parts of CO_2 in 10,000. An increase from 2 to 4 parts in 10,000 for enclosed spaces above the outside conditions has been considered good, even for schools and hospitals, and very good for workshops.

These conditions, however, do not comprise the whole problem. Further effort should be directed toward drying air by some simple mechanical process. In attempting to free air from an excess of humidity, which is often as much of an impurity as are the other forms of contamination, I have the following data to offer:

About two years ago I worked to perfect an apparatus[1] that could be put in the porthole or the dead light of a ship and would exclude the rain or spray, while freely admitting large quantities of air to the cabin of the ship, without admitting the water. This led to freeing the air of an excess of humidity.

The experiments conducted with the preliminary apparatus for excluding rain or spray while freely admitting the air as in the case of a ship rolling heavily at sea, suggested the possibility of removing the excess of humidity in the air, particularly with a view to admitting air to the radio room of a ship, and not only exclude the rain and the spray but also regulating the humidity, so as to keep the air at *some common standard of saturation* as far as humidity was concerned. The purpose was to overcome a difficulty with the attuning apparatus of the receiving and sending instruments, either at sea or in the higher atmosphere.

This led to the design of an apparatus for a radio room on the lines already set forth, that would admit air not only separated from rain, salt spray and spume, but that would also condition or regulate the humidity within the room by keeping it at a common standard of humidity, regardless of the outside changes.

Cold water in the spray form will do this provided the spray can be gotten rid of after it has combined with the excess of humidity (steam in the air) and then separated from the air by some practicable form of apparatus that is simple, and that occupies small space.

While a shower of rain will clear the atmosphere, the elements of nature have all outdoors in which to set up the apparatus for such a result. The cabin of a ship or a radio cabinet is infinitely small in comparison with all outdoors, yet a similar result can be achieved in a space as small as a cabin or radio cabinet.

To accomplish this I used a cold-water spray apparatus similar to one I had designed two years earlier for the purpose of precipitating the CO_2 when found in great excess in a confined space, as in the hold of a submarine, when forced to stay a long time under water.

In this machine a spray of potash water was used in connection with a mechanical dust precipitator for the purpose of seizing on the carbonic acid in the air and throwing it down so as to eliminate the CO_2 at the dust and water discharge of the apparatus.

It was proposed to put the apparatus in a bulkhead; the discharge side of the apparatus coming into the air of the

[1] A description of this apparatus, with illustrations, appeared in the [illegible] of the American Society of Heating and Ventilating Engineers, [illegible] 1917.

For presentation at the Annual Meeting, December, 1917, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 West 39th Street, New York. All papers are subject to revision.

living quarters, the air freed of its CO_2 being forced backward again into the chamber of greatest vitiation, thus forming a cycle.

In the general experiments it was found that a prepared spray of chemical liquid or even cold water not only seized on the dust but on other gases in the air, with which the chemical in the spray would combine, and that a pure-water spray turned into the apparatus would keep the humidity of the air constant by suitable regulation of the temperature of the water spray. In a room at 90 deg. fahr. and a humidity of almost 90 per cent we could drop the humidity to 45 per cent by reducing the temperature of the spray to 70 deg. fahr.

A simple form of the apparatus arranged for cooling a room is shown in Fig. 1. The apparatus from the inlet to the

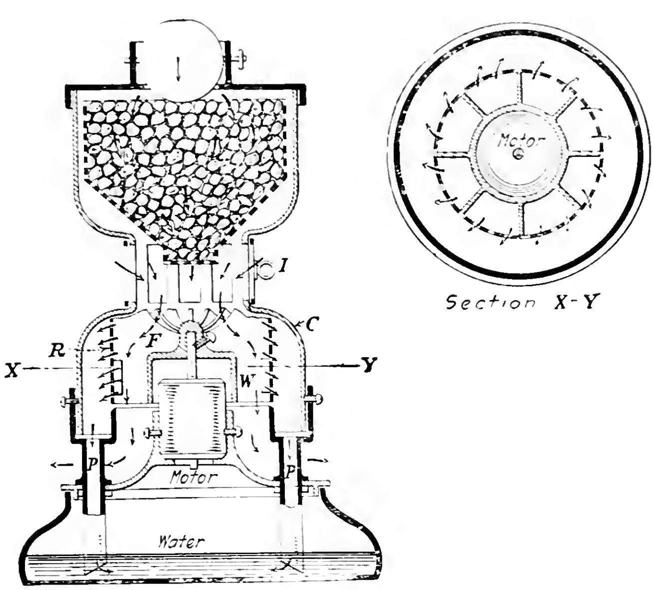


Fig. 1 Apparatus for Purifying and Cooling the Air of a Room and Illustrating Also the Principle Used in Various Other Forms of the Device

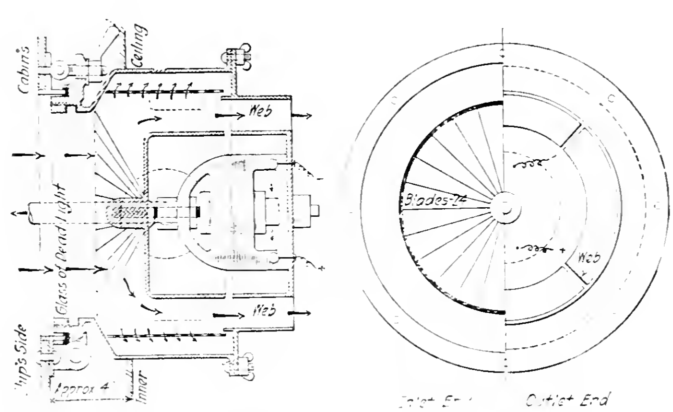


Fig. 2 Apparatus Attached to Porthole of Ship for Admitting Air and Excluding Rain or Spray

line X-Y is an ordinary fan or blower F, and the downward extensions of the fan blades or wings W are necessary to accelerate the rotary motion of the air.

The rotor R is a rotating hoop of permeable metal, against the inner side of which the air is thrown with all its impurities. If the heavy particles in the air, such as dust, mud or particles of water, strike into the perforations of the hoop, they pass through into a quiet space formed by the outer case C. Or, if they strike on the solid part of the hoop, they are rubbed through the nearest holes by the forward movement of the air. They then pass into the quiet space C, drop down within it, and escape by the pipe or pipes P into the tank.

The air does not escape with the heavy particles, as might appear at first, for the lower ends of the pipe legs are sealed by the water in the tank. The tank may be of any shape, or there may be no tank, the separated particles going to a waste pipe.

The greater the velocity of the rotor R the more efficient is the apparatus. A speed of 5000 ft. per min. is very practicable, but 10,000 is not excessive, either from the point of bursting or for any other reason.

The fan gives the same static pressure as any other centrifugal blower of equal diameter and speed and requires only equal power for equal work, and the power required for separation and friction is considerably under 25 per cent of the blower power required to move the air.

The device as described above illustrates the principle of the various types of apparatus, whether used for taking the

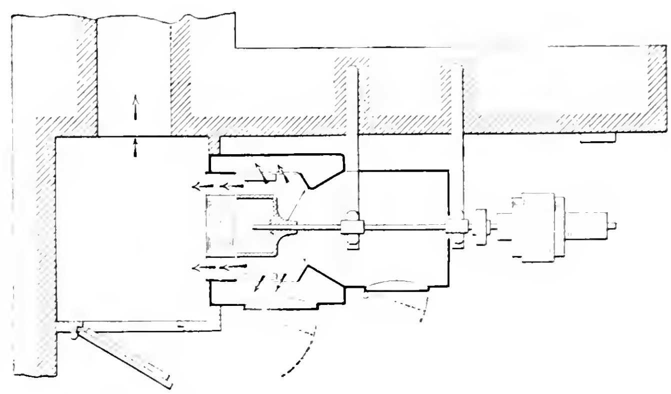


Fig. 3 Application of Apparatus to Base of Chimney for Removing Particles of Dust from Gases of Combustion

dust from the air, the CO_2 from a chimney or an enclosed space, the excess of humidity from the air, throwing down fog, cooling and moving air, etc. It will be noted that the ice in the upper tank serves both as a cooling medium and for the supply of cold water, broken into spray by the rapid motion of the fan, for the purification of the air.

In Fig. 2 is shown a type of the apparatus as developed for use in the porthole of a ship, and in Fig. 3 a horizontal design for the removal of dust particles from the gases of combustion in a chimney.

France and England freely acknowledge that they greatly decreased their efficiency by sending their scientific men to the trenches. Although they have since withdrawn most of those still alive and are now using them in special service, the dearth of technically trained men has been and is severely felt.

The American Association for the Advancement of Science and many national scientific societies affiliated with it will hold its seventieth meeting in Pittsburgh, Penn., from December 28, 1917, to January 2, 1918, under the auspices of the University of Pittsburgh, the Carnegie Institute, the Carnegie Technical Schools and other institutions.

REVISION OF BOILER CODE

THE Council of the Society directed that a hearing be conducted in accordance with the recommendation in the Boiler Code that a meeting at which all interested parties may be heard be held at least once in two years to make such revisions as may be found desirable in the Code and to modify the Code as the state of the art advances. The first of these meetings was held at the Society's headquarters in New York, December 8 and 9, 1916.

The Council also directed that the proposed revisions in the Boiler Code be published in THE JOURNAL with the request that they be fully and freely discussed, so as to make it possible for any one to suggest changes before the Rules are brought to the final form and presented to the Council for approval. Discussions should be mailed to Mr. C. W. Obert, Secretary of the Boiler Code Committee, 29 West 39th Street, New York, N. Y., and they will be presented and acted on by the Boiler Code Committee.

Revisions formulated by the Committee earlier in the year were published in the June 1917 issue of THE JOURNAL, pages 517 to 522, and in the August 1917 issue, page 705. The revisions which follow are divided into two parts, namely: Part I, Modifications of the Proposed Revisions published in the June and August issues (the modifications being made to conform with recommendations submitted to the Committee by those discussing the proposed revisions), and Part II, Aditional Revisions proposed by the Boiler Code Committee.

PART I

Modifications of the Proposed Revisions Published in the June and August Issues of THE JOURNAL

PAGE 50

PAR. 200. CHANGE PAR. 200 TO MAKE IT READ AS FOLLOWS:

200 *Staybolts.* The ends of screwed staybolts shall be riveted over or upset by equivalent process. Staybolts must be hollow or the outside ends of solid staybolts, 8 in. and less in length, shall be drilled with a hole at least 3-16 in. diameter to a depth extending at least ½ in. beyond the inside of the plates, except on boilers having a grate area not exceeding 15 sq. ft., or the equivalent in gas or oil fired boilers, where the drilling of staybolts is optional. Solid staybolts over 8 in. long, and flexible staybolts of either the jointed or ball and socket type need not be drilled.

PAR. 201. ADD TO PAR. 201 THE FOLLOWING:

If the outstanding legs of the two members are fastened together so that they act as one member in resisting the bending action produced by the load on the rivets attaching the members to the head of the boiler, and provided that the spacing of these rivets attaching the members to the head is approximately uniform, the members may be computed as a single beam uniformly loaded and supported at the points where the through braces are attached.

PAR. 214. CHANGE PAR. 214 TO MAKE IT READ AS FOLLOWS:

214 *Areas of Segments of Heads to be stayed.* The area of a segment of a head to be stayed shall be the area enclosed by lines drawn 2 in. from the tubes and a distance d from the shell as shown in Figs. 13 and 14. The value of d used shall be the larger of the following values but not less than 3 in.

(1) d = the outer radius of the flange, not exceeding 8 times the thickness of the head

(2) $d = \frac{5 \times t}{\sqrt{P}}$

Where d = unstayed distance from shell in inches
t = thickness of head in sixteenths of an inch
P = maximum allowable working pressure in lb. per sq. in.

PAR. 215. CHANGE PAR. 215 TO MAKE IT READ AS FOLLOWS:

215 When the heads of drums of water tube boilers are 30 in. or less in diameter and the tube plate is stiffened by flanged ribs or gussets, no stays need be used if a hydrostatic test to destruction of a boiler or unit section built in accordance with the construction, shows that the factor of safety is at least five.

PAGE 54

TABLE 4. SEVERAL REVISIONS HAVE BEEN MADE IN TABLE 4 AND IT WILL NOW READ AS FOLLOWS:

TABLE 4 MAXIMUM ALLOWABLE STRESSES FOR STAYS AND STAYBOLTS

Description of Stays	Stresses, lb. per sq. in.	
	For lengths between supports not exceeding 120 diameters	For lengths between supports exceeding 120 diameters
a Unwelded or flexible stays less than twenty diameters long screwed through plates with ends riveted over	7,500	.....
b Unwelded stays and unwelded portions of welded stays, except as specified in line *a* and line *c*	9,500	8,500
c Steel through stays exceeding 1½ in. diameter	10,400	9,000
d Welded portions of stays	6,000	6,000

PAGE 58

PAR. 231. CHANGE PAR. 231 TO MAKE IT READ AS FOLLOWS:

231 *Maximum Allowable Working Pressure on Truncated Cones.* *a.* Upper combustion chambers of vertical submerged tubular boilers made in the shape of a frustum of a cone, when not over 38 in. diameter at the large end, may be used without stays if computed by the rule for plain cylindrical furnaces (Par. 239) making D in the formula equal to the diameter at the large end, and provided that the longitudinal joint conforms to the requirements of Par. 239.

b. When over 38 in. in diameter at the large end, that portion which is over 30 in. in diameter shall be fully supported by staybolts or gussets to conform to the provisions for staying flat surfaces. In this case the top row of staybolts shall be at a point where the cone top is 30 in. or less in diameter.

In calculating the pressure permissible on the unstayed portion of the cone, the vertical distance between the horizontal planes passing through the centers of the rivets at the cone top, and through the center of the top row of staybolts shall be used as L in Par. 239, and D in that paragraph shall be the inside diameter at the center of the top row of staybolts.

PAGE 61

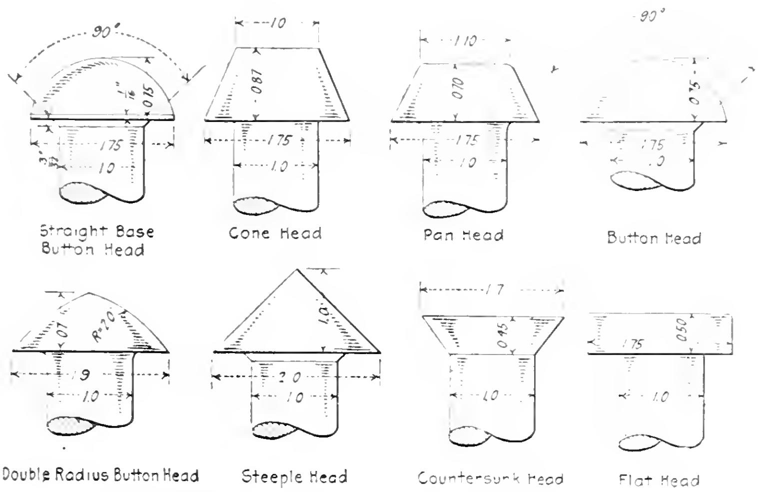
Par. 239. Insert after the formula and just preceding the example in Par. 239, eliminating the present sentence:

Where the furnace has a riveted longitudinal joint, it may be of the lap type for inside diameters not exceeding 36 in. for furnaces 36 in. or less in height or length, and for inside diameters not exceeding 30 in., irrespective of the height or length. Otherwise butt and strap construction shall be used. The efficiency of the joint shall be greater than:

$$\frac{P \times D}{1250 \times T}$$

PAGE 64

Par. 246. As stated in the June issue of The Journal it had been decided to change Par. 246, to Par. 246*a*,



Proportions may be larger or 1/10 smaller than those shown.
Fillet under heads may be used but are not required.

Fig. 17a Acceptable Forms of Rivet Heads

and to add Par. 247, calling it Par. 246*b*. Since the publication of the June issue of The Journal it has been proposed to revise this new Par. 246*b* (formerly Par. 247) to read as follows:

b A cast-iron header when tested to destruction, shall withstand a hydrostatic pressure of at least 1200 lb. per sq. in. and a malleable-iron header, 1500 lb. A hydrostatic test at 400 lb. per sq. in. for cast iron and 500 lb. per sq. in. for malleable iron shall be made on all new headers with tubes attached.

This has been referred to a Sub-Committee of the Boiler Code Committee on Malleable Iron for consideration.

Par. 247. As it was decided to change Par. 247 to Par. 246*b*, a new Par. 247 was proposed and published in the June issue of the Journal. The new paragraph contained two parts, *a* and *b*. It has been decided to omit the first part, *a*, entirely, and to revise the remaining portion slightly, so that Par. 247 will read as follows:

247 Where it is impossible to calculate with a reasonable degree of safety the strength of a boiler structure or any part thereof, a full sized sample shall be built by the manufacturer and tested to destruction in the presence of the Boiler Code Committee or one or more representatives of the Boiler Code Committee appointed to witness such test.

PAGE 65

Par. 253. Change Par. 253 to make it read as follows:

253 *Drilling of Holes.* All rivet holes and staybolt holes and holes in braces and lugs shall be drilled full size or they may be punched not to exceed 1/4 in. less then full diameter for material over 5-16 in. in thickness, and 1/8 in. less than full diameter for material not exceeding 5-16 in. in thickness, and then drilled or reamed to full diameter with plates, butt straps, braces, heads and lugs bolted in position. Tack bolts for seams shall be not over 12 in. apart.

Par. 255. The illustration showing forms of rivet heads that will be acceptable is Fig. 17*a*.

PAGE 68

Par. 268. Change Par. 268 to make it read as follows:

268 *Threaded Openings.* A threaded pipe connection 1 in. in diameter or over shall have not less than the number of threads given in Table 7.

TABLE

If the thickness of the material in the boiler is not sufficient to give such number of threads, the opening shall be reinforced by a pressed steel, cast steel, or bronze composition flange, or plate, so as to provide the required number of threads as shown in Fig. 18a.

When the maximum allowable working pressure exceeds 100 lb. per sq. in., a flanged nozzle shall be used for all threaded pipe openings over 3 in. pipe size.

Par. 269. Change Par. 269 to make it read as follows:

269 *Safety Valve Requirements.* Each boiler shall have two or more safety valves, except a boiler for which one safety valve having a relieving area of 3/4 sq. in. or less is required by the rules.

PAGE 69

Par. 273. Change Par. 273 to make it read as follows:

273 Each safety valve shall be plainly marked by the manufacturer. The markings may be stamped on the body, cast on the body, or stamped, etched, or cast on a plate or plates riveted to the body, and shall contain the following:

a The name or identifying trademark of the manufacturer
b The nominal diameter with the words "Bevel Seat" or "Flat Seat"
c The steam pressure at which it is set to blow
d The lift in inches of the valve disc from its seat, measured at a pressure 3 per cent higher than that at which the valve is set to blow
e The weight of steam discharged in pounds per hour at a pressure 3 per cent higher than that for which the valve is set to blow
f A.S.M.E. Standard.

PAGE 74

Par. 282. Change Par. 282 to make it read as follows:

282 For the purposes of inspection and to insure the valve being free, each safety valve shall have a substantial lifting device by which the valve may be raised from its seat at least 1-16 in. when there is no pressure on the boiler.

PAR. [illegible] ADD TO PAR. [illegible] THE FOLLOWING:

[illegible] safety valve shall be non ferrous [illegible] safety valve shall be fastened [illegible] such a way that there is no [illegible]

[illegible] PAR. [illegible] TO READ AS FOLLOWS:

[illegible] used in safety valves shall not show a [illegible] exceeding 1/32 in. ten minutes after being [illegible] from a cold compression test closing the spring [illegible]. The spring shall be so constructed that the valve [illegible] at 1/10 the diameter of the seat before the coils are closed or before there is other interference.

PAR. 286. CHANGE PAR. 286 TO MAKE IT READ AS FOLLOWS:

286 All flange dimensions shall conform to the American Standard given in Tables 15 and 16 of the Appendix for the pressures therein specified except that the face of the safety valve flange and the nozzle to which it is attached may be flat and without the raised face for pressures up to and including 250 lb. per sq. in. For higher pressures, the raised face shall be used.

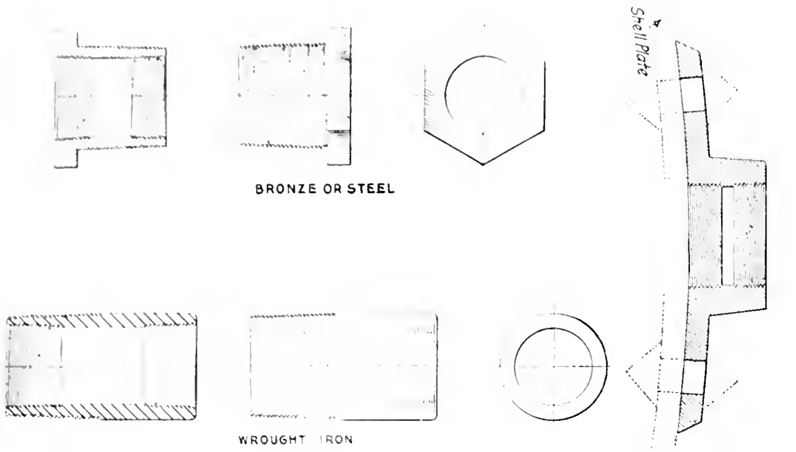


FIG. 18A TYPES OF BOILER FLANGES AND BUSHINGS

PAGE 75

PAR. 291. ADD TO PAR. 291 THE FOLLOWING:

The lowest permissible water level for various classes of boilers shall be the location of the fusible plug as given in Par. 430 of the Appendix.

PAR. 292. A REVISION OF THIS PARAGRAPH WAS PUBLISHED IN THE JUNE ISSUE OF THE JOURNAL BUT IT HAS BEEN FINALLY DECIDED TO CANCEL THIS PROPOSED REVISION AND TO LEAVE PAR. 292 AS IT STANDS IN THE 1914 EDITION OF THE CODE. THIS MATTER HAS BEEN REFERRED TO A SPECIAL SUB-COMMITTEE OF THE BOILER CODE COMMITTEE.

PAGE 76

PAR. 299. CHANGE PAR. 299 TO MAKE IT READ AS FOLLOWS:

299 [illegible] *and Fittings.* Flanged cast iron pipe [illegible] used for boiler parts, for pressures up to and [illegible] lb. per sq. in., shall conform to the American [illegible] in Tables 15 and 16 of the Appendix, [illegible] the face of the flange of a safety valve as [illegible] a safety valve nozzle, may be flat and [illegible] For pressures above 160 lb. per sq. in. steel cast or wrought steel fittings shall be used for boiler parts with exceptions specified in Pars. 9 and 12. An allowable variation of 20 per cent from the flange thickness required by Tables 15 and 16 may be made for steel cast and forged steel fittings, leaving the drilling of bolt holes unchanged. For pressures above 250 lb. per sq. in., the flange thickness and the thickness of the bodies shall be increased to keep within the same deflection limits and to give at least the same factor of safety as the fittings specified in Tables 15 and 16. The flange of a safety valve may have a flat face for pressures up to and including 250 lb. per sq. in., and shall have a raised face at higher pressures; a safety valve nozzle may have a flat face for pressures up to and including 250 lb. per sq. in. and shall have a raised face at higher pressures. Tables 15 and 16 do not apply to flanges on the boiler side of steam nozzles or to flanges left by the manufacturer as part of the boiler, and do not apply to fittings designed as part of the boiler.

PAR. 307. CHANGE PAR. 307 TO MAKE IT READ AS FOLLOWS:

307 *Blow-off Piping.* A surface blow-off shall not exceed $1\frac{1}{2}$ in. pipe size and the internal and external pipes shall form a continuous passage, but with clearance between their ends and arranged so that the removal of either will not disturb the other. A properly designed brass or steel bushing as shown in Fig. 18A or flanged connection, shall be used.

PAGE 77

PAR. 311. CHANGE PAR. 311 TO MAKE IT READ AS FOLLOWS:

311 *a.* On all boilers except those used for traction and portable purposes, when the maximum allowable working pressure exceeds 125 lb. per sq. in., each bottom blow-off pipe shall have two valves, or a valve and a cock, and such valves, or valve and cock, shall be extra heavy, except that on a boiler having multiple blow-off pipes, a single master valve may be placed on the common blow-off pipe from the boiler, in which case only one valve on each individual blow-off is required.

b. All traction and portable boilers shall have one bottom blow-off valve; when the maximum allowable working pressure exceeds 125 lb. per sq. in., the blow-off valve shall be extra heavy.

PAR. 315. ALLOW THE REVISION TO STAND AS IT APPEARS IN THE JUNE JOURNAL AND ADD TO IT THE FOLLOWING:

In Fig. 18*a* is illustrated a standard form of flange to use on boiler shells for passing through piping such as feed, surface, blow-off connections, etc., and which permits of the pipes being screwed in solid from both sides in addition to the reinforcing of the opening in the shells.

PAGE 79

PAR. 325. ALLOW THE REVISION TO STAND AS IT APPEARS IN THE JUNE JOURNAL AND ADD TO IT THE FOLLOWING:

For traction or portable boilers, studs with pipe threads may be used.

PAR. 328. CHANGE PAR. 328 TO MAKE IT READ AS FOLLOWS:

328 A water-tube boiler shall have the firing door or clinker doors of the inward opening type unless such doors are provided with substantial and effective latching or fastening devices to prevent them from being blown open by pressure on the furnace side.

PAGE 82

PAR. 343. ALLOW THE REVISION TO STAND AS IT APPEARS IN

the June issue except that it is now made one paragraph as follows:

343 In a *hot-water* boiler to be used exclusively for heating buildings or hot-water supply, when the diameter does not exceed 60 in. and the grate area does not exceed 10 sq. ft., or equivalent as defined in Pars. 359 and 360, longitudinal lap joints will be allowed. When the grate area exceeds 10 sq. ft., or euivalent as defined in Pars. 359 and 360, and the diameter of the boiler does not exceed 60 in., longitudinal lap joints will be allowed provided the maximum allowable working pressure does not exceed 50 lb. per sq. in.

PAGE 113—APPENDIX

Par. 430. A revision of the first line of Par. 430 was published in the June issue of The Journal. It has now been decided to cancel this revision and let the first line stand as it appears in the 1914 Edition of the Code. In the June Journal a proposed addition to Par. 430 was published, and it has been decided to allow this addition to remain as it appears in The Journal, so that the final form of Par. 430 is the same as in the 1914 Edition of the Code with the addition of clause *v* as follows:

v Fire Engine Boilers are not usually supplied with fusible plugs. Unless special provision is made to keep the water above the firebox crown sheet other than by the natural water level, the lowest permissible water level shall be at least 3 in. above the top of the firebox crown sheet.

PART II

Additional Revisions Proposed by the Boiler Code Committee

PAGE 1

Title Page

Change line at bottom of p. 1 which reads as follows:

Edition of 1914 with Index

to read as follows:

Edition of 1918

(New edition of Boiler Code to be copyrighted under date of 1918).

PAGE 2

Letter to the Council

Change letter to the Council to read as follows:

To the Council of The American Society of Mechanical Engineers.

Gentlemen: Your Committee respectfully submits the following revised report on Rules for the construction of, and allowable working pressures on stationary boilers, this report forming a part of the task that has been assigned to it. Stationary boilers as here considered are land boilers and include portable and traction boilers. The Rules do not apply to boilers which are subject to federal inspection and control, such as marine boilers, boilers of steam locomotives and other self-propelled railroad apparatus.

The primary object of the Rules is to secure safe boilers. The interests of boiler users and manufacturers have been carefully considered and the requirements made such that they will not entail undue hardship by departing too widely from present practice.

The Code applies only in part to certain special forms of boilers such as those of the forced circulation or flash type. New matter has been added to state that the material for boilers of this class shall conform to the requirements of the Code, and that other requirements shall also be met except where they relate to special features of construction made necessary in boilers of this type, and to accessories that are manifestly not needed or used in connection with such boilers, such as water gages, water columns, and gage cocks.

In those states and municipalities which have adopted the Boiler Code, your Committee recommends that all requests for interpretations of the Boiler Code be referred to the state authorities having jurisdiction over such matters. In order to maintain uniformity of practice it is also suggested that the authorities having jurisdiction be requested to submit all inquiries where there is any question of doubt to the Boiler Code Committee. Where there is a question respecting the interpretation of the Code, or where constructions apparently are not covered by the Code, it will be most desirable to have the matter referred to the Boiler Code Committee. Unless this procedure is followed, the aim to obtain uniformity in the application of the Code will be defeated. The Boiler Code Committee desires to coöperate to the limit of its ability in assisting in the application of the Code, and will take pleasure in considering all matters where there is any question of doubt that may be brought before it by the various states and municipalities that adopt the Code.

The Committee does not pass on questions concerning specific designs of boilers or appurtenances thereto.

Your Committee recommends that a hearing be held by the Boiler Code Committee at least once in four years at which all interested parties may be heard, in order that such revisions may be made as are found to be desirable, as the state of the art advances.

Yours truly,

John A. Stevens, *Chairman*,

Wm. H. Boehm, Boiler Insurance
Rolla C. Carpenter, Engineering Research
Frank H. Clark, Railroad Sub-Committee, The American Society of Mechanical Engineers
Francis W. Dean, Consulting Engineers
Thomas E. Durban, Chairman, The American Uniform Boiler Law Society. All types of boilers
Elbert C. Fisher, Scotch marine and other types of boilers
Charles E. Gorton, Steel heating boilers
Arthur M. Greene, Jr., Engineering Education
Richard Hammond, Scotch marine and other types of boilers
A. L. Humphrey, Railroad Sub-Committee, The American Society of Mechanical Engineers
Charles L. Huston, Boiler plate manufacturer
D. S. Jacobus, Water-tube boilers
S. F. Jeter, Boiler Insurance
Wm. F. Kiesel, Jr., Railroad Sub-Committee, The American Society of Mechanical Engineers
W. F. MacGregor, National Association of Tractor and Thresher Manufacturers
Edward F. Miller, Engineering Research
M. F. Moore, Steel heating boilers
I. E. Moultrop, Boiler users
Richard D. Reed, Cast iron heating boilers
H. H. Vaughan, Railroad Sub-Committee, The American Society of Mechanical Engineers
C. W. Obert, Secretary to Committee.

PAGE 5

Heading

Insert above heading of p. 5 the following:

A.S.M.E. Boiler Code

PAGE 7

Heading

Insert above heading of p. 7 the following:

A.S.M.E. Boiler Code

PAGE 8

Par. 9. It has been proposed to add a sentence to Par. 9, as follows:

> Malleable iron may be used when the maximum allowable working pressure does not exceed 200 lb. per sq. in., and the maximum inside diameter or diagonal dimension does not exceed 7 in.

This has been referred to a Sub-Committee of the Boiler Code Committee on Malleable Iron for consideration.

Par. 14. Insert the following at the beginning of Par. 14:

> In determining the maximum allowable working pressure.

PAGE 10

Par. 21. Add to Par. 21 the following:

> Specifications and maximum allowable working pressures for various gages for super-heater tubes shall be the same as for water tubes.

PAGE 12

Par. 29*b*. Strike out the words "or under" from the first line.

PAGE 44

Par. 182. Modification of this paragraph is in the hands of a special Sub-Committee of the Boiler Code Committee of Back Pitch.

PAGF 46

Par. 192. Add new section to Par. 192 as follows:

> *c* The strength of those ligaments between the tube holes which are subjected to a longitudinal stress shall be at least one-half the required strength of those ligaments which come between the tube holes which are subjected to a circumferential stress.

PAGES 55-56

Par. 221. Replace Fig. 15 by revised cut

PAGE 47

Par. 193. Modification of this paragraph is in the hands of a special Sub-Committee of the Boiler Code Committee on Diagonal Ligaments

PAGE 49

Par. 198. Change Par. 198 to read as follows:

> 198 A manhole opening in a dished head shall be flanged to a depth of not less than three times the *required* thickness of the head measured from the outside.

Par. 199. Add the following at the end of Par. 199:

> Acceptable proportions for the ends of through stays are indicated in Fig. 12a.

PAGE 59

Par. 234. Under "where" change derivation of D to read:

> D = least horizontal distance between tube centers on a horizontal row, in.

Immediately below the derivation of letters insert:

> Where tubes are staggered the vertical distance between the center line of tubes in adjacent rows must be not less than $1/2 \sqrt{(2dD + 4^2)}$.

The above formula has been referred to a special Sub-Committee of the Boiler Code Committee.

PAGE 64

Par. 245. It has been proposed to change Par. 245 to read as follows:

> 245 *Cast-iron and Malleable Iron Headers.* The pressure allowed on a water-tube boiler shall not exceed 160 lb. per sq. in. when the tubes are secured to cast-iron headers, nor 200 lb. when the tubes are secured to malleable iron headers. The form and size of the internal cross section perpendicular to the longer axis of a cast-iron or malleable iron header at any point shall be such that it will fall within a 7 in. by 7 in. rectangle.

This has been referred to a Sub-Committee of the Boiler Code Committee on Malleable Iron for consideration.

Par. 251. Change Par. 251 to read as follows:

> 251 The ends of all tubes, suspension tubes and nipples shall be flared not less than $\frac{1}{8}$ in. over the diameter of the tube hole on all water-tube boilers and superheaters, or they may be flared not less than $\frac{1}{8}$ in., rolled and beaded, or flared, rolled and welded.

PAGE 65

Par. 254. Change Par. 254 to read as follows:

> 254 After drilling or reaming rivet holes the plates and butt straps shall be separated, the burrs and chips removed, the plates and butt straps reassembled metal to metal with barrel pins fitting the holes, and with tack bolts.

Par. 256. Change Par. 256 to read as follows:

> 256 Rivets shall be machine driven wherever possible with sufficient pressure to fill the rivet holes, and shall be allowed to cool and shrink under pressure. Barrel pins fitting the holes and tack bolts shall be used. The tack bolts shall be not over 12 in. apart, and a rivet shall be driven each side of each tack bolt before removing the tack bolt.

PAGES 65-66

Pars. 260-261

> The Executive Committee of the Boiler Code Committee will report later respecting openings that need not be reinforced and on methods of reinforcing openings that need not come under the same rules as for manholes.

PAGE 67

Par. 261. Change the two lines of Par. 261 at the top of p. 67 to read:

> l = length of center line of opening in shell in direction parallel to axis of shell plus the sum of the diameters of the rivet holes that come in or adjacent to the center line of the opening, in.

PAGE 69

Par. 272. Change Par. 272 to read as follows:

> 272 Safety valves shall be of the direct spring loaded

pop type with seat and bearing surface of the disc inclined at any angle between 45 deg. and 90 deg. to the center line of the spindle. The valve shall be rated at a pressure 3 per cent in excess of that at which the valve is set to blow.

Safety valves may be used which are constructed with pilot valves or assistant cylinders. Such valves may give any opening up to the full discharge capacity of the area of the opening at the base of the valve, provided the opening of the valve is gradual so as not to induce lifting of the water in the boiler.

All safety valves shall be so constructed that shocks, detrimental to the valve or boiler, are not produced.

The question of the blow-down limit has been referred back to the Executive Committee.

Par. 274. Change Par. 274 to read as follows:

274 The minimum allowable relieving capacity of the safety valve or valves required on a boiler shall be determined on the basis of 6 lb. of steam per hour per sq. ft. of boiler heating surface for water tube boilers. For all other types of power boilers with pressure above 100 lb. the minimum allowable relieving capacity shall be determined on the basis of 5 lb. of steam per hour per sq. ft. of boiler heating surface and on the basis of 3 lb. with pressures at or below 100 lb. per sq. in. The heating surface shall be computed for that side of the boiler surface exposed to the products of combustion, exclusive of the superheating surface. In computing the heating surface for this purpose only the tubes, fireboxes, shells, tube sheets and the projected area of headers need be considered. The minimum number of safety valves required shall be determined on the basis of the minimum allowable relieving capacity and the relieving capacity marked on the valves by the manufacturer.

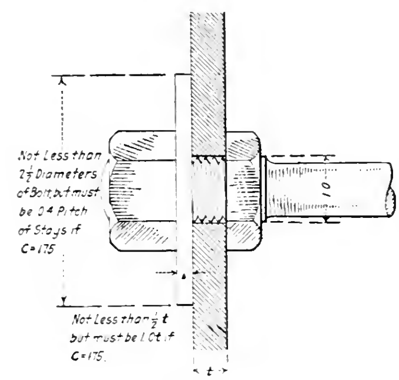


Fig. 12a Acceptable Proportions for Ends of Through Stays

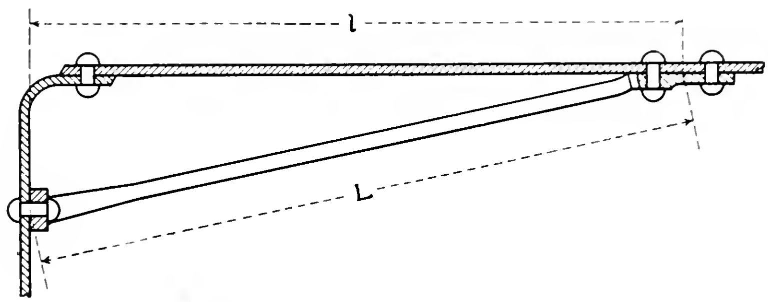


Fig. 15 Measurements for Determining Stresses in Diagonal Stays

PAGE 74

Par. 287. Change Par. 287 to read as follows:

287 When the valve body is marked with the letters A.S.M.E. Std. as required by Par. 273, this shall be a guarantee by the manufacturer that the valve conforms with the details of construction herein specified.

Par. 288. Change Par. 288 to read as follows:

288 Every superheater shall have one or more safety valves near the outlet. The discharge capacity of the safety valve or valves on an attached superheater may be included in determining the number and size of safety valves for the boiler provided there are no intervening valves between the superheater safety valve and the boiler, and provided the discharge capacity of the safety valve or valves on the boiler as distinct from the superheater is at least 75 per cent. of the total valve capacity required.

PAGE 77

Par. 314 Omit the last sentence so that Par. 314 reads as follows:

314 *Feed Piping.* The feed pipe of a boiler shall have an open end or ends inside of the boiler.

Par. 317 Add to Par. 317 the following:

Wherever globe valves are used on feed piping, the inlet shall be under the disc of the valve.

PAGE 79

Par. 332. Change Par. 332 to read as follows:

332 After obtaining the stamp to be used when boilers are to be constructed to conform with the A.S.M.E. Boiler Code, it is understood that a state inspector, municipal inspector, or an inspector employed regularly by an insurance company which is authorized to do a boiler insurance business in the state in which the boiler is built and in the state in which it is to be used, is to be notified that an inspection is to be made and shall inspect such boilers during construction and after completion. At least two inspections shall be made, one before reaming rivet holes and one at the hydrostatic test. In stamping the boiler after completion, if built in compliance with the Code, the builder shall stamp the boiler in the presence of the inspector, after the hydrostatic test, with the A.S.M.E. Code stamp, the builder's name and the serial number of the manufacturer. A data sheet shall be filled out and signed by the manufacturer and the inspector. This data sheet together with the stamp on the boiler shall denote that it was constructed in accordance with the A.S.M.E. Boiler Code.

The name of the state in which the boiler is built shall be stamped under and about one-half inch below the symbol. The name or initials of the manufacturer shall be stamped below the name of the state, together with the serial number of the boiler, and not over one-half inch therefrom. (Samples of data sheets appear in the Appendix, p. ....)

Stamps for the official symbol shown in Fig. 19 are obtainable from The American Society of Mechanical Engineers.

PAGE 80

Fig. 20. Par. 332.

A revision of Fig. 20 was published in the June issue of The Journal, but it has been decided to revise it again as follows:

(Name of State)
..................STD
(Manufacturer's number of boiler)
.....................1
(Name and location of builder)
(Installation No.) (Name of State)
.....................1
(Year put into service)
....

PAGE 81

[illegible] Ma[illegible] to [illegible] 81 [illegible] read as follows:

A.S.M.E. Boiler Code

PART I. SECTION II

[illegible] for low pressure steam and hot water heating and boilers for hot water supply

Par. [illegible]. Change Par. [illegible]15 to read as follows:

[illegible]. A boiler used for low pressure steam heating or [illegible] water supply shall be provided with washout holes [illegible] removal of any sediment that may accumulate [illegible]. Steel shell boilers of the locomotive or vertical fire tube type shall conform to the requirements of Pars. 205 and 206 for washout holes.

Par. 351. Change Par. 351 to read as follows:

351a. No shut-off of any description shall be placed between the safety or water relief valves and boilers, nor on discharge pipes between them and the atmosphere.

b. No boiler for hot water supply shall be connected to a water supply pipe fitted with a check valve or pressure reducing valve.

PAGE 86

Par. 363. Add to Par. 363 the following:

Temperature Regulator. A temperature regulator shall be applied to *hot water* supply boilers which will prevent the temperature from rising above 200 deg. fahr.

PAGE 89

Heading. Insert above heading of p. 89 the following:

A.S.M.E. Boiler Code

PAGE 91

Par. [illegible]2. Change Par. [illegible]2 to read as follows:

[illegible] the methods outlined in sections *b* or *c* of Par. 391 is employed, the safety valve capacities shall be those given in Table 10.

[illegible] and their [illegible], furnace [illegible] and domestic coil or pipe, gas or [illegible] under this section.

PAGE 95 APPENDIX

Heading. Insert above heading of Page 95 the following:

A.S.M.E. Boiler Code

PAGE 103

Par. 417

Change first sentence of Par. 417 to read as follows:

417 Figs. 28 and 29 illustrate other joints that may be used in which eccentric stresses are avoided.

Also in Appendix insert the following:

Where repairs are necessary which in any way affect the working pressure or safety of a boiler, a state inspector, municipal inspector, or an inspector employed regularly by an insurance company which is authorized to do a boiler insurance business in the state in which the boiler is used, shall be called for consultation and advice as to the best method of making such repairs; after such repairs are made they shall be subject to the approval of a state inspector, municipal inspector, or an inspector regularly employed by an insurance company which is authorized to do a boiler insurance business in the state in which the boiler is used.

Under Table 3 reference is made to Fig. 31 showing application of Pars. 205, 206 and 207.

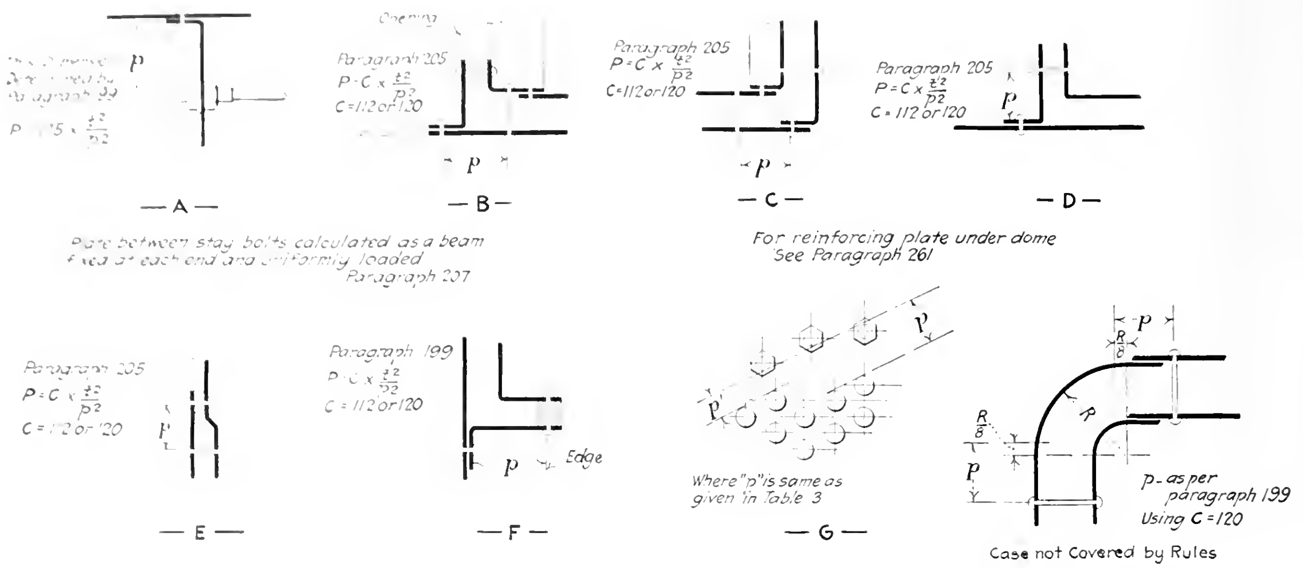


Fig. 31 Details Showing Application of Pars. 205, 206 and 207 to the Staying of Wet-Bottom Boilers

JOINT MEETING OF THE SPECIAL SUB-COMMITTEE ON MATERIAL SPECIFICATIONS

A joint meeting of the special Sub-Committee of the Committee A-1 on Steel of the American Society for Testing Materials and the special Sub-Committee of The American Society of Mechanical Engineer's Boiler Code Committee, appointed to confer on the subject of material specifications, was held in the Engineering Societies Building, New York, on October 26, 1917.

Specifications for Boiler-Plate Steel

It was agreed that 8000-lb. range for tension tests of firebox steel is too small to allow for check tests and that in order to make check tests the range should be 10,000 lb. It

MANUFACTURERS' DATA REPORT OF BOILER

As Required by the Provisions of the A.S.M.E. Rules

1. Boiler manufactured by.. at...............
2. Boiler manufactured for.. of...............
3. Type of boiler **LOCOMOTIVE** and other Internally-Fired Boilers, STATIONARY........................ BOTTOM Serial No................
(State if wet bottom or open bottom.)
(Alternate) HORIZONTAL RETURN TUBULAR and other Externally-Fired and Water Tube Boilers.
4. Shell plates and butt straps made by..
5. (*a.*) Mill test report on shell plates:.......................................Yield point...................
(Tensile strength. Lb. per sq. in.) (Lb. per sq. in.)
(*b.*) Elongation..........%. Phos....0.........%. Sul....0...........%. Man....0....to 0...........%
(In 8 Inches.)
6. Mill test report on butt straps.. Thickness..........in.
(Brand and tensile strength.)
7. Stamps on shell plates.. Thickness..........in.
(Brand and tensile strength.)
8. Furnace sheets made by....................Stamped.................................. Thickness..........in.
(Brand and tensile strength.)
9. Heads made by......................Stamped.................................. Thickness..........in.
(Brand and tensile strength.)
10. Rivets made by.. Material...................
11. Stays made by.. Material...................
12. Channel or angle irons on heads..Upper tubes to shell.........in.
(No. and size on each head.)
13. (*a.*) Stays above tubes...
[No. each head, and type (through, head to head, or diagonal, welded or weldless) and net cross-sectional area of each size of each type.]
(*b.*) ....Area to be stayed................sq. in.
(Each head above tubes.)
(*c.*) Stays below tubes...
[No. each head, and type (through, head to head, or diagonal, welded or weldless) and net cross-sectional area of each size of each type.]
(*d.*) ....Area to be stayed................sq. in.
(Each head below tubes.)
14. (*a.*) Stay bolts:--Made by........................Material..........................Size..........sq. in.
(Area at bottom of thread.)
(*b.*) Maximum pitch of................in.×................in.
[Circumferential (or Horizontal) X Vertical.]
15. **Shell:—Diam**..............in. Length over all.............ft...............in. No. of courses...........
(Inside of outside course.)
16. (*a.*) Longitudinal joints:—Type of.. Riveting......................
(Double, triple, quad., etc.)
Diam. rivet holes..........in. Pitch of rivets.........."×........."×........." Efficiency of joint.......%
(Minimum pitch on each row.)
(*b.*) Circumferential joints:—Type of.................................... Riveting......................
Diam. rivet holes..........in. Pitch of rivets.........."×........."×........." Efficiency of joint.......%
(Minimum pitch on each row.)
17. Tubes—No.......Gage......... Diam.............in. Length...............ft................in.
18. Steam outlets:—No.......... Material of nozzle or reinforcement.......................... Sizes..........in.
(Cast steel or cast-iron, pressed steel or steel plate.)
19. Grate area................sq. ft.
20. Size of feed connection............in. Size of bottom blow-off connection...........in.
21. Constructed for a pressure of...............lb. per sq. in. Tested to...............lb. per sq. in.
(Hyrostatic pressure.)
22. If boiler has a dome, send working drawing of dome, also showing connection to boiler and openings in shell under dome.

REMARKS:—..
....

We certify the above data to be correct and that all details of **MATERIAL, CONSTRUCTION** and **WORKMANSHIP** on this boiler conform to the A.S.M.E. Rules.

(Signed)..
(Manufacturer.)

.............................19 by...............................

Received.......................19 Checked.......................19 by.......................
Authorized State or Insurance Inspector

Rules allow a max. pressure of.........lb., this being based on...

Fig. 32 Front Side of Data Sheet Form

CERTIFICATE OF BOILER SHOP INSPECTION

Insurance Company's Serial Number..
BOILER WORKS OF.................................... at...

I, the undersigned, holding a certificate of competency as an inspector of steam boilers in THE STATE OF......................., and employed by the..... .... of...................., inspected internally and externally, the boiler specified in this report, on..................... ....19 , and certify that the statements made on this report are correct, corresponding with the mill test reports of material as furnished by the builders, and measurements made of the boiler when completed; and that this boiler is constructed in accordance with the A.S.M.E. Rules.

....
Inspector of Boilers for State or Boiler Insurance Company.

Fig. 33 Rear Side of Data Sheet Form

was then pointed out by those representing the Boiler Code Committee that should the range be made 10,000 lb., the physical requirements for firebox and flange steel would be identical, with the single exception that a homogeneity test is required for firebox and not for flange steel. Those representing the Boiler Code Committee were most earnest in the belief that should the tensile requirements be made the same, something should be introduced into the specifications to further differentiate between the physical qualities of the two grades.

It was proposed that as one of the essential differences between firebox and flange steel is in the amount of discard, a test of material taken from the top of the plate might be employed to show the difference between the firebox and flange grades. The samples for the bending test in the proposed revision are specified to be taken transversely from the middle of the top of the finished rolled material, and it would seem that the requirements for these cross-bending tests could be made more exacting for firebox steel than for flange steel. After considerable discussion it was unanimously agreed that the sub-committees recommend to their respective associations that the tensile range for firebox steel be made 10,000 lb. (55,000 to 65,000 lb.) and that the requirement for the bending tests for firebox steel be made more exacting than for flange steel.

It was further agreed that a recommendation be made that the diameter of the mandrel about which a specimen is bent in the bending tests should depend on the square of the thickness of the plate.

Specifications for Steel Castings

After consideration of the question of the sulphur requirement, it was the sense of the meeting that it would be inexpedient at the present time to make any change in the sulphur requirements for Class B steel castings.

ACTION OF BOILER CODE COMMITTEE

The minutes of the above meeting, which included a tentative rule for the diameter of mandrels to be used in the bending tests and a table of values for various thicknesses of plate, were approved as to form by the Boiler Code Committee at the meeting of Nov. 9. At this same meeting the Boiler Code Committee directed its Sub-Committee to take up with the Sub-Committee of the American Society for Testing Materials the advisability of making homogeneity tests for firebox steel on the samples used for the bending tests, which in the proposed revision are specified to be taken transversely from the middle of the top of the finished rolled material.

TABLE 10 DISCHARGE CAPACITIES FOR DIRECT SPRING-LOADED POP SAFETY VALVES, WITH 45 DEG. BEVEL SEATS

Gage Press., Lb. per Sq. In.		Diameter of Valve, In.								
		1	1¼	1½	2	2½	3	3½	4	4½
15	Lb.hr.	163	203	293	456	651	977	1254	1564	1906
25	Lb.hr.	218	272	392	610	871	1307	1676	2090	2547
50	Lb.hr.	354	444	639	994	1419	2129	2732	3406	4151
75	Lb.hr.	492	615	886	1377	1968	2951	3788	4722	5756
100	Lb.hr.	629	786	1133	1761	2516	3774	4843	6038	7358
125	Lb.hr.	767	957	1379	2145	3064	4596	5899	7354	8963
150	Lb.hr.	904	1129	1625	2529	3613	5419	6954	8670	10566
175	Lb.hr.	1040	1301	1872	2913	4161	6242	8010	9984	12173
200	Lb.hr.	1178	1472	2119	3296	4709	7064	9068	11305	13773
225	Lb.hr.	1315	1643	2366	3680	5258	7890	10120	12616	15383
250	Lb.hr.	1451	1814	2613	4064	5807	8708	11175	13938	16980
275	Lb.hr.	1589	1986	2860	4448	6354	9533	12233	15248	18585
300	Lb.hr.	1746	2157	3107	4832	6903	10358	13290	16568	20195

The discharge capacity of a flat seat valve of a given diameter with a given lift, may be obtained by multiplying the discharge capacity given in the Table for a 45 deg. bevel seat valve of same diameter and same lift, by 1.4.

In a report upon accidents and accident prevention in machine building, which has just been completed by the Bureau of Labor Statistics, an innovation in the preparation of statistics of this character is introduced to show the seriousness of accidents as well as their frequency. For this purpose, new data are introduced under the title of "severity rates." The result is a collection of illuminating figures which show not only the number of accidents occurring in plant or industry or per thousand of employees, but also the extent to which the working forces employed have been actually incapacitated by injuries incident to their occupations.

A shaft seldom breaks all at once. The conditions that cause the break have been in existence and started the trouble a long time before the final complete rupture comes. The unintentional and undue strain on the shaft every time it jumps in the boxes and the continual heavy strain at regular intervals soon cause a crystallized condition in that part of the shaft where the greatest strain occurs. The crystallization usually begins at a point on the outer circumference of the shaft and travels toward the center. It does not necessarily—and in fact seldom does—affect the entire circumference. At this fragile point, then, a crack is started and as the crystallization grows the crack grows deeper until finally the good metal remaining, no longer able to withstand the strain, breaks. When the broken ends are examined, the fresh break shows only as far as the good metal held on. The original crack may have been started months before, and the constant motion caused the broken parts to rub together until they appear as if they had never been united. Many times the owner of the machine uses the expression, "That was never welded properly," or "The shaft was only partly welded." The common opinion or supposition that crankshafts are welded together is ill-founded. Cranks are generally either drop-forgings or steel castings or made by cutting them out of solid steel billets, and no welding process whatever enters into their formation.—*Power.*

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

THE offices of the Society are particularly busy at this time and all the departments are carrying an overload. About 20 per cent of the membership are directly or indirectly engaged in war activities. This means that the Society is without the services of nearly 2000 members, and, as might be expected, it is always the most active ones—not only in this Society but in other organizations generally—who are the first to offer themselves for the service of their country. The result has been that many adjustments in personnel of committees and provisions for taking care of committee and section work, have had to be made.

The Committee on Meetings has lost the opportunity for consultation with Major John H. Barr, who is now in Washington in the trench-warfare division of the War Department in charge of bombing devices.

The Publication Committee has lost Prof. J. W. Roe, who is working for the Government on specifications and rules for instruction for aviation work. The Chairman of the Committee, Mr. Fred R. Low, reports that he is greatly handicapped by a depletion in his staff.

The Committee on Sections has lost Mr. Whitlock who is a Major in the Engineer Officers' Reserve Corps. The personnel of the Executive Committees of several of the Sections has been depleted by war activities.

The New York Section Committee which, in addition to its regular meetings work, is in charge of the entertainment at the forthcoming Annual Meeting, has had to get along without Messrs. Swan, Prindle and Blake. Mr. Swan has a commission in the Engineer Officers' Reserve Corps, and Mr. Blake is in Washington working in the Ordnance Department.

Prof. W. B. Gregory, another member of the Council and a member of the New Orleans Section Committee, is now in France reporting directly to General Pershing. Mr. John Hunter, of the St. Louis Section Committee and Vice-President-elect, is on the Emergency Shipping Board. The Worcester Section Committee has lost two members in the persons of Messrs. Richard G. Williams and E. Howard Reed. The Erie Section has lost its chairman, Mr. J. F. Wadsworth.

Mr. George M. Brill, member of the Committee on Student Branches, is a Major in the Engineer Officers' Reserve Corps and Prof. W. D. Ennis, chairman of the Brooklyn Polytechnic Institute Branch, has a similar commission.

Mr. Park A. Dallis, chairman of the Atlanta sub-committee on Increase of Membership, is a Captain in the Engineer Section of the Officers' Reserve Corps.

Many of the special committees of the Society are depleted for this same reason of war activities. Mr. Ralph D. Mershon, member of the Research Committee, is a Major in the Engineer Officers' Reserve Corps. Prof. Lionel S. Marks, chairman of the Sub-Committee on Clinkering of Coal of the Research Committee, has been in Washington for some time as internal-combustion-engine expert for the Government.

Prof. Carl C. Thomas, member of the Research Committee and chairman of the Sub-Committee on Air Machinery of the Committee on Meetings, is now manager of machinery fabrication for the American International Shipbuilding Corporation.

Mr. Charles Day, member of the Sub-Committee on Industrial Buildings, is a member of the Production Committee of the Emergency Fleet Corporation and is now in England.

Mr. W. S. Gifford, member of the Joint Committee of Standards for Graphic Presentation, is Director of the Council of National Defense.

Mr. Edwin B. Katte, member of the Sub-Committee of Railroads, is a Major in the Engineer Officers' Reserve Corps.

These changes in committees have, of course, produced additional loads on the members left behind, but in all cases handicaps have been satisfactorily met.

Of the departments in the office, the Year Book Department has been rather severely taxed by the unusually large number of changes in addresses caused by members going into active service, coupled with the normal increase in membership in the Society, which has been sustained and has, so far, suffered no change on account of the war. The Publication Committee hopes to have the Year Book out on time and in good shape.

The Secretary's office has been unusually active in connection with the Annual Meeting which, as was anticipated, has been a very difficult one to prepare for. The Committee on Meetings is desirous of making the forthcoming convention a memorable one in the annals of the Society and at the same time bring out the service which the engineer can render the public at this critical time. Details of the program this year have been very difficult to consummate on account of the inability of prominent men to make promises in advance.

The Sections Department has also been particularly busy in maintaining this activity in the face of war conditions which have precluded many of the active Section members from contributing their normal work.

The number of callers at the office has been exceptionally heavy during the month, practically two-thirds of those coming in requesting information regarding service to our country.

The increased activity in the Employment Department, which commenced about three months ago, has been maintained and this department is taking care of at least twice the amount of its normal work. This department is coöperating with the Committee on Engineering Resources, in supplying the Government with large numbers of trained specialists.

CALVIN W. RICE,
Secretary.

The New York Alumni Associations of various colleges where technical courses are given will again hold reunions during the Annual Meeting. The following colleges are among those which have planned reunions for "College Reunion night," this year on December 7: Massachusetts Institute of Technology, Pennsylvania State College, Purdue University, Worcester, Polytechnic Institute. Other colleges will also hold these "get-together" functions, and complete announcement will be made in the final program.

ANNUAL MEETING PROGRAM

New York, December 4 to 7, 1917

Tuesday, December 4

12:00 m. Opening of Registration Bureau in Engineering Societies Building

12:30 p.m. Conference Luncheon, Council and Sections Delegates

2:[illegible] p.m. Council Meeting

2:[illegible] p.m. Meeting of Gage Committee

2:00 p.m. Sections Conference

8:30 p.m. Report of Tellers of Election and Introduction of the President-elect
Conferring of Honorary Membership upon Major-General George W. Goethals, followed by an address by Hon. William H. Taft
Reception by the President and the President-elect

Wednesday, December 5

9:45 a.m. Business Meeting: Amendments to the Constitution and By-Laws; Reports of Standing Committees; Address on the Activities of the Society for 1917, by President Hollis; Presentation to the Society of a Bust of Admiral B. F. Isherwood; Reports by Sub-Committees of the Research Committee

The consent of the meeting will be asked to adjourn the business meeting to Thursday morning in order to allow time for the addresses of the Keynote Session.

10:00 a.m. Keynote Session on The Service of the Engineer to the Public in Times of Crises

Universal Public Service in Peace and War, Dr. Ira N. Hollis, President of the Society. Other addresses will be given by distinguished men of national reputation on the following subjects relating to problems incident to the war: Coöperation of Engineers; The Agricultural Problem, The Fuel Problem; Engineering Research; Special Education in War Time; Building a Merchant Marine; Rail Transportation; Motor Transportation; The Aircraft Problem; Cantonments. This will be an all-day session.

12:30 p.m. Buffet Luncheon

2:00 p.m. Continuation of Keynote Session on The Service of the Engineer to the Public in Times of Crises

2:30 p.m. Simultaneous Sessions

POWER-PLANT SESSION

Preventable Waste of Coal in the United States, David Moffat Myers

A Commercial Analysis of the Small Turbine Situation, W. J. A. London

Bagasse as a Source of Fuel, E. C. Freeland

The Cooling of Water for Power-Plant Purposes, C. C. Thomas

The Steam Motor in the Automotive Field, E. T. Adams

GENERAL SESSION

The Transfer of Heat Between a Flowing Gas and a Containing Flue, Lawford H. Fry

A Study of Surface Resistance with Glass as the Transmission Medium, H. R. Hammond and C. W. Holmberg

Apparatus for Cooling, Drying and Purifying Air, W. J. Baldwin

Recent Developments in Balancing Apparatus, N. W. Akimoff.

Plotting Blower-Test Curves, A. H. Anderson *(By title only.)*

Cross-Current Predeterminations from Crank-Effort Diagrams, Louis Illmer *(By title only.)*

INDUSTRIAL-SAFETY SESSION

Two codes will be presented for discussion by the Sub-Committee on Protection of Industrial Workers, on Safety Standards for Elevators and Woodworking Machinery

3:[illegible] p.m. Meeting of Committees on Increase of Membership

3:[illegible] p.m. Ladies' Reception and Tea

(Continued on Next Page)

Wednesday, December 5 (*Continued*)

4:30 p.m. Student Branch Conference

8:15 p.m. Smoker

Get-together meeting for members. Mr. John R. Freeman, Past-President Am.Soc.M.E., will give an illustrated talk upon his trip to the Orient taken last winter with Dr. John A. Brashear and Mr. Ambrose Swasey, Past-Presidents Am.Soc.M.E. Music by Glee Club. Refreshments

Thursday, December 6

9:45 a.m. Business Meeting continued, followed by General Sessions

LOCAL-SECTIONS SESSION

This session will be held under the direction of the Sections Committee, for a discussion of the work of the Sections and of Society Affairs, by representatives of the 24 Sections of the Society

GENERAL SESSION

An Account of the Engineering Work of E. D. Leavitt, F. W. Dean

An Exact Volume Regulator for Blast Furnace Engines, L. C. Loewenstein

Expenses and Costs, H. L. Gantt

The following papers contributed by Local Sections will be presented by title:

By-Product Coke and Coking Operations, C. J. Ramsburg and F. W. Sperr, Jr.

The Submarine, C. H. Bedell

Combined Stresses, A. L. Jenkins

The Trumble Refining Process, N. W. Thompson

10:00 a.m. Joint Meeting of A.S.M.E. and S.A.E. Committees on Steel Roller Chains

12:30 p.m. Luncheon, at which there will be an address on The Relation of Industrial Management to Engineering, by Prof. Dexter S. Kimball

2:30 p.m. Simultaneous Sessions

MACHINE-SHOP SESSION

Under the auspices of the Sub-Committee on Machine Shop Practice

Topical Discussion on the subject of Inspection with the following introductory discussions:

The Logic of Inspection, A. L. DeLeeuw

The Relation of Inspection to Product, F. A. Waldron

General Principles of Government Inspection and Relations Between Inspectors and Manufacturers, Col. B. W. Dunn

TEXTILE SESSION

Under the auspices of the Sub-Committee on Textiles

Labor-Turnover Records and the Labor Problem, Richard B. Gregg

Accident Prevention in the Textile Industry, David S. Beyer

The Moisture Content of Textiles and Some of its Effects, William D. Hartshorne

8:30 p.m. Lecture and Annual Reunion

The Beautiful in Commonplace Things, Dr. John A. Brashear. Following the lecture there will be a reunion and dance, with refreshments, on the fifth floor of the Engineering Societies Building

Friday, December 7

10:00 a.m. Simultaneous Sessions

MANAGEMENT SESSION

Topical discussion on the Employment of Women in the Skilled Industries, with particular reference to war conditions. To be introduced by Mr. John W. Upp, General Electric Co., and Mr. C. B. Lord, Wagner Electric Manufacturing Co.

The Engineer, the Cripple and the New Education, by Major Frank B. Gilbreth

POWER-TEST HEARING

A public hearing by the Power Test Committee, preliminary to a proposed revision of the Power Test Code of the Society, comprising rules for conducting tests on prime movers of different types, and auxiliary apparatus

2:00 p.m. Council Meeting

8:00 p.m. College Reunions

THE ANNUAL MEETING

THE Annual Meeting this year will be different from any [illegible] held by the Society. Upwards of one [illegible] members of the Society will come together at their [illegible] a remarkable program will be carried out. [illegible] which will pervade the meeting rooms, the [illegible] where the members group together [illegible] for war. The discussions at the meetings, and [illegible] of the Keynote Session, the Machine Shop Session and the Sections Session will center on this same topic. It will be uppermost in the minds of those attending committee meetings, for the regular committees have been seriously [illegible] by the absence of members in active service and new committees have been appointed expressly for service to the Government at this critical time. The New York Section is not giving out the secret as yet, but even the social events of the meeting will be interspersed with patriotic exercises.

Everyone who comes to the convention will go away with impressions, not on the theory and practice of machines, nor with a better knowledge of power plants, nor of the latest developments in technical research as such, but on the practice of war—engineering war. All other questions are in abeyance at this time and the one justification for calling busy members of any large organization into convention at such a time as this is to have them bring up, discuss, settle and go away to act upon their war problems.

And what an opportunity for both gathering and disseminating information on war problems this occasion offers! Over a thousand engineers and specialists, most of whom are engaged in the vital work of the prosecution of the war will take the time to get together, not for their mutual good, but for the good of the country they have the honor to serve! Who can prescribe the limits to the benefits of this meeting? One question solved at this convention may effectualize the work of hundreds of war helpers.

Many persons have doubted the wisdom of calling large meetings at this time and the Government has expressed its general disapproval of such meetings when not essential to the public good. But the Spring Meeting of our Society in Cincinnati demonstrated strikingly that considerable benefits could accrue and no disadvantages follow from continuing the General Meetings of the Society and so there has been no question as yet of discontinuing them. We must have coöperation at this time. More than that we must have cohesion which means something much more intense, and which can only result from the most intimate contact of engineering elements. The engineers, heads of large plants putting out great quantities of munitions, supervisors of enormous tasks of providing agricultural machinery, means of transportation, aeroplanes, ships and more ships, are the elements in this case, and they must all cohere. This convention offers the opportunity and every member of the Society owes it not alone to himself, to his fellow member, nor to his Society, to attend the Annual Meeting; but he owes it to his country and to democracy.

The program of the meeting appears on the two preceding pages. Publication of the papers began in the October issue of The Journal and has been continued in the succeeding issues.

Authors of the Papers

EDWARD T. ADAMS has had a long experience in the design of large steam units and great gas-engine plants. More recently he has been chief designer for companies manufacturing modern tractors. At present his time is devoted to investigations of the use of steam, heavy oil and gasoline engines in the automobile and other fields.

NICHOLAS W. AKIMOFF has specialized in various applications of dynamics to mechanical engineering. His first paper on Dynamic Balance was presented to the Society at the Spring Meeting, 1916. His recent book on Lagrange's Equations was reviewed in The Journal.

A. M. ANDERSON, during his thirteen years' connection with the Armour Institute of Technology, has been instrumental in the development of a new form of pitot tube for air and gases. His other engineering activities have been principally in pneumatics and hydraulics, covering determinations of velocities in ventilation ducts, compressed-air pipes, gas pipes, and water meters, current meters, and anemometers.

WILLIAM J. BALDWIN was a member of the Society's Committee which first formulated the American Standard Pipe Thread, the Briggs formula, and it was he who was responsible for bringing the Briggs system to the attention of the committee. He has been engaged in consulting-steam-engineering practice in New York City for many years, and the apparatus for mechanically drying air described in his paper is the result of his experiments to overcome and abate the smoke and dust nuisance in Manhattan.

C. H. BEDELL was for twenty years head of the electric laboratory of the Electro Dynamic Company, during which time the inter-pole adjustable-speed motor was developed. For the last nine years he has served as electrical engineer for the Electric Boat Co.

DAVID S. BEYER was for eleven years in charge of technical survey of plants and fire insurance, and later chief safety inspector of the American Steel & Wire Co. He is the author of a number of papers on accident prevention. He presented a paper on Recent Application of Safety Devices for Textile Machinery at the annual congress of the National Safety Council in New York this year.

ADOLPH L. DeLEEUW writes from a very extended experience, having been designing engineer with the Niles Tool Works Co., mechanical engineer with the Cincinnati Milling Machinery Co., and at present is mechanical engineer with the Singer Manufacturing Co. He has written quite a number of papers on the important subject of metal cutting and metal cutters.

F. W. DEAN, who writes on the work of Mr. E. D. Leavitt, was associated with Mr. Leavitt for several years. Since that time he has been practising mill engineering and architecture in Boston, dealing with mill construction, steam plants, water power, and general consulting and expert engineering. Since the date of his joining the Society in 1883 Mr. Dean has contributed voluminously to its proceedings.

LAWFORD H. FRY is now general inspector of the Standard Steel Works Co. In 1908 he contributed to the Institution of Mechanical Engineers a paper on Combustion and Heat Balances in Locomotives, which was one of the first analyses made of the experiments on the Pennsylvania Railroad locomotive-testing plant. Since then he has contributed a number of papers to technical societies and to technical journals dealing with various aspects of locomotive operation, paying particular attention to the action of the boiler. His later work has been largely connected with the heat-treatment of steel.

HENRY L. GANTT, consulting enigneer, was associated with the late Frederick W. Taylor in the initial stages of development of the latter's system of industrial management, and for more than the past ten years has given his professional attention to administration, management, and other subjects which confront the

industrial engineer. He has presented many valuable papers on management and kindred topics before the Society, and has otherwise embodied his ideas in published works that have become a part of the authoritative literature on the subject.

FRANK B. GILBRETH, now a Major in the Engineer Officers' Reserve Corps, has been particularly active of late in connection with the problem of taking care of soldiers crippled in the war, and using them in the industries. Mr. Gilbreth was recently successful in securing official recognition of this work, and is now devoting his whole time to this problem.

RICHARD B. GREGG was during the summer of 1916 in direct charge of an investigation into the hours, wages and working conditions of some 500 shops in the dress and waist industry of New York City. In addition to consulting and organizing work, he has thoroughly studied for the employers the labor situation in a number of textile mills and establishments in other industries.

WILLIAM D. HARTSHORNE can claim a thirty-four years' experience with textile-mill conditions. For twenty years of this period he was employed in the respective capacities of chemist, manager of dyeing and finishing department, and as general superintendent of the worsted department of the Arlington Mills at Lawrence, Mass. For the last fourteen years of this service he was resident agent of the Textet Corporation, covering both worsted and cotton departments. He has contributed a number of papers concerning textile-manufacturing problems and mill conditions to the proceedings of several societies.

LOUIS ILLMER, who has specialized as gas and oil-engine expert for the past fifteen years, is now engaged in high-speed development work for Mr. Simon Lake, the submarine expert at Milford, Conn. Prior to this work, he developed the Illmer gas-engine and complete producer-plant equipment for the Reading Iron Co., Reading, Pa. The results of some of his rather extensive research studies into the fine points of engine design are embodied in a number of papers.

A. LEWIS JENKINS, of the University of Cincinnati, has made a number of contributions on the strength of punch and riveter frames, and stresses due to bending and twisting, and has done considerable work on the stress relations in pressed fits. He was the first to publish the present accepted formulæ for the design of pressed fits. He has written several articles on hydraulic presses, intensifiers, accumulators and pumps.

LOUIS C. LOEWENSTEIN has had a varied experience in designing machinery for marine use with several large shipbuilding and other concerns. He was for six years in charge of instruction of machine design and steam-engineering subjects at Lehigh University. Since 1907 he has been engaged in design and theoretical engineering of steam turbines and centrifugal compressors with the General Electric Co., at Lynn, Mass.

W. J. A. LONDON served his apprenticeship with Sir Charles A. Parsons on turbine work and was later connected with the Brown-Boveri Co., in Switzerland doing the pioneer work of introducing steam turbines on the continent. He was at one time special research engineer on turbine work for Mr. George Westinghouse, and was for seven years chief engineer of the Terry Steam Turbine Co. He is at present engaged in developing a new design of steam turbine known as the steam motor.

CHESTER B. LORD, general superintendent of the Wagner Electric Co., has had a long connection with the construction, layout and equipment of new plants. He was for six years general foreman in charge of tools, dies and special machines of the General Electric Co.

DAVID MOFFAT MYERS is a member of the firm of Gregg & Myers, Consulting Engineers of New York City. He has devoted much attention to the use of special fuels, such as tan-bark, chestnut-chips and bagasse, especially in the plants of the United States Leather Co.

CHARLES J. RAMSBURG was connected for seventeen years with the United Gas Improvement Co., of Philadelphia, in various capacities, and for nine years as assistant engineer of works in charge of daily operation of Philadelphia gas works. He has presented numerous papers before the American Gas Institute on general technical subjects connected with the gas industry, and was awarded the Beal Medal by the Institute in 1910 for his paper on Gas Purification. He became associated with H. Koppers Co., in 1913 in the capacity of vice-president, and since that time has contributed a number of papers on by-product coke-oven subjects.

FREDERICK W. SPERR, JR., now chief chemist of the H. Koppers Co., started in the by-product coke-oven business in 1910 as a chemist for the first plant of Koppers ovens in America, the plant of the United States Steel Corporation at Joliet, Ill. He has subsequently been chief chemist of the Fairfield plant of the Tennessee Coal, Iron & Railroad Company and of the blast furnace and coke department of the Inland Steel Company, both of these companies operating Koppers plants.

CARL C. THOMAS was for a number of years on the Atlantic Coast in charge of marine-machinery design at the Maryland Steel Co., Sparrows Point, and connected with building of merchant and naval vessels. He was called to Cornell University as professor of marine engineering in 1904, to the University of Wisconsin as professor of steam engineering in 1908, and to Johns Hopkins University in 1913 as head of the Department of Mechanical Engineering, from which institution he is now on leave of absence. He is the inventor of the Thomas meter, which has been described in the TRANSACTIONS of the Society.

JOHN W. UPP has been connected with the General Electric Co., at Schenectady, for seventeen years. He began in the engineering department and was later placed in charge of the drafting department; he is now manager of the switchboard department. He is a member of the Society's special committee on Standard Cross-Sections and Symbols.

FREDERICK A. WALDRON has had experience with the Brown & Sharpe Manufacturing Co., Beaman & Smith and the Yale & Towne Manufacturing Co. With the last mentioned company he worked his way up to the position of superintendent. He has been practising as an industrial engineer for some years, and is chairman of the sub-committee on Industrial Buildings of the Society.

Power Test Hearing

On Friday morning, December 7, of the Annual Meeting there will be one of the most important sessions in respect to standardization that this Society has ever held. This will be a public hearing by the Power Test Committee, held in pursuance of a requirement of the Council that this Committee should hold meetings from time to time at which interested parties may have an opportunity to present suggestions for purposes of revision.

The Power Test Codes were formulated by the Power Test Committee in 1915 and were published in Volume 37 of the TRANSACTIONS. They comprise rules for conducting performance tests on boilers, engines, turbines, pumps, compressors, blowers, complete steam plants, locomotives, gas-power apparatus and water wheels.

The Power Test Committee will welcome a thorough discussion of the Rules in the hope that they may be made of the greatest value to manufacturers and users of power-plant apparatus and to the profession generally.

The different sections of the Codes will be taken up in detail to facilitate suggestions which later will be considered by the Committee as material for the revision of the Codes.

Invitations have been extended to over fifty societies to send delegates, and colleges, railroads, manufacturing firms, and testing laboratories have also been asked to send representatives.

REPORTS OF STANDING COMMITTEES

THE reports of Standing Committees of The American Society of Mechanical Engineers will be presented at the forthcoming Annual Meeting as an appendix to the Annual Report of the President of the Society's activities for the year. The Standing Committee reports are published below:

Reports of Finance Committee

The Finance Committee reports that the income of the Society for the year ending September 30, 1917, was $207,016.98. The total expenditures chargeable to income were $186,547.57, leaving an excess of income over expenditures of $20,499.41, this being a net balance after reserving $14,000 for obligations undertaken but not yet completed.

The expenditures of the Society per member for the fiscal year just closed are as follows:

General Salaries	$ 2.06
Headquarters, Library, Supplies, etc.	1.84
Committees on Membership and Increase of Membership	1.27
Sections	.98
Council contingencies, mileage and employment	.77
House Committee	.40
Meetings, Annual and Spring	1.18
Year Book	.63
Journal and Condensed Catalogues	8.47
Transactions	2.42
Other activities	2.73
Making a total of	$22.75

The recommended Budget Appropriation for the year 1917-1918 is as follows:

Finance Committee		
Administrations	$ 22,700	
Occupancy of Building and Engineering Council	8,800	
Library	4,000	
		$ 35,500
Membership Committee		2,900
Council		
Contingencies	3,000	
Committees not otherwise provided for	6,700	
Mileage	2,200	
Employment Bulletin	2,400	
		14,300
Sections Committee		10,750
Increase of Membership Committee		8,300
House Committee		4,335
Meetings Committee		10,265
Publication Committee		104,405
Research Committee		500
Students' Committee		1,000
Junior Prizes Committee		75
Sales Expenditures		11,000
John Fritz Medal Board of Award		75
Engineering Resources Committee		1,500
Coöperation and Organization Committee		100
Public Relations Committee		500
Total		$205,505

The estimated income for the year 1918 is $228,500.

Appended will be found reports of the accounts of the Society as shown in the books for the fiscal year ending September 30, 1917.

Respectfully submitted,

R. M. DIXON, *Chairman,*
A. E. FORSTALL,
GEO. M. FORREST,
W. D. SYMONS,
Finance Committee.

REPORT OF ACCOUNTS

MR. R. M. DIXON,
CHAIRMAN, FINANCE COMMITTEE.

DEAR SIR:

In accordance with your instructions, we have examined the books and accounts of The American Society of Mechanical Engineers for the twelve months ended September 30, 1917.

The results of this examination are set forth in the three exhibits attached hereto, as follows:

Exhibit A Balance Sheet, September 30, 1917.
Exhibit B Income and Expenses, for the twelve months ended September 30, 1917.
Exhibit C Receipts and Disbursements for the twelve months ended September 30, 1917.

We hereby certify that the accompanying Balance Sheet is a true exhibit of its financial conditions as of September 30, 1917, and that the attached statements of Income and Expenses, and Receipts and Disbursements, are correct.

Respectfully submitted,

(Signed) WM. J. STRUSS & CO.,
Certified Public Accountants.

EXHIBIT A

BALANCE SHEET, SEPTEMBER 30, 1917

RESOURCES

Equity in Society's Building (No. 25 to 33 West 39th Street)	$365,846.62	
Equity in one-third of Cost of Land (No. 25 to 33 West 39th Street)	180,000.00	
		$545,846.62
Library Books	13,000.00	
Furniture and Fixtures	5,000.00	
		18,000.00
Stores, including plates and finished publications		25,809.91
Trust Funds Investment		
New York City $3\frac{1}{2}$'s 1954 (par $45,000)	39,696.81	
St. Louis, Peoria & N. W. 1st 5's 1948 (par $10,000)	10,613.89	
United New Jersey Canal Co. (par $1,000)	970.00	
Cash in Banks representing Trust Funds	4,510.51	
		55,791.21
City of East Orange, Loan Certificate		21,371.95

Liberty Bonds, Investment	10,000.00	
Liberty Bonds, Accounts	1,599.00	
		11,599.00
Accounts Receivable		
Membership Dues	14,015.73	
Initiation Fees	6,430.00	
Sales of Publications, Advertising, etc.	34,840.52	
		55,286.25
Advance payments		2,734.06
Cash: In Banks for general purposes	31,890.64	
Petty Cash, on hand	500.00	
		32,390.64
		$768,829.64

LIABILITIES

Trust Funds		
Life Membership Fund	$45,595.15	
Library Development Fund	4,902.71	
Week's Legacy Fund	1,957.00	
Melville Fund	1,127.36	
Hunt Memorial Fund	208.99	
Junior and Student Prize Funds	2,000.00	
Total		$ 55,791.21
Dues paid in advance		2,167.07
Initiation Fees uncollected		6,430.00
Replacement Fund		1,336.70
Internal Revenue		1.40
Accounts Payable		2,917.26
Annual Meeting Social		9.11
		68,652.75
Unexpended Appropriation 1915-1916.	267.35	
Unexpended Appropriation 1916-1917.	16,684.79	
Unappropriated Revenue	17,814.62	
		34,766.76
Capital Investment	551,346.62	
Surplus and Reserve	114,063.51	
		665,410.13
		$768,829.64

EXHIBIT B

Income and Expenses for the Twelve Months Ended September 30, 1917

INCOME

Membership Dues	$110,493.65	
Sales—Gross Receipts	14,437.89	
Advertising	63,927.96	
Interest and Discount	4,707.48	
Initiation Fees	13,480.00	
Total		$207,046.98

EXPENSES

Finance Committee			
Office Administration	$21,614.53		
Occupancy Building	6,432.36		
Library	4,016.67		
		$ 32,063.56	
Membership Committee		3,062.11	
Council			
Contingencies	2,673.02		
Mileage	1,564.38		
Employment Bulletin	2,063.61		
		6,301.01	
Increase of Membership Committee		7,328.76	
House Committee		3,244.28	
Meetings Committee		9,672.70	
Sections Committee		8,058.65	
Publication Committee			
Advertising	35,665.93		
Journal Text	33,766.63		
Revises	433.72		
Transactions	19,710.00		
Year Book	5,148.89		
		94,725.17	
Sales			
General	8,093.70		
Boiler Code	2,942.77		
Power Test Code	550.79		
		11,587.26	
Research Committee	261.43		
Students' Committee	1,199.47		
Junior and Student Prizes	70.38		
John Fritz Medal	77.04		
Coöperation and Organization	83.75		
Engineering Resources	1,432.50		
Alterations on Building	7,379.50		
		10,504.07	
[1] Total			186,547.57
Excess of Income over Expenses			$20,499.41

EXHIBIT C

Receipts and Disbursements for the Twelve Months Ended September 30, 1917

RECEIPTS

Membership Dues	$107,359.87	
Initiation Fees	26,925.00	
Membership Dues paid in advance	2,789.69	
Sales of Publications, Badges, Advertising, etc	72,962.59	
Interest	5,431.02	
Liberty Bonds	851.00	
	$216,319.17	
Cash on hand and in Banks		
General and Trust Funds, September 30, 1916	51,352.14	
		$267,671.31

DISBURSEMENTS

Disbursements for General Purposes	$184,448.21	
Building Improvement	12,500.00	
City of East Orange Loan	21,371.95	
Liberty Bonds	12,450.00	
	$230,770.16	
Cash on hand and in Banks		
General and Trust Funds, September 30, 1917	36,901.15	
		$267,671.31

[1] Note: The item of total expenses includes $14,000 not yet paid to complete work already in progress and chargeable to this year's activities.

Report of Committee on Meetings

Professional Sessions

Although it has been the aim of the Meetings Committee to maintain a high standard for papers presented and discussed at the professional sessions of general meetings, the Committee has realized that many members of the Society regard of equal importance the opportunities afforded for personal conferences, for special committee meetings, for discussion of problems of peculiar interest to a limited number only, and for bringing about a personal contact among the members of the Society that is becoming truly national. With these points in view the Committee has ever before it the idea of so balancing the programs at the meetings that they shall not be overburdened with detailed technical papers, and would emphasize as a guiding principle for the future the wisdom of somewhat limited, carefully chosen programs stimulating general discussion, in preference to sessions overburdened with an unduly large number of papers.

Keynote Session

Besides a number of professional sessions devoted to the interests of various specialties of the members, it has been the aim of the Committee for the past few years to have during each Annual and Spring meeting a so-called "keynote" session which should offer an opportunity for the presentation of the broad but timely problems of general interest. With these points in mind, Industrial Valuation was chosen as the general theme for the keynote session of the Annual Meeting, December 1916.

As the Spring Meeting of 1917 came shortly after the declaration of war, the Committee felt that perhaps the most timely subject was the manufacture of munitions. The large attendance at the Cincinnati meeting is in part attributed to the announcement of this important subject and partly to the exceptional opportunity afforded the members of the Society to coöperate with the members of the National Machine Tool Builders' Association, with whom a joint session was arranged.

So important has become the relation of the engineer to the problems resulting from the war that the Committee has chosen for the keynote session of the coming Annual Meeting, December 4 to 7, 1917, Service of the Engineer to the Public in Times of National Crises.

Special Exercises

In connection with the Annual Meeting, December 1916, special memorial exercises were held in honor of John E. Sweet, the beloved founder of the Society.

At the coming Annual Meeting, December 1917, there will be special exercises in connection with the conferring of honorary membership upon Major-General George W. Goethals, upon which occasion the address of the evening will be delivered by William H. Taft, ex-President of the United States.

Social Functions

At the Annual Meeting of 1916 all social events were held in the Engineering Societies Building. Owing to this fact the democratic spirit of the Society was more keenly developed, as more freedom was felt on the part of the members and guests in attending these various functions. The spirit of good fellowship thus promoted is a distinct asset to the Society.

The success of the smokers held the last two years has prompted the Committee to arrange for the repetition of this part of the program for the Annual Meeting of 1917, with such modifications as past experience has shown would be desirable.

The delightful functions provided in connection with the Spring Meeting at Cincinnati were all in accord with the aims of the Committee on Meetings to promote the most cordial democratic spirit among the members.

Inspection Trips

It is the belief of the Committee that inspection trips to various points of engineering interest should be continued in connection with both the Annual and the Spring Meetings. It is the feeling of the Committee, however, that a small number of such trips thoroughly organized is distinctly more beneficial and pleasanter for the membership than a large number of informal trips, offering too large a variety of opportunities.

Attendance at Meetings

Evidences of the broader field of activity of the Society are apparent in the attendance at the Annual and Spring Meetings. The total registration at the Annual Meeting, December 1916, was 1868, the largest in the history of the Society. Of this number 953 were members and 915 were guests. The number of members present represented 12.5 per cent. of the total membership, and exceeded that of the Annual Meeting of 1915 by 431.

It is somewhat more difficult to compare the figures of attendance at the Spring Meetings, owing to the fact that the geographical location of the meeting has a distinct bearing upon attendance, but it is interesting to note that the attendance at Cincinnati in 1917 broke all previous spring-meeting records, the total registration being 868, of which 410 were members and 458 guests.

Sub-Committees of the Meetings Committee

The work of the sub-committees of the Committee on Meetings has for the most part been exceedingly satisfactory. It stimulates a wide interest in the work of the Society and results in the presentation of excellent papers and discussions. The Committee feels that it is wise to continue those sub-committees that keep alive and awake to their opportunities, but it also believes it unwise to appoint too many such committees on account of the danger of overspecialization and the possibilities of unwieldly programs.

Respectfully submitted,

ROBERT H. FERNALD, *Chairman,*
L. P. ALFORD,
JOHN H. BARR,
DEXTER S. KIMBALL,
A. L. DE LEEUW.
Meetings Committee.

Report of Publication Committee

During the year THE JOURNAL has been developed by extending the Engineering Survey to include engineering activities outside of those of our own or other societies, especially in the way of engineering research. The Review of Engineering Periodicals has been broadened to include publications in English as well as in the foreign languages. Reviews, written by specialists in their several fields, have been published of

notable additions to the literature of our subject. Mr. C. M. Sames has been added to the editorial staff. The makeup and distribution of The Journal for the first seven months of 1917 were as follows:

Makeup of The Journal, 1917

Technical Section	48 per cent
Society Affairs	19 per cent
Engineering Survey	33 per cent
	100 per cent

Distribution of The Journal, 1917

To Members	8250 copies per month
Exchanges	250 copies per month
Subscriptions	450 copies per month
Advertisers	300 copies per month
Students	500 copies per month
	9750 copies per month

The cost of publishing The Journal for the fiscal year ending October 31, 1917, was about $53,428, and its income from advertising about $34,928, leaving a deficit of about $18,500. No credit is given to The Journal for copies sold to subscribers and furnished, in partial return for their dues, to the membership and student branches. These, furnished at present to the number of over 9000, at $3.00 per year to subscribers and $2.00 to the membership, would more than cover the apparent deficit and show The Journal to be paying its own expenses.

It is the purpose of the Committee to make The Journal an epitome of current information in the field of mechanical engineering, and to devote to this service whatever revenue the paper may produce.

The last issue of Condensed Catalogues cost about $15,500 and brought in a revenue of about $29,000, making a profit of about $13,500. It has been improved by the addition of an index of manufacturers of mechanical equipment.

In 1913 the Committee was allowed an appropriation of $750 for indexing the Transactions. To this has been added $350, making $1100 in all. It was pointed out when these appropriations were asked for that they would meet the expenses only of preparation, but not of publishing. We are now able to report the complete indexing of Transactions from Volume I to date in card form. To publish this in book form will cost about $2000 plus 90 cents per copy, thus:

Estimated Cost of Transactions Index

For 2000 copies	$2000
2000 x 90 cents	1800
	$3800
For 10,000 copies	$2000
10,000 x 90 cents	9000
	$11,000

These ought to be furnished free to the membership as they have been in the past, and we recommend that the Committee be authorized to expend not to exceed $2000 in printing it with a view to its distribution when the necessary funds become available.

It has been the practice of the Society to preserve all undistributed copies of Transactions and of the separate papers. The accumulation is becoming burdensome, and the Committee has decided to retain not over 25 copies of each volume of the Transactions up to and including Vol. XXV and 100 copies each of Vols. XXVI to XXXIII inclusive. Several of the earlier volumes are completely exhausted and the Society is seeking them at a premium. No more than the reserved number of any volume are on hand in the bound form. The surplus will be sold to those desiring them at $2.50 per volume in paper covers, or at $2.00 gathered and stitched ready for binding.

With the increased appropriation at the disposal of the Committee for the coming year, we hope to make the publications of the Society, especially The Journal, of still greater benefit to the membership.

Respectfully submitted,

Fred. R. Low, *Chairman,*
C. I. Earll,
George J. Foran,
Fred. J. Miller,
Joseph W. Roe,
Publication Committee.

Report of Standardization Committee

The Standardization Committee is charged with a general oversight of the standardizing activities of the various committees within the Society. That means that it does not concern itself with any of the details of the actual work of standardizing, but rather with the work being carried on by other committees according to a general routine and principles adopted by the Society. It concerns itself further with the promotion of interrelation of the activities of the various committees where that seems advisable.

In carrying out its duties this Committee has interpreted its mandate to exercise the least possible authority so far as committees were concerned that were appointed before its creation.

With regard to committees appointed after the creation of this Standing Committee, the latter has confined itself strictly to suggestions made directly to the Council as to the personnel and general routine activities of the various special committees.

The most important activity of the Standardization Committee has been its work in connection with the creation of an American Engineering Standards Committee. Active in this work were jointly the American Society of Civil Engineers, the American Institute of Mining Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Society for Testing Materials. Delegates from these societies created an Executive Committee consisting of one member from each and this committee reported a Constitution and By-Laws to the main Joint Committee, which latter accepted the report and caused it to be sent to the founder societies for their action.

Approval was given to this by all except the American Society for Testing Materials, and that approval is expected as soon as its governing body meets this fall. A copy of the American Engineering Standards Committee's Constitution and By-Laws is appended. A careful study of this Constitution is recommended, as it is probably the beginning of what is hoped will eventually fill a very important national and international need. It is expected that with time every technical association or society, whether of an engineering or other nature, not only in the United States, but abroad, will participate in the work of this committee. A beginning in this direction has already been made in that the British Engineer-

[illegible] Standards Committee has invited this American Engineering Standards Committee to send delegates to London to consider a change in the British standard Whitworth thread [illegible] complete cross section of the United States screw thread, and to consider also the question of metric threads.

It is gratifying to note that the suggestions made by the [illegible] of our own Committee while that was a special committee on standardization, formed the basis in the formulation of the Constitution of this American Engineering Standards Committee and have to a considerable extent been adopted by it.

Respectfully submitted,

Henry Hess, *Chairman*,
H. L. Gantt,
W. F. Kiesel,
Carl Schwartz.
Standardization Committee.

Report of Library Committee

Your Library Committee has the honor to present the following report for the year ending September 30, 1917.

As the library of the Society has been incorporated in the United Engineering Society Library, the duty of the Committee has been to represent the Society on the Library Board of that organization, and this report summarizes briefly the work of the United Engineering Society Library during the year.

The Library contained 49,702 volumes and pamphlets on October 1, 1916, and 132,070 on September 30, 1917. The extraordinary increase is due to the absorption of the library of the American Society of Civil Engineers which occurred in February 1917, and which added 67,242 volumes and pamphlets to the collection. Of the current accessions, 206 were presented through The American Society of Mechanical Engineers.

In March, Mr. W. P. Cutter presented his resignation as Librarian, which was accepted. Mr. H. W. Craver, Librarian of the Carnegie Library of Pittsburgh, was elected to fill the vacancy, and assumed the duties of the position on April 1. The title of the position was changed to Director of the Library at this time.

The number of readers during the year was 12,710.

In addition, the Library Service Bureau has met the needs of inquirers by preparing bibliographies and translations, and by copying articles. This branch of the work shows a steady gain in volume as engineers become more familiar with its advantages.

Respectfully submitted,

John W. Lieb, *Chairman*,
Jesse M. Smith,
Walter M. McFarland,
A. M. Hunt,
Calvin W. Rice.

Report of Membership Committee

The Membership Committee held nine meetings during the year 1916-1917.

The number of applications considered in the transaction of its work and a summary showing the action taken, follows:

Applications pending October 1, 1916	700
Applications received during the fiscal year	1695
Total	2395

The following action was taken on these applications:

Recommended for membership	1494
Recommended for membership (special cases)	15
Deferred indefinitely	7
Deferred	11
Denied promotion	5
In regular course of procedure	863
Total	2395
Reinstatements and reconsiderations pending	18

Those recommended for membership were divided into the following grades:

Members	412
Promotion to Member	75
Associates	115
Promotion to Associate	2
Associate-Members	342
Promotion to Associate-Member	43
Juniors	505
Total	1494

The reinstatement of thirteen members was recommended to the Council.

Under B 16, it was recommended to the Council that the dues of seven members be permanently remitted.

Respectfully submitted,

Hosea Webster, *Chairman*,
James W. Nelson,
S. D. Collett,
W. C. Morris,
Nicholas S. Hill, Jr.
Membership Committee.

Report of House Committee

The report of the House Committee for last year referred to certain building additions and alterations, which made it necessary to hold the Annual President's Reception on the fifth floor of the Engineering Societies Building instead of in the Society's rooms. This function was very satisfactorily carried out, judging from the comments of members and guests who attended the reception, and no doubt future receptions can be held in the same manner and place, with equally good results.

The changes in the Board Room referred to in last year's report have been made, but it has been considered advisable to withhold redecorating this room and hall, or lobby, until the contractors for building changes have completed this work, on account of the dust which accumulates through the building. It is hoped that this work can be completed before the Annual Meeting in December 1917.

It has been found necessary to make certain extensive alterations in the working offices of the Society's quarters, with a view to providing more room and far better facilities for lighting, arrangement of desks for employees, intercommunication and acoustic properties. These changes are well under way and should be completed by October 1, 1917. The expense involved is about $6600, but no doubt will prove to be one of the best investments the Society ever made.

During the year the Society received as a gift from Miss Hoadley a most excellent oil portrait of Past-President J. C. Hoadley. This has been hung on the wall of one of the Society's rooms.

Of Past-Presidents' photos, that of Dr. D. S. Jacobus has

been received and added to the Society's most excellent collection.

Respectfully submitted,

Fredk. A. Scheffler, *Chairman*,
James W. Nelson,
Orrie P. Cummings,
H. O. Pond,
Maxwell W. Upson.
House Committee.

Report of the Committee on Constitution and By-Laws

The Committee on Constitution and By-Laws, at meetings held January 19, March 26, and April 16, 1917, discussed various proposed amendments and additions to the Constitution and By-Laws of the Society, and subsequently recommended changes to the Council. These amendments were approved by the Council on April 20, and were presented at the Spring Meeting in Cincinnati in May.

In accordance with C57, the amendments to the Constitution were published in the October issue of The Journal. They will be presented for discussion and final amendment at the forthcoming Annual Meeting and will subsequently be sent to all members entitled to vote, and the final vote of adoption will be closed on March 4, 1918.

Some of the changes in the Constitution necessitated changes in the By-Laws which have also been recommended to the Council and were approved on October 12, as well as new By-Laws for Professional Sections, Local Sections, etc.

The By-Laws governing Local Sections are the combined effort of about two years' work on the part of the Committee on Constitution and By-Laws and the Committee on Sections, and were framed to conform with all phases of the Local Sections' work to be found in different parts of the country, to afford the Sections every opportunity to carry on activities of local interest and at the same time to have their procedure in conformity with the Constitution and the By-Laws of the Society. These amendments are appended to this report.[1]

The changes in the By-Laws made necessary by the amendments to the Constitution and the new By-Laws, including those governing the Professional Sections, are also appended.

The Committee has also under consideration modifications to the By-Laws to provide for the decision of the Council to suspend the dues of members in active service for the period of the war and for six months after peace is declared, and also to exempt from dues a member reaching the age of seventy years, and who has paid dues for thirty-five years.

Respectfully submitted,

F. R. Hutton, *Chairman*,
Ira H. Woolson, *Secretary*,
James E. Sague,
George M. Basford,
Jesse M. Smith.

APPENDIX

Changes in the By-Laws Necessitated By Changes in the Constitution

The Committee on Constitution and By-Laws recommends that the By-Laws governing the Library Committee, the House Committee and the Research Committee be amended, and that new By-Laws governing the Public Relations Committee, the Standardization Committee and the Constitution and By-Laws Committee be provided, as follows:

Committee on Library

B 24 There shall be a Standing Committee on Library to consist of four Members and the Secretary of the Society. One of the four Members shall be appointed by the President before the first day of each calendar year to serve for four years.

It shall be the duty of the Committee to represent the Society on the Library Board of the United Engineering Society.

The Committee shall deliver to the Secretary before October 15 of each year a detailed report of its work for the preceding twelve months and also of the work which it recommends for the next fiscal year, with an estimate of the cost thereof.

House Committee

B 25 There shall be a Standing House Committee to consist of five persons who shall be Members, Associates, Associate-Members or Juniors. The term of office of one Member of the Committee shall expire at the end of each Annual Meeting. It shall be the duty of the House Committee to have the care, management and maintenance of the rooms of the Society and furnishings, the historical relics, the paintings, and objects of art, and to recommend to the Council suitable regulations for their care and use. At the end of each fiscal year the Committee shall deliver to the Secretary a detailed report of its work.

Research Committee

B 43 There shall be a Standing Research Committee to consist of five Members, Associates, Associate-Members or Juniors. The term of office of one member of the Committee shall expire at the end of each Annual Meeting.

(*a*) This Committee shall have supervision of such research or investigations as may be directed or approved by the Council; shall correspond and collaborate with committees of kindred technical, scientific or other societies; shall keep in touch with researches conducted in other countries, which are of value to the engineer, and shall report the same quarterly to the Council.

(*b*) The Committee will be expected to maintain a system of announcement of results of research and the trend of investigations in any field which will be of value to the engineering profession.

(*c*) Gifts or bequests to the Society for the conduct of research or investigation shall be expended under the direction of the Council, and shall be kept separate from other Society funds.

Public Relations Committee

B ? There shall be a Standing Public Relations Committee to consist of five persons who may be members in any grade. The term of office of one member of the Committee shall expire at the end of each Annual Meeting.

It shall be the duty of the Committee to consider and report to the Council its recommendations covering any matters which may be referred to it bearing upon the relations of the engineer as a man of science to the community in which he lives.

Committee on Standardization

B ? There shall be a Standing Standardization Committee to consist of five Members of the Society. The term of office of one member of the Committee shall expire at the end of each Annual Meeting. It shall be the duty of this Committee:

(*a*) To formulate and revise standards of principle, method or procedure, in engineering practice.

[1] Published in The Journal, November 1917, p. 940.

[illegible] To coöperate with committees of bodies of [illegible] or [illegible] of the Society, in the formula[illegible] [illegible] and to appoint under approval [illegible] committees of experts in specialized subjects [illegible] with them. The Chairman may represent the committee on standardization at any conferences.

To report to the Council with its recommendation any [illegible] standards for its approval, and when approved to [illegible] and recommend such standards to the members of the Society, and secure this publication in The Journal and Transactions of the Society.

Committee on Constitution and By-Laws

B ? The Committee on Constitution and By-Laws shall consist of five persons who shall be Members of the Society. The term of office of one member of the Committee shall expire at the end of each Annual Meeting.

It shall be the duty of the Committee to consider and report on all matters relating to the Constitution, By-Laws and Rules of the Society which shall be referred to it.

New By-Laws

It was recommended that the existing Rules 17 to 24 inclusive, defining the functions of Professional Sections and Geographical Groups, be changed to a By-Law, and that they be amended to read as follows:

Professional Sections

B ? (*a*) A professional Section of the Society shall consist of Honorary Members, Members, Associates, Associate-Members and Juniors of The American Society of Mechanical Engineers and of other persons to be designated Affiliates as hereinafter described.

(*b*) A Professional Section of The American Society of Mechanical Engineers may, with the approval of the Council, be organized for the consideration of any engineering, scientific, or professional topic, provided that a number satisfactory to the Council, of Members of The American Society of Mechanical Engineers, unite in making written request for such an organization. Such a section shall be designated as . . . Section of The American Society of Mechanical Engineers—the blank being filled by the topic specialized.

(*c*) The provisions of the Constitution, By-Laws and Rules of The American Society of Mechanical Engineers, and the precedents of the Society with respect to professional sessions for the discussion of papers, shall cover the procedure of the Professional Sections except that no meeting of a section shall be considered a meeting of the Society as a whole.

(*d*) For the convenient conduct of its professional affairs the section shall organize an Executive Committee of five members of the Society, under the general direction of the Council. Such officers as the section shall require must be selected from the membership of the Society. Other committees of the section shall be appointed by its Executive Committee.

(*e*) The Executive Committee of the section, subject to the approval of the Secretary of the Society, shall designate a Secretary of the section whose duties shall be those usually attaching to the Secretary of a professional section, and who shall also see that the discussions of papers are satisfactorily reported and transmitted to the Secretary of the Society.

(*f*) Expenditures for the purpose of a section chargeable to the Society must be authorized by the Secretary of the Society before they are incurred, and must be provided for in the budget approved by the Council. No liability otherwise incurred shall be binding on the Society. Any expenditure not so provided must be met by the section itself.

(*g*) Engineers and others not members of The American Society of Mechanical Engineers, but desiring to participate in the meetings of the section may enroll themselves as Affiliates as heretofore provided, with the approval of the Executive Committee of the section. Such Affiliates shall have the privilege of presenting papers and taking part in the discussions. They shall pay $5 per annum, which shall be due and payable in advance on October 1 of each year of their enrollment, and shall thereby be entitled to receive the regular issues of The Journal for a period covered by such subscription.

(*h*) The Council of The American Society of Mechanical Engineers may, at sixty days' notice, suspend or disband any section.

Quorum at Council Meetings

B ? The number of persons constituting a quorum of the Council shall be one-third of the number of members of the Council then in office.

Committee on the Washington Award

B ? The Committee on the Washington Award shall consist of two members appointed by the Council to serve for a term of two years. The term of office of one member of the Committee shall expire at the close of the Annual Meeting of the Society in each year. The appointment to fill a vacancy shall be made before January 1 in each year.

This Committee shall coöperate with the Western Society of Engineers in selecting the recipient of the Washington Award which is to be presented annually to an engineer who has contributed preëminent service in promoting the public good.

ROLL OF HONOR

At the October 12 meeting of the Council it was voted that a list of all the members of the Society now in active service be published and distributed at the Annual Meeting. This list will be prepared from the Honor Rolls published in The Journal from May to December inclusive, with such other names as may be sent in in time. The Publication Committee requests information regarding any members who have joined the armed forces of the country but whose names have not been listed as yet in the Roll of Honor. Such information if forwarded to the Secretary by November 30 will be included in the Annual Meeting pamphlet.

We have published in The Journal notices of 601 members from all parts of the Union who have notified us of their enlistment. A large proportion of members listed are commissioned in the Engineer Officers' Reserve Corps or in the Ordnance Department, Officers' Reserve Corps. The Aviation Section of the Signal Corps, and the Naval Reserve, are also well represented.

The following Roll of Honor supplements those already published, and also includes the Providence Engineering Society.

Alden, John L., Second Lieutenant, Ordnance Department, N. A.

Allen, Walter C., Major, Signal Corps, American Expeditionary Forces, France.

Armstrong, Henry C., Captain, Ordnance Department, United States Reserve.

Boardman, Albert J., Captain, Division American Ordnance Base Depot in France, Washington.

Boyd, F. F., Lieutenant, United States Naval Reserve Force.

Clark, W. Chas. M., Lieutenant, Naval Service, United States Navy Yard, Philadelphia.

Crawford, C. H., Captain, 302nd Engineers, Camp Upton, Yaphank.

Diemer, Major, Ordnance Department, United States Reserve.

Doll, William E., 35th Engineers, Camp Grant, Rockford, Ill.

Fell, Shelby G., First Lieutenant, Sanitary Corps, Port of Embarkation, Newport News, Va.
Fox, Rudolph H., First Lieutenant, Ordnance Department, Officers' Reserve Corps.

Gunby, F. M., Major, Quartermaster's Corps, United States Reserve.

Harris, George E., Reserve Officers' Training Camp, Fort Niagara, N. Y.
Hartwell, Arthur E., First Lieutenant, Engineer Sub-Depot, Camp Wheeler, Ga.

Kelly, William, Reserve Officers' Training Camp, Fortress Monroe, Va.
Kessler, A. G., Lieutenant, N. N. V., Navy Department, Bureau of Ordnance.
Kessler, Herbert J., First Lieutenant, Ordnance Department, Officers' Reserve Corps.
Kneass, Strickland, Jr., Sergeant, 332nd Infantry, Camp Sherman, Chillicothe, Ohio.

Laney, Thomas G., Second Lieutenant, Battalion E., 341st Field Artillery, Camp Funston, Kan.
Lea, Edward S., Major, Frankford Arsenal.

McGlone, R. G., Captain, 23rd Engineers, Camp Meade, Md.
Marshall, William C., Captain, Ordnance Department, U. S. R.
Misch, Arthur A., Lieutenant, Ordnance Department, United States Reserve.

Ogden, Nelson, Gun Division, Ordnance Department, Washington, D. C.

Parish, William F., Signal Corps, Equipment Division, Specification Department, Washington, D. C.
Parks, Burritt A., Captain, Engineer Officers' Reserve Corps.
Patton, Thomas A., First Lieutenant, Ordnance Department, United States Reserve.

Robinson, Parker M., First Lieutenant, Ordnance Department, Frankford Arsenal.
Rogers, John D., Captain, Railway Engineers.
Rogers, Theo. B., Second Lieutenant, Engineer Officers' Reserve Corps, 114th Engineers, Camp Beauregard, Alexandria, La.
Root, Virgil A., Captain, Ordnance Department, United States Reserve.

Swift, Harley L., First Lieutenant, Engineer Officers' Reserve Corps, 16th Engineers (Railway), American Expeditionary Forces, France.

Weber, John, Lieutenant, General Engineer Depot, U. S. A.
Welling, Lindsay H., Ordnance Detachment, Rock Island Arsenal, Ill.

Yoder, Thomas M., Captain, Ordnance Department, N. A., Watervliet Arsenal, N. Y.

Providence Engineering Society

The following members of the Providence Engineering Society, affiliated with our Society, are engaged in active military or naval service:

Major Franklin E. Edgecomb, United States Coast Artillery Corps.
Major John T. Keenan, United States Reserve Engineers' Corps.
Major Frank B. Gilbreth, United States Reserve Engineers' Corps.
Major Cyril L. D. Wells, United States Coast Artillery Corps.
Lieut. Lucian Minor, United States Navy.
Lieut. Edwin C. Bliss, United States Naval Reserve Force.
Capt. Norman D. MacLeod, 103d Regiment Field Artillery.
Capt. Leighton T. Bohl, United States Reserve, National Army.
Capt. N. V. S. Mumford, United States Reserve, Ordnance Department.
First Lieut. Frederick E. Cooper, Reserve Officer, Ordnance Dept.
Second Lieut. Valentine G. Libby, Reserve Officer, Engineers' Corps.
Sergt. Wallace Burton, 103d Regiment Field Artillery.
Sergt. C. K. Appleby, Coast Artillery Corps.
Sergt. Earl W. Taylor, Coast Artillery Corps.
Ralph S. Mohr, 103d Regiment Field Artillery.
Wm. McSweeney, Engineer Corps.
Anthony Caputi, Naval Reserve.
Lester W. Preston, Naval Reserve.
Ernest S. Fitz, School of Military Aeronautics.
Bicknell Hall, Jr., School of Military Aeronautics.
Robert N. Foote, School of Military Aeronautics.
Hugh Bain, Reserve Officers' Training Camp.
Howard H. Quinham, Reserve Officers' Training Camp.
Frederick E. Stockwell, Reserve Officers' Training Camp.
John V. Keily, National Army.
Ralph Now, National Army.

Fuel Conservation

To the Editor:

The following letter was received from Mr. H. A. Garfield of the Fuel Administration in Washington:

> Dear President Hollis:
>
> I wish you to know how much I appreciate the offer of assistance of the Engineering Societies in connection with the campaign for the conservation of fuel.
>
> As explained to you in conversation, President Wilson has charged Mr. Hoover and me with prosecuting a campaign looking to the conservation of food and fuel. We, in turn, are looking to the experts in their several fields for assistance. Already I have conferred with the officers of the Bureau of Mines and representatives of the Council of National Defense.
>
> I venture to suggest that an effective co-operating body be organized, so constituted as to furnish to this Administration expert advice and suggestions.
>
> Very truly yours,
>
> (*Signed*) H. A. Garfield, *Fuel Administrator.*

This letter refers to the national campaign for the conservation and use of fuel during the war. It has great possibilities for the future, after the war is over, when we may make a more permanent organization for the saving of waste, not only in fuel, but in everything. The engineers are naturally the experts on all subjects relating to fuel and to the industries, so that they must be prepared to take their share under any Government organization.

All members of our Society are urged to assist in the nation-wide campaign for conservation of fuel. They can do this in the power stations over which they have control by teaching the employes better methods, and by careful study of possibilities of saving.

Part of the success is a campaign of publicity. We have not yet waked up to the fact that only by sacrifice and saving can we serve our country best. Every engineer of our Society, and of other Societies as well, should be prepared to speak on saving, and they should offer themselves wherever the opportunity arrives. This is one form of service that may be extremely useful.

The members of The American Society of Mechanical Engineers are well fitted by technical knowledge to speak on coal conservation, and they ought to be ready to speak in such a way that the general public can understand. In the campaign of publicity, the fuel administration will consult the Bureau of Mines, and will strive to make all leaflets and posters sent out technically correct. Any member of our Society who is not drawn into the Army, and who desires to assist in fuel conservation, would do well to write Prof. O. P. Hood, of the Bureau of Mines, Washington, volunteering to serve in some way at home, especially in teaching how to use coal and wood with economy.

It may be that in some parts of the country their services will not be needed; at the same time we all ought to be ready to do our part wherever we are. Doubtless some method will be found for organizing a speaking campaign, whether under the Bureau of Mines, through the Chambers of Commerce, or directly by the Fuel Administratioon. Professor Hood will be able to supply information on the subject, and will let our members who volunteer for speaking know definitely where to apply. This war calls for sacrifice on every one's part, and for the present we must all be prepared to volunteer our services without pay; later, methods may be found to pay engineers who give all of their time to the home campaign for saving.

Yours very truly,

Ira N. Hollis, *President.*

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER JANUARY 10, 1918

Below is the list of candidates who have filed applications for membership since the date of the last issue of The Journal. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate Member, those in the next class under Associate or Associate Member, those in the third class under Associate Member or Junior, and those in the fourth under Junior grade only. Applications for change of grading are also posted.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. **All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by January 10, 1918, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about February 15, 1918.**

The total of new applications since January 1 is 1633.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be slower than under normal conditions.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

Colorado

RIENKS, George W., Assistant Chief Engineer, Great Western Sugar Co., Denver

Connecticut

RYAN, E. F., Factory Superintendent, Remington Arms U. M. C. Co., Bridgeport

TOMLINSON, William R., 2nd Vice-President and Factory Manager, Billings & Spencer Co., Hartford

TRUAX, William H., Employment Manager, The Yale & Towne Mfg. Co., Stamford

WARDWELL, George W., Chief Draftsman, Norwalk Iron Works Co., South Norwalk

District of Columbia

KLONOWER, Arthur A., Mechanical Engineer, Bureau Yards & Docks, Washington

Florida

GREENE, Henry F., Assistant Manager, Coronet Phosphate Co., Plant City

Illinois

BACHMAN, Charles L., 1st Lieutenant, U. S. Engineers Reserve Corps, Chicago

MOWRY, Harry W., Standardization Engineer, Western Electric Co. Inc., Chicago

PEEBLES, James C., Assistant Professor, Armour Institute of Technology, Chicago

SCHOLES, D. R., Vice-President and General Superintendent, Illinois Malleable Iron Co., Chicago

WESTERBERG, Alfred E., Field Manager, Appraisal Work, Coates & Burchard Co., Chicago

Kansas

JOHNSON, Charles E., Engineer, The Diamond, Osage & Ajax Gasoline Cos., Kansas City

Maine

JACKSON, Lawrence B., Mechanical Engineer, The Texas Steamship Co., Bath

Massachusetts

BREKENFELD, Jacob C., Assistant Superintendent Shops, N. Y., N. H. & H. R. R., Readville

HINCKLEY, Frank C., State Inspector of Boilers and Examiner of Engines, The Commonwealth of Mass., Springfield

TOWNE, Joseph M., Vice-President, National Blank Book Co., Holyoke

WATERHOUSE, Ezra P., Envelope Manufacturer, Worcester Envelope Co., Worcester

Michigan

STEERE, Frank W., Vice President and General Manager, Steere Engineering Co., Detroit

New York

ACHESON, Edward G., President, Acheson Corp., New York

GRAY, James H., Metallurgical Engineer, New York

KEMBLE, Thomas S., Assistant Engineer, Motor Division, Curtiss Aeroplane & Motor Corp., Buffalo

LUKE, John D., Chief Draftsman and Tool Designer, Remington Typewriter Works, Ilion

MILLER, Samuel W., Proprietor, Rochester Welding Works, Rochester

RACHALS, Walter, Assistant Chief Engineer, United States Steel Corp., New York

SCHEIN, Alexander, Assistant Chief Engineer, The Sperry Gyroscope Co., Brooklyn

WEMYSS, Duncan, Superintendent Steel Factory, Library Bureau, Ilion

ZAMBONI, Lawrence, Consulting Mechanical Engineer, New York

Ohio

CARROLL, Emil J., Electrical Engineer, American Laundry Machinery Co., Norwood

NORMAN, Carl A., Professor Machine Design, Ohio State University, Columbus

Pennsylvania

BENNETT, William B., Production Engineer, Union Steel Casting Co., Pittsburgh

CANBY, W. P., Engineer of Tests, Parkersburg Iron Co., Parkersburg

DONLEY, William G., Engineer, The Barrett Co., Frankford, Philadelphia

MORGAN, James L., Resident Engineer, Bayer Steam Soot Blower Co. of St. Louis, Philadelphia

PATTERSON, Thomas S., Assistant Professor Mechanics, Pennsylvania State College, State College

Tennessee

WATERMAN, J. S., General Manager, William J. Oliver Mfg. Co., Knoxville

Australia

FORD, Artuhr S., Chief Designer, Commonwealth Small Arms Factory, Lithgow, New South Wales

Canada

BERLINER, Edgar M., Director, Berliner Gramophone Co., Ltd., Montreal

England

POYNOR, Frederick W., Chief Engineer, R. Martens & Co. Ltd., London, E. C.

FOR CONSIDERATION AS ASSOCIATE OR ASSOCIATE-MEMBER

Delaware

QUERISPEL, Fred J., Chief Draftsman, Electric Furnace Corp., Philadelphia

New York

BISHOP, Ernest W., Engineer, Manual Apparatus Div., Western Electric Co. Inc., New York

Ohio

RICHARDSON, Thomas B., Turbine Construction Foreman, General Electric Co., Cincinnati

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

California

DE FREMERY, DONALD, Structural Steel Inspector, California & Hawaiian Sugar Refining Co., San Francisco

Colorado

SELINDH, HERBERT S., Mechanical Engineer, Holly Sugar Corp., Swink

Georgia

FLEMING, WILLIAM P., JR., Assistant Engineer, J. S. Schofield's Sons Co., Macon

Illinois

KROEPLIN, WILLIAM A., Secretary, Sheet Metal & Conveyor Co., Chicago

Ohio

DAWSON, MAYNARD S., Draftsman, The Woodard Machine Co., Wooster

FOR CONSIDERATION AS JUNIOR

Connecticut

CARTMELL, NATHANIEL M., Industrial Engineer's Staff, Winchester Repeating Arms Co., New Haven
LAZARUS, GEORGE H., Department Engineer, Remington Armory, Bridgeport
PALATINE, RENARD L., Instructor, Continuation School, Waterbury
PORTER, RAYMOND E., Designer and Draftsman, The Lake Torpedo Boat Co., Bridgeport

Illinois

MINKEMA, WILLIAM H., Assistant to Production Manager, The Whitman & Barnes Mfg. Co., Chicago

Louisiana

GIACOMINO, JOSEPH L., Production Engineer, Fylton Bag & Cotton Mills, New Orleans

Maryland

SPICER, GEORGE W., Designing Draftsman, Bethlehem Steel Co., Sparrows Point

Massachusetts

FLEWELLING, MILTON F., JR., Chief Draftsman, Ashton Valve Co., Cambridge
GOULD, HAROLD L., Draftsman, Morgan Construction Co., Worcester

New York

BROWNELL, FREDERICK J., Engineer, Western Electric Co., New York
HENNINGSON, LOUIS A., Designer and Estimator, Maintenance Department, American Locomotive Co., Schenectady
ISENBERG, MARTENS H., Erecting Engineer, Combustion Engineering Corp., New York
MORSE, EVERETT R., 1st Lieutenant Ordnance Department, U. S. A., Ithaca
REBER, JAMES B., Superintendent, Columbian Rope Co., Auburn
RIXMANN, CHRISTIE, Installation Div., De La Vergne Machine Co., New York
SCHENKER, ABRAHAM W., Designer, Lawrance Aero Engine Corp., New York
YOUNGBLUTH, R. O., Managing Engineer, Architectural Dept., American Radiator Co., New York

Ohio

MILKEY, LESTER E., Field Engineer and Assistant Sales Manager, The Sandusky Foundry & Machine Co., Sandusky

Pennsylvania

CROWLEY, HENRY L., Production Engineer, No. 4 Shop, Bethlehem Steel Co., South Bethlehem
WIKAN, CORNEL, Designer, Pittsburgh Steel Products Co., Monessen

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE MEMBER

Massachusetts

COE, HARRY L., Vice-President, Harpham, Barnes, Stevenson & Coe, Boston

PROMOTION FROM JUNIOR

Illinois

BIGELOW, CARLE M., Chief Engineer, Cooley & Marvin Co., Chicago

Missouri

BECK, CHARLES E., District Sales Manager, De La Vergne Machine Co., Kansas City

New Jersey

SCHMIDT, FRANCIS W., Assistant Engineer, American Agricultural Chemical Co., Carteret

New York

TOWNSEND, ALBERT C., Associate with H. R. Geiger, New York

Ohio

RODGERS, HORACE P., District Sales Manager, Steam Equipment Mfg. Co., Cleveland

Rhode Island

HALL, JAMES A., Assistant Professor of Mechanical Engineering, Brown University, Providence

REINSTATEMENT AND PROMOTION FROM JUNIOR

New York

NOLDE, FRED, Chief Engineer and Manager, Ice Machine Dept., De La Vergne Machine Co., New York

NECROLOGY

GEORGE SMITH RIDER

George S. Rider was born in Providence, R. I., on May 4, 1858. Upon leaving college he served an apprenticeship with the Brown & Sharpe Manufacturing Co. in Providence, and then spent a number of years in their shops. Later he traveled abroad extensively, and upon his return he became connected with the Warner & Swasey Co. at the time of the construction of the Lick telescope.

Mr. Rider's next position was with the Cummer Engine Co., from which he resigned to become an instructor in drawing and machine work in the University School of Cleveland, where he remained for about twelve years.

During these years at the University School Mr. Rider also carried on a private business as a consulting engineer, which in later years developed into the firm of George S. Rider & Co., consulting and designing engineers, of Cleveland, Ohio. He was the senior member of this firm up to the time of his death—a period of about fifteen years, during which time he designed many large and important power and industrial plants in that part of the country.

He was a member of The Franklin Institute of Philadelphia, the Cleveland Engineering Society, and the Cleveland Chamber of Commerce.

Mr. Rider became a member of the Society in 1900. He died on September 11, 1917.

WILLIAM THOMPSON ILER, JR.

William T. Iler, Jr., was born in New York on June 28, 1892. He was educated in the public schools of the city and was graduated from the Stuyvesant High School. In June 1915 he received his degree in mechanical engineering from New York University.

During the summer of 1913 he worked under the Heights of Buildings Commission in New York as engineering drafts-

[illegible] served as rodman and as- [illegible] Department of Public Works, [illegible] York. He obtained his shop experience in the [illegible] H. W. [illegible] & Co., Bound Brook, N. J.

William T. Iler, Jr.

Later he became assistant junior engineer with Gunn, Richards & Co. in Utica, N. Y. At the time of his death he was holding the position of assistant manager of the Slocum, Avram & Slocum Laboratories, N. Y.

He became a Junior of the Society in 1916. He died on October 18, 1917.

GEORGE E. SCARFE

George E. Scarfe was born in London, England, in November, 1856. He received his education in the London grammar schools, and when still very young started to learn his trade by becoming a machinist's helper.

His bent was toward electrical science, and in 1890 he accepted a position as engineer with an electric lighting company in New York. He resigned in 1892 to become associated with the Western Electric Co., in whose employ he was sent to San Miguel, San Salvador, Central America, as assistant engineer of construction on an electric-light plant there. Subsequently Mr. Scarfe held the positions of chief engineer of the Towanda Electric Lighting Co., and construction engineer of the Warren Manufacturing Co., Sandusky, Ohio.

In 1900 he became associated with the Pacific Gas and Electric Co. in its Nevada division in charge of the power plant, and in 1904 became manager of the South Yuba Water Co. Mr. Scarfe's ability was evidenced not only in the immediate work of the company, but as a consulting engineer for the large gold-mining companies of that region.

After several years' connection with the Pacific Gas and Electric Co., Mr. Scarfe was appointed to the office of district superintendent, which position he held till April, 1916, resigning to enter the private practice of electric and mechanical engineering. He acted as consulting engineer for the Pacific Gas and Electric Co., Empire Mines Co., Pittsburgh Mines, South Eureka Mines, and a number of others.

He was an associate member of the American Institute of Electrical Engineers. He became a member of the Society in 1916. He died at his home in Nevada City on August 24, 1917.

SVERRE TRUMPY

Sverre Trumpy was born in Bergen, Norway, in January 1882. He was educated in a German preparatory school and received the degree of B.M.E. in 1903 from the Royal Technical University, Berlin.

During his college course, from 1899 to 1903, he served his apprenticeship with the Accumulatoren Fabrik Aktiengesellschaft, Hagen, Westphalia. Upon graduation he accepted the position of assistant superintendent of the municipal electric plant, Bergen, Norway. His next position was with the Fort Wayne Electric Works of the General Electric Co., Madison, Wis., as machinist. In 1904 he became associated with the Gisholt Machine Co. in Madison as draftsman, and in 1906 was made chief draftsman of the vertical boring-mill department. In 1911 he was placed in charge of the engineering department and the drafting room.

Mr. Trumpy became a member of the Society in 1913. He died at his home in Madison, October 17, 1917.

THOMAS C. WALKER

Thomas C. Walker was born in England in 1859. He was educated in the public schools there, and it was there also that he served his apprenticeship in machine work and tool making. He gained his shop experience with the Birmingham Small Arms Co.

For four years he was in charge of the machinery for the Carbon Mill in Colorado. He was also associated for about four years with the Denver & Rio Grande Railroad Co. At the time of his death he was president of the Walker Manufacturing Co., Denver, Col.

George E. Scarfe

He became a member of the Society in 1891. He died on February 13, 1917.

AMONG THE SECTIONS

Four signal events this year will go down in the history of the Sections as marked developments in this activity. The first is the new By-Laws which were approved at the Council meeting in October and published in the November issue of The Journal. The second is the Sections Session to be held at the forthcoming Annual Meeting. The third is the development of the first State Section—Connecticut—with five Branches, at Bridgeport, Hartford, Meriden, New Haven and Waterbury. The fourth innovation is the holding of meetings of the Committee on Sections in the various cities where Sections are established; such meetings have recently been held with marked success at St. Louis, Milwaukee, Chicago and Detroit.

The Sections Session, which will be held on Thursday morning of the convention, represents the first time that the Session of a general meeting has been given over to the discussion of Sections' matters. This Session will be in charge of the Committee on Sections and Mr. D. Robert Yarnall will preside. Three-minute talks will be given by delegates from each of the Sections, followed by general discussion.

The Committee on Meetings and the Committee on Sections decided to hold this Session to discuss ways and means of increasing the coöperation and cohesion of the Section elements at this period of the Sections' development. There are many vital topics to be considered and it is hoped that the discussion will be fruitful and will guide this activity of the Society into the way of accomplishing big things, not only for the engineering profession but for the public at large.

The phases of the Sections' work are manifold. In each center in which Sections are established, opportunities for service arise at every turn. The new Sections' By-Laws govern the activities of each Section only to the extent of ensuring that its procedure is in conformity with the Constitution of the Society; they leave the Section free to carry out the details of its coöperative work with other societies' sections and with the local organizations and the public.

In addition to the talks they will give at the Sections' Session, the delegates will come into personal contact with the Council and with the management of the Society at the convention, and will thus have opportunity for familiarizing themselves particularly with the parent Society's attitude towards its branch organizations. This is an important essential, for the individual Section members should understand clearly in just what relation they stand to the parent Society, and by such understanding they will be able to derive the greatest benefit for themselves and to perform the most good for their fellow Section members and for the membership of the Society at large.

Other Section activities at the Annual Meeting will include "experience meetings" held by delegates, in which each delegate will outline what his Section has accomplished during the year; the Sections' Luncheon, which will be held this year at the Engineers' Club, 32 West 40th Street, New York, on Tuesday, December 4, at 12:30 p.m., and the usual informal meetings of Sections' delegates with the Committee on Sections.

THE PRESIDENT'S TRIP

In the following letter to Mr. Rice, Dr. Hollis conveys the impressions of his recent trip to the Pacific Coast Sections. The President was very much struck by the spirit of self-sacrifice he found everywhere among the engineers—everyone wanting to serve his country.

My Dear Mr. Rice:

I left Washington on the evening of October 15 and had dinner in St. Louis on the following evening with the Executive Committee of our society in that center.

Then I went to El Paso, arriving on the afternoon of October 18, and made an address to the Southwestern Society of Engineers during the evening, on the subject of The Engineer and the War. There were present all of the members who could get to El Paso, and a general audience of citizens. On the nineteenth the entire membership made an inspection of the engineers' camp on the Rio Grande, not far from El Paso, and in the evening there was a dinner.

I arrived in Los Angeles in the very early morning of the twenty-first and there made two addresses. The first was before the engineers of Southern California, and about 250 were present, representing all of the engineering societies; the subject was again The Engineer and the War. At Throop Institute I addressed the entire body of students. This institute is in Pasadena and will become the same kind of institution that the Rensselaer Polytechnic Institute at Troy is.

I reached San Francisco on the evening of the twenty-fourth and met the engineers representing all societies at dinner on the following evening. About 250 were present, and the subject was The Moral Influence of Engineering Efficiency. On the twenty-sixth I visited the University of California, but did not meet the students as I went there to see the instruction in aviation. On the twenty-eighth I met a number of the members of our society in Portland, Ore., and had dinner with them.

On the evening of the twenty-ninth I had dinner in Seattle with all of the societies represented in that city. There were something under 100 present.

On the thirty-first I left for home on the Canadian Pacific and arrived on Monday, November 5.

The strong impression I received from this trip was the spirit of self-sacrifice amongst the engineers, every one of whom wants to serve the country in some capacity. In Southern California and Arizona alone 250 engineers have already gone into the Engineer Corps of the Army, and there was not a single discordant note in connection with the requests for opportunities to serve.

The only symptom that was at all disturbing to an American citizen was the evident lack of information on the meaning of this war. While all were willing to serve, a great many seemed slow to understand the sacrifice that this great struggle is going to demand of all of us.

Another thing that impressed me was the value to the engineering societies of more frequent communication with the West. I believe the four engineering societies ought to unite to provide just such visits as this every year to ensure the Coast being kept in complete touch with what we all want to do.

(*Signed*) Ira N. Hollis.

On his way out to the Coast Dr. Hollis attended a conference at the U. S. Chamber of Commerce, at Washington, on the coal question, and offered the services of the Engineering Council in connection with the campaign for the conservation of fuel. During this conference he, Professor Breckenridge and Mr. Lieb were added to the Chamber of Commerce Committee on Fuel.

SECTIONS' COMMITTEE VISIT

Committee on Sections at St. Louis, Milwaukee, Chicago and Detroit, October 22 to 25

THE members of the Committee on Sections feel that a great deal was accomplished by their recent trip to four of the Sections located in the Middle West, and the opinions which have been expressed by the officers of the respective Sections visited are indicative of their appreciation of the recognition shown them.

The following members of the Sections Committee made the trip: D. Robert Yarnall, *Chairman*, L. C. Marburg, Prof. Walter Rautenstrauch, Dean Charles Russ Richards. Ernest Hartford, Secretary to the Sections Committee, accompanied the party. The only member of the Committee unable to be present was Major E. H. Whitlock, whose work for the Government made it impossible for him to obtain a leave of absence.

The party arrived at St. Louis on October 22 and was met at the station by the Executive Committee of the St. Louis Section. A visit was made to the Ashley Street Power Station of the Union Electric Light and Power Co., where the operations involving the change from the old reciprocating units to the new 20,000 kw. turbines were demonstrated to the party.

The St. Louis members turned out to the number of over sixty to the supper which was followed by a paper on the developments at the Ashley Street Power Station, presented by Mr. John Hunter, Vice-President-elect. Then the visitors each spoke outlining their work in the interest of the Sections, the manner in which Sections may coöperate in making THE JOURNAL the leading publication of its kind and suggestions for coöperation between Sections and the vital work of the Research Committee.

On the following day the Committee reached Milwaukee, visited the plant of the Allis Chalmers Company, and later had supper and discussed section matters with members of the Milwaukee Section. At this meeting a movement was started to develop the membership and scope of the Milwaukee Engineering Society with which the A.S.M.E. Section is affiliated.

The Chicago Section was next visited and a supper meeting held at the Hotel La Salle, at which were present about twenty-five of the active members of the Chicago Section. At this meeting plans were laid in the direction of securing close coöperation of the A.S.M.E. Section with the Western Society of Engineers, the Chicago Engineers' Club and the other engineering organizations of the city.

On the fourth successive day the Committee were guests of a Section, this time the A.S.M.E. organization in Detroit. The local committee met the visitors at the train and conducted them during the day to a number of plants where a more intimate acquaintance was obtained with the local conditions and the individual leaders in the engineering profession in Detroit. In the evening a dinner was held at the Chamber of Commerce, about sixty being present. Professor Rautenstrauch presented a paper on the Relation of the Engineer to Finance, and Dean Richards told of the research work being carried on at the Experiment Station of the University of Illinois. The meeting voted unanimously to invite the Society to hold its 1919 Spring Meeting at Detroit. All the week's activities were productive of much that should materially enhance the value of membership to those located not only in the four Sections visited, but to the entire Society.

D. ROBERT YARNALL,
Chairman, Committee on Sections.

CONNECTICUT SECTION INITIAL MEETING

THE first meeting held under the auspices of the new Connecticut Section was held at New Haven on November 14. There were two sessions, both devoted to the subject of fuel conservation. The first began at 2.30 p. m. at Lampson Lyceum, Yale University, with Mr. Henry B. Sargent in the chair. Over 150 were in attendance.

At the outset of the meeting, Mr. Sargent outlined the development which led to the formation of the Connecticut Section with its five branches at Bridgeport, Hartford, Meriden, New Haven and Waterbury.

Prof. L. P. Breckenridge presented the first paper on The Problem of Coal Conservation. He outlined the necessity of coal for heat, light and power, and by means of a series of lantern slides gave some very interesting data relative to the production of coal throughout the world, and also, in more detail, the production in the several states of this country. The distribution of coal by rail and water were shown generally to be the determining factors in the choice of coal used. Charts showed the percentage of coal used (*a*) by states, (*b*) by industries, commerce, in homes and for making steam, (*c*) per capita for several states, and (*d*) in relation to manufactured products.

The latest available data on coal production and consumption is for the years 1914 and 1915. In 1914 of the 1,800,000,000 tons produced throughout the world, about 600,000,000 came from the United States. Great Britain ranked second and Germany third. About one-sixth of the coal produced in the United States is anthracite, but the statistics show that since 1880 the production of hard coal has never reached 100,000,000 tons. During the same period the production of bituminous coal has advanced from 50,000,000 to probably over 600,000,000 tons this year. The conclusion drawn by the speaker was that we would have to learn to burn bituminous coal in our homes.

The total production of coal in the United States from 1906 to 1915 was 4,918,717,285 tons. Of this, Pennsylvania produced all of the anthracite and a large portion of the bituminous. West Virginia, Illinois, Ohio, Kentucky and Indiana ranked next in the order given in the production of bituminous coal. In 1915, Pennsylvania used more anthracite than any other state, New York ranking next, the New England States third. Three million tons were exported.

The railroads used 122,000,000 tons of bituminous coal in 1915, and the use by states was, Pennsylvania most, and, in their order, Illinois, Ohio, the New England States, and New York. New York is the only state which used more anthracite than bituminous.

The use of coal per capita in the Pacific States is 0.35 tons;

in New York, New Jersey and Pennsylvania, 6.52 tons; in Ohio, Indiana, Illinois and Michigan, 5.31 tons; and in the New England States, 4.85 tons.

Professor Breckenridge's paper was discussed by Professors Seward, Perry, and Barker, Messrs. R. J. S. Pigott and A. J. German. Mr. T. W. Russell, fuel administrator for Connecticut, also participated.

The following suggestion to save fuel in Connecticut was made by Professor Breckenridge and adopted by vote of the meeting:

Voted, That the Connecticut Section of the A.S.M.E. instruct the chairmen of its several branches to name a committee on fuel saving for their respective localities.

After a series of motion pictures, dinner was served at the Yale Dining Club, at six o'clock.

EVENING SESSION

The evening session was held at Mason Laboratory, Sheffield Scientific School, with Mr. J. Arnold Norcross in the chair.

Mr. O. P. Hood, mechanical engineer of the Bureau of Mines, Washington, D. C., described briefly the scope of the Bureau's work, but his paper generally covered the subject of Fuel Conservation by the Bureau of Mines.

Mr. Hood said that under normal conditions the Government buys over $8,000,000 worth of coal annually. The Bureau has been making war on waste for years and has tried to get people to believe what they knew to be so. The Bureau has believed that educational methods were, in the long run, the sane methods by which to accomplish fuel conservation, but under the present conditions it is necessary that power also be used to compel saving—and at the same time the educational campaign must be speeded up and carried on on a magnitude never before attempted. In view of the fact that only about 20 per cent of the coal mined is used for domestic purposes, whereas 63 per ceut is used in the production of power, it is through those persons engaged in the latter occupation that the greatest saving can be most easily secured.

The 20 per cent used for domestic purposes is handled by about 20,000,000 persons and the possible saving would be about 10 per cent, so that it would be an expensive proposition to attempt to reach this enormous group to effect a net saving of 2 per cent of the coal mined. On the other hand, the 63 per cent used for power purposes passes over the shovels of not over a quarter of a million firemen, so that it is in this direction the first drive for conservation should be made. Fuel economy is an art and must be taught to the man at the furnace.

The coal recently mined has shown by analysis from 14 to 15 per cent ash, as against about 8 per cent normally, showing that the increased production of coal is really an increase in ash. One of the prominent central-station operators recently stated that this additional ash has cost his plant an additional 20 per cent to secure the same production. This faulty condition likewise increases the number of coal cars that are required to transport this additional ash.

In its experiments the Bureau has developed that it is feasible to burn soft coal for heating purposes and obtain practically the same results as are secured by the use of hard coal.

Mr. Hood pointed out that investigation in the conservation of fuel soon unearths the many fallacies that are in circulation. The engineers have the correct technical data at hand to further consistent conservation of fuel, and the Bureau of Mines is coöperating with the engineering societies and other organizations in order to give such organizations the benefit of its service in having facts correctly stated before they are disseminated.

Mr. Hood suggested that considerable data of value were contained in the Bureau of Mines technical papers Nos. 80, 97, 137. He also called attention to a pamphlet about to be issued of interest to designers of boilers. This is being prepared by Henry Kreisinger, Mem.Am.Soc.M.E.

The paper was discussed by Prof. E. H. Lockwood, Mr. Bromley, associate editor of *Power*; Mr. F. O. Wells, and Professor Breckenridge.

The meeting closed with a very inspiring address by President Ira N. Hollis on the part the engineer is destined to play in the service to mankind in the twentieth century. The audience was much impressed by the stirring words of Dr. Hollis.

SECTIONS REPORTS

BALTIMORE

November 7. The first meeting of the season was held at the Engineers' Club and the following discussions were presented: Evaporators, by William L. DeBaufre, Mem.Am.Soc.M.E., mechanical engineer, U. S. Naval Engineering Experiment Station, and Considerations in Municipal Ownership, by Prof. A. G. Christie, Mem.Am.Soc.M.E., Johns Hopkins University.

With the aid of lantern slides, Mr. DeBaufre first described simple evaporators and multiple-effect evaporators. He said that experiments at the Naval Experiment Station had demonstrated that increased efficiency could be secured by reducing the amount of tube surface in former standard types of evaporators, and that the rate of heat transfer had been thereby increased from 250 B.t.u. per sq. ft. per degree difference in temperature per hour to a new rate of 900 to 1000 B.t.u. Methods of handling had also been developed which obviated the necessity of frequent cleaning to remove scale.

Mr. DeBaufre next showed a new form of evaporator he had developed and with which the efficiency of a triple effect could be obtained in a single effect. In this new evaporator a portion of the vapor leaving the evaporator at low pressure is carried to a nozzle-type ejector which receives live steam through a nozzle. The low-pressure vapor is caught up by the high-velocity steam from the nozzle and forced into a diffuser tube in which it is compressed to the higher pressure, then led back into the evaporator jackets where its latent heat is available for further evaporation. Tests were presented by the speaker showing the efficiency of the apparatus, and diagrams were also shown which illustrated graphically where the gains occurred.

In the discussion that followed, one of the speakers pointed out that this system with its high efficiency should prove of value to power-plant engineers in view of the increasing tendency toward using distilled water for boiler feed.

Professor Christie compared experiences in municipal ownership of public utilities of cities in Canada and in the United States and outlined the conditions that have tended to make the Canadian experiences successful and the American ventures generally failures. Emphasis was laid on the need of absolute separation of the utility from politics and of placing its control under a single trained executive, preferably an engineer. The financial problems of municipal ownership were outlined and discussed. The final conclusion was that political conditions at present existing in the United States did not appear to be favorable to the adoption of municipal control of utilities. Private ownership under close supervision of public utility commissions seemed to be the best solution of the problem.

A. G. Christie,
Section Secretary.

BUFFALO

October 17. Scientific Research was the subject of a discussion by Dr. C. E. K. Mees, director of the research laboratory of the Eastman Kodak Co., at a meeting of the society.

Dr. Mees [illegible] that the Geniuses who have accomplished so [illegible] of scientific research are not geniuses but [illegible] who accomplish much because they [illegible] have the laboratory organizations. He [illegible] that great scientific discoveries are simply a matter of [illegible] hard work and luck, and that it is just as possible to speed [illegible] work as other kinds. The more men at work and the better the organization of the laboratory, the more work will be accomplished. Today is the day of standards, classifications, grades, brands and comparative analytical tests, he said, and tomorrow will bring, with its still higher standards and more exacting tests, synonyms for tremendously accelerated competition.

Dr. Mees illustrated his talk with stereoptican views of modern laboratory methods and equipment.

The Automotive Section of the Engineering Society of Buffalo held a very interesting meeting on October 24, at which Mr. Otto M. Burkhardt, mathematical research engineer of the Pierce-Arrow Motor Car Co., read a paper on Crankshaft Design. Discussion followed, in which David Fergusson and Ernest Harris, of the Pierce Company, and Forest E. Cardullo and Charles M. Manley of the Curtiss Company took part. In the course of his discussion Mr. Burkhardt drew the following striking parallel:

"Three groups of scientists are remarkably interested in one and the same problem, i.e., the problem of balancing.

The economist is seeking—The balance of trade.

The statesman is eagerly watching—The balance of power.

And last but not least, the engineer is developing balanced crankshafts.

(1) If balance weights are attached to a 3 or 4-bearing 6-throw crankshaft, its running at high speed should improve remarkably because considerable centrifugal forces and subsequent transverse deflections are eliminated.

(2) It is an easy matter to attach weights to a 7-bearing 6-throw crankshaft. This will not improve its running because there is practically no transverse deflection that could be eliminated, and the main bearings are less favorably loaded.

(3) A 3 or 4-bearing 6-throw crankshaft if properly balanced will not be much lighter (if at all) than a 7-bearing shaft.

(4) In the case of a 3 and a 4-bearing crankshaft, an intense torque occurs in the crankpin, a phenomenon which does not pertain to the 7-bearing type of crankshaft.

The subject proved very timely and interesting and the meeting was well attended.

Louis J. Foley,
Assistant to Section Secretary.

CONNECTICUT

November 14.—The first meeting held under the auspices of the new Connecticut Section was held in New Haven on November 14. A full account of this meeting appears on page 1022.

Henry B. Sargent,
State Section Chairman.

CINCINNATI

October 18. The Research Laboratory Applied to Industry was the subject of an address by F. O. Clements at an interesting meeting of the Section. The speaker described how for some years a group of manufacturers of Dayton have been looking forward to the building of a number of factories surrounding a research laboratory that would be common to all of these factories. While some of the factories were being erected, war was declared and the purposes for which these factories were to be used were changed. One of the factories was turned over to the Dayton-Wright Airplane Co., although it had originally been intended for another purpose. The research laboratory had been intended for the study of problems connected with industry, and its purposes were somewhat modified by the declaration of war. However, its general organization had been pretty carefully thought out, and a laboratory was organized about six months ago. It contains a group of enthusiastic young chemists and engineers, carefully selected. The speaker mentioned some of the problems that had come up for solution and the progress made toward their solution. Naturally, many of the problems that are being studied are of a secret nature, and cannot be mentioned, but the possibilities of such a research laboratory were discussed at some length. The speaker paid a tribute to the general spirit of coöperation which prevails in the city of Dayton and which made such a research laboratory possible.

John T. Faig,
Section Secretary.

ERIE

November 13. The Engineers Society of Northwestern Pennsylvania and the Local Section of the Society held a joint meeting at the Erie Public Library, under the auspices of the Local Section of the Am.Soc.M.E. An illustrated lecture was delivered by H. G. Barnhurst, chief engineer of the Fuller Engineering Co., Allentown, Pa., on Pulverized Coal and Its Future. The subject proved to be of considerable interest, as the present high cost of petroleum has boosted the price of fuel oil to a point that makes discussion of available substitutes of interest to all engineers. Mr. Barnhurst is unusually qualified to speak on this subject, as he has been closely following the matter for some years, and has supervised the installation of a number of large plants.

M. W. Sherwood,
Section Vice-Chairman.

NEW YORK

November 13. The November meeting of the Section was preceded by a buffet luncheon at which over 80 were present. The Acquaintanceship Committee took special pains to welcome new members and the occasion was made very enjoyable for all present.

Mr. Maxwell W. Upson presented the paper of the evening on "Concrete Piling." Mr. Upson spoke at the outset on some of the problems involved in overcoming the difficulties met with in supplying special equipment of this character. He then gave a detailed, illustrated description of the Raymond concrete pile, a new development which has never been used to any commercial extent before. This pile is a composite pile, the lower part being of wood and the upper of concrete. The special advantage of this pile construction is that it overcomes two of the problems always inherent to the composite pile. The first is to secure a satisfactory joint between the concrete and the wood, and the other is to maintain alignment between the two parts.

The speaker also touched on the advantage of this kind of pile due to the ease of transportation of the wooden part. At this time it is impossible to transport long wooden piles from one section of the country to another.

Herman Greul,
Section Committee Member.

PHILADELPHIA

October 16. A most important and successful meeting was held by the Philadelphia Section in conjunction with the Engineers' Club at Witherspoon Hall. Homer, L. Ferguson, president and manager of The Newport News Shipbuilding & Dry Dock Co., presented the timely and interesting subject of The War's Effect on Merchant Shipbuilding. Mr. Ferguson outlined the effect of the submarine menace, and called attention to the necessity for action on the part of the United States Government. He pointed out the difficulties involved in building ships due to the scarcity of labor, and particularly to the scarcity of that kind necessary in the shipbuilding trades. The war would be won, he said, if America would only provide sufficient shipping facilities to properly transport and supply our armies on the other side. A number of new shipbuilding concerns have sprung up to meet the great demand and he expressed it as his belief that many of the leaders in these enterprises do not appreciate the tremendous difficulties involved in this line of work. The high-handed action of some of the labor unions in limiting the number of apprentices and production at this time he considered greatly to be regretted.

John P. Mudd,
Section Secretary.

PROVIDENCE

November 9. Several meetings of note have been held during the past month, among which might be mentioned that of the

Efficiency Section at which Chester T. Morey, assistant superintendent of the Rhode Island Tool Company, read a paper on the Handling and Moving of Material. He discussed the question of incoming and outgoing material and its arrangement, control and transportation within the shop.

On Tuesday evening, November 13, a paper was read on Some Steels used in Machine Construction, by Chester B. Sadler, of the Rhode Island Tool Company. Mr. Sadler touched on the composition, physical properties, heat treatment and metallography of these steels.

The regular November meeting of the Providence Engineering Society was held on Tuesday evening, November 20, Chester T. Lucas, associate editor of *Machinery*, being the speaker of the evening. Mr. Lucas showed a moving picture film of the Machining of a 9.2-in. High-Explosive Shell furnished by *Machinery* and gave a talk on the manufacture of artillery ammunition.

James A. Hall,
Correspondent.

SAN FRANCISCO

October 25. The activities of this Section so far have been confined to the dinner tendered to President Hollis on the occasion of his recent visit to the Coast. This meeting took the form of a joint meeting of the local branches of the national engineering societies, each of the societies being represented by a speaker.

Prof. Harris J. Ryan, of Leland Stanford Jr. University, spoke on behalf of the American Institute of Electrical Engineers. Prof. C. D. Marks, of Stanford University, represented the American Society of Civil Engineers. Prof. Andrew C. Lawson, of the University of California, spoke for the American Institute of Mining Engineers, and Dr. L. H. Duschak, of the U. S. Bureau of Mines, represented the American Chemical Society. Prof. B. F. Raber, chairman of the San Francisco Section, presided at the meeting, and the guest of honor was introduced by Geo. W. Dickie, Vice-Pres.Am.Soc.M.E., with whom Dr. Hollis had been associated at the time he was naval inspector at the Union Iron Works, San Francisco.

The general subject discussed during the evening was the relation of engineering to the war, each speaker taking up the particular branch of engineering represented by his society.

The event of the evening was a stirring address by President Hollis on the subject of The Moral Influence of Engineering and Efficiency.

C. H. Delany,
Section Secretary.

ST. LOUIS

October 16. The visit of Dr. Ira N. Hollis, president Am.Soc. M. E., was made the occasion of a dinner reception at the Missouri Athletic Club. Owing to the fact that the president's stay in St. Louis was limited to a few hours, it was impossible to arrange a meeting of the Section, but the time was spent in talking over the affairs of the Society with the executive committee.

The members of the executive committee were greatly impressed with the fact that Dr. Hollis's policy throughout the year has been first and foremost one of service to the engineering profession. Surely there could be no more effective results obtained by the president of such an organization as ours than the adherence to the idea that everyone in the organization is to do his part toward being of some real service to his fellow engineers.

October 22. On this evening, at the American Hotel Annex, the St. Louis Section held a joint meeting with the National Committee on Sections. The meeting was preceded by a dinner, at which were seated seventy-five members of the Section and guests. Mr. R. L. Radcliffe, chairman of the Local Section, introduced Mr. D. Robert Yarnall, chairman of the National Committee on Sections, asking him to preside during the meeting. Very interesting and helpful talks were made by the different members of the visiting committee, whose ideas with reference to the management and activities of the Local Section were received with a great deal of interest and will prove of great value.

Mr. John Hunter, Mem.Am.Soc.M.E., chief engineer of power plants of the Union Electric & Power Co., delivered an illustrated lecture upon the subject The Development and Operation of a Large Power Station. Mr. Hunter took the Ashley Street Plant of his company as illustrative of his lecture, and showed during the course of the evening seventy stereopticon views of the growth and development of this great station. The audience of technical men was deeply interested in what Mr. Hunter had to say, and the explicit manner in which he demonstrated his subject.

The chairman of the Committee on Sections congratulated the Local Section on the nomination of Mr. Hunter to vice-presidency in the Society.

E. H. Tenney,
Section Secretary.

STUDENT BRANCHES

Student Branch Conference

As has been the custom for the past few years there will be a Conference of Student Branch representatives held during the Annual Meeting. Each of the forty-five Branches is invited to send a delegate to attend this Conference, which will take place on the afternoon of Wednesday, December 5, at four-thirty o'clock.

This Month's Reports

BUCKNELL UNIVERSITY

November 5. L. W. Sipley gave an interesting talk on Steam Turbines. Prof. Frank E. Burpee, Mem.Am.Soc.M.E., expressed his regret that the usual custom of the University's tours of inspection of the different plants would probably not be carried out this year as many of the plants have been closed to visitors.

H. R. Pars,
Branch Secretary.

CARNEGIE INSTITUTE OF TECHNOLOGY

November 7. There was a large attendance at this regular meeting, at which it was announced that practically every junior and senior student in mechanical engineering had joined the Society this year. Following the regular business session a talk on central-power-station operation was given by Mr. J. C. Hobbs, Mem.Am.Soc.M.E.

Mr. Hobbs first spoke on modern automatic stoking and described in detail the very efficient devices at the Detroit Edison Co. for burning all the combustible material in the refuse. These devices consist of grinders which carry out the refuse and prevent clinkers from being formed. He laid special stress on the construction of firebrick walls to take care of unequal expansion on opposite sides.

Mr. Hobbs gave a brief description of turbines, stating that the best practice in starting turbines, also in opening steam valves into large pipes, is to open with a shock, then cut off again almost immediately and come on gradually. This is to prevent the steam from floating in on top in a cloud, and causing unequal expansion to the top and bottom of the turbine casing and the pipes.

The speaker did not think that dry pipes on boilers were practical; in fact he said he had obtained better results by removing the dry pipes from the boilers. He also gave some ideas on determining the most efficient piping.

The talk was followed by a general discussion, and after a short social session, during which smokes and refreshments were served, the meeting adjourned.

G. R. Brandin,
Branch Secretary.

UNIVERSITY OF MISSOURI

The officers elected at the November 8 meeting of the Branch were: Honorary Chairman, H. Wade Hibbard, Chairman, L. N.

[illegible] J. W. Baldwin, Secretary [illegible] H. K. King [illegible] Committee, H. Wade Hibbard [illegible] E. R. Wharton, William Copper, M. M. [illegible]

[illegible] by the Honorary Chairman on the [illegible] National Society and the relations to it and the [illegible] a student branch, also by Prof. [illegible] Mem.Am.Soc.M.E., upon his summer work in [illegible] factory about to be taken over [illegible]. At a later meeting the Honorary Chairman [illegible] upon his work this summer for the War [illegible] Washington, D. C., as an organization, manage[illegible] production engineer in the laying out of organization [illegible] plant for expanding departments expending $[illegible],000,000, according to present appropriations.

The School of Engineering is engaged in a thoroughly patriotic service in infusing into the students an intensity of purpose in preparing for their later engineering work in the Army or munitions plants; to this the students are heartily responding. The Honorary Chairman never knew of such enthusiastic and intense study as is now being given to the various courses. The men almost feel that they are in uniforms and serving their country. Forty-seven members of the University faculty are in uniform and drilling three times a week under Captain Craigie of the U. S. Army, a course specifically authorized by Act of Congress in a university where the Government has authorized a Reserve Officers Training Corps. Six hundred students are in the Corps also. The Faculty Company will shortly be in target practice on the rifle range, will be taken out among the hills for map plotting, and next summer will go into camp in the Ozark Mountains, under Captain Craigie. The quota of the University in Columbia and Boone County was made for the Liberty Loan, the faculty alone subscribing about $50,000. The faculty and students are giving $10,000 for the Army Y. M. C. A. in the $35,000,000 campaign.

H. Wade Hibbard,
Honorary Chairman.

NEW YORK UNIVERSITY

November 4. Ernest Hartford, Secretary to the Committee on Student Branches, addressed the members at the first meeting of the Branch for the season. He explained the privileges of the student-members, the benefits to be derived from the Society and also announced the meetings that the Am.Soc.M.E. is to hold and the topics to be discussed. Professor Houghton made a few suggestions concerning the organization of this Branch.

It was decided to hold one big meeting each month on the third Friday of the month, at the Engineering Societies Building at 8.00 p. m. Prominent men in the engineering world will head the program of each meeting, with addresses and illustrated lectures. It was announced that the first meeting would be held November 23, and everybody would be welcome.

Frederick Groepler,
Branch Secretary.

POLYTECHNIC INSTITUTE OF BROOKLYN

November 6. The first meeting of the Branch for the season resulted in the election of Charles L. Schweizer as chairman, to replace Frederick Bromm, who has been called into service, and William Sumner as vice-chairman. The regular business was followed by a lecture on Atoms, Electrons and the Constitution of Matter, delivered by Dr. A. A. Adler, Mem.Am.Soc.M.E. Interesting topics of Dr. Adler's talk were the size of the electron, the composition of X-rays and the heat waves of the sun.

Nathan N. Wolport,
Branch Secretary.

RENNSELAER POLYTECHNIC INSTITUTE

November 7. The third regular meeting of the Branch was held on this date at 7:45 p. m.

Mr. J. M. Dewey spoke upon the present plans for equipping the army with field laundry machinery. He thoroughly explained the problems met with in designing this machinery for motor-truck units, train units, and base units, and the methods pursued in overcoming each of these problems.

Mr. G. H. Carragan described the manufacture of paper. His talk was in the nature of a supplement to the recent trip the Branch made through the plant of the West Virginia Pulp and Paper Co., at Mechanicville, N. Y. He gave the history of the development of the industry, a summation of the various kinds of fibers used in paper making and a review of the different grades of paper and the processes followed in making each grade.

R. A. Marriott,
Branch Secretary.

EMPLOYMENT BULLETIN

The Secretary considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping anyone desiring engineering services. The Society acts only as a clearing housé in these matters.

In forwarding applications, stamps should be enclosed for transmittal to advertisers; applications of non-members should be accompanied by a letter of reference or introduction from a member, such reference letter to be filed with the Society.

GOVERNMENT POSITIONS

The Society has been asked to make suggestions of men for the following positions with the Government. Non-members possessing the necessary qualifications may avail themselves of these notices by enclosing with their reply a personal introduction to the Secretary.

SEVERAL ENGINEERS who have had considerable experience in the design of machines and machine tools, which would enable them to comprehend quickly questions involved in the designs of field-artillery material. 2426.

THE MOTOR SECTION of the Ordnance Department is charged with the procurement of tractors and trucks for hauling artillery and ammunition, including maintenance, inspection and training of drivers, also similar work in connection with armored cars and armored tanks. The principal duties of this section, however, will be the maintenance and upkeep of these vehicles in the field. 2427.

A NUMBER OF MEN with milling, mechanical or electrical engineering training and experience, at salaries ranging from $1440 to $1800 per annum, for investigating grain-dust explosions and fires in grain mills and elevators throughout the various parts of the United States. Traveling expenses and sustenance will be provided. 2428.

CIVILIAN POSITIONS

SEVERAL INSTRUCTORS in mechanical engineering are needed by one of the large state universities in Middle West; men having specialized training and experience in machine design, gas-power engineering and general laboratory work. Give complete statement of training, experience, minimum salary expected, and recent photograph. 1045.

DRAFTSMAN with at least five years' experience in the detail of machine parts. Permanent position. State age, experience, salary expected, and references. Location near New York City. 2012.

YOUNG MAN not over 35 and not subject to military draft. Must possess some technical training or experience in mechanical lines including drafting. Energetic man with executive ability required. Salary to start, $1300 to $1500. Location New York. 2166.

PHYSICISTS, ENGINEERS, DESIGNERS AND DRAFTSMEN for work of research development and design related to problems of telephonic, telegraphic and radio communication, which are matters of public importance. Opportunities for such men in both temporary and permanent positions. Apply by letter. Location: New York. 2178.

DESIGNERS, DETAILERS and TRACERS for chemical plant. Location Philadelphia. 2370.

MEN with mechanical engineering training, in connection with the various operating and test problems in operation of a large power plant. (*a*) Two junior engineers who have had experience in test work on various types of power apparatus to start at $100 per month. (*b*) For the shift-operating jobs three vacancies, starting with salary of $150 per month. Numerous opportunities for promotion; men who make good always considered for transfers to various other plants. Location Virginia. 2371.

ENGINEERS to train and develop in the fundamentals of a New York firm primarily engaged in the distillation of coal tar with the resultant principal production of bituminous road and roofing materials, with the ultimate object of filling operating positions in various plants as foreman, head chemist, assistant superintendents, or superintendents. Preferably, but not essentially, men of chemical-engineering training. As contemplated work will eventually be of an executive nature; ability to handle men is a desirable asset. 2374.

DESIGN DRAFTSMEN on plant layout. Not necessarily technical graduate. Salary $30 to $35. Location New York. 2383.

THREE TECHNICAL GRADUATES for steam engineering and general testing. Work covers steel mills in Pennsylvania, Ohio, West Virginia and Indiana. 2384.

YOUNG MAN with experience as engineer or draftsman to assist in sales department. Apply, stating salary expected. Location Pennsylvania. 2386.

HIGH-GRADE DESIGNING DRAFTSMEN on jigs, fixtures and gages, preferably men experienced in this line. Apply by letter stating experience and salary expected. Location New York. 2388.

PRACTICAL STEAM AND FUEL ENGINEER who also has a technical education. 2389.

ASSISTANT ENGINEER to take general charge of engineering work, including bearing application and shop engineering. Send full particulars in reference to past experience, age, and salary expected. Location Ohio. 2390.

PRODUCTION MANAGER, experienced in factory management, to take charge of factory. Prefer graduate mechanical engineer, and if possible a designer of automatic machinery. Man with executive ability and organizing ability, training in modern efficiency methods and factory management who is systematic, thorough and able to plan methods for getting work through the factory and has demonstrated ability to increase production. Factory makes small articles requiring precision machinery and employs 500 to 600 people. Location New York State. 2391.

MAN capable of taking charge of department employing about 100 men. Must thoroughly understand the bleaching, dyeing, sizing and calendering of cotton goods, a good handler of men; should command respect and obedience. Position would pay about $35 per week to start and more after the man was able to demonstrate his ability. Location Staten Island. 2394.

EXPERIENCED MAN capable of aiding in organizing and following up the introduction of a production department along modern lines, at a large factory located in the East. Must possess initiative and originality and be able to handle successfully shop problems. Man who has had experience in hardware or small tool lines preferred. State experience, age, reference and approximate salary required. 2395.

PLANNING DEPARTMENT AND TIME-STUDY MEN. A well-established firm can offer exceptional opportunities for effective and interesting work to engineering graduates who have had substantial experience with modern industrial methods, with special reference to time study, the determination of standard tasks, and planning and scheduling production. In reply state age, education, experience, present and expected salary. Location Massachusetts. 2396.

MACHINE-DESIGNING DRAFTSMAN. Technical graduate with some years' practical experience in a shop and at least 4 or 5 years in drawing room designing as well as making drawings. Desire man who can follow up work in shop and inspect machinery, a special line of stapling machinery for use in box making being manufactured to contract. Salary about $150 to $200 per month, according to qualifications. Location Illinois. 2399.

FACTORY MANAGER to assume complete charge of large firebrick plant. Must be between 28 and 36 years of age, forceful, possessed of technical as well as practical knowledge and able to prove former success in large undertakings. Location Missouri. 2402.

DRAFTSMAN acquainted with smelting work for position in El Paso, Tex. 2404.

VALUATION ENGINEER for important eastern railroad, to take charge of rolling-equipment valuation work. Should have special experience in valuation, cost and depreciation of car and locomotive equipment. Salary $3600 or more, dependent upon qualifications. 2406.

DRAFTSMEN of general mechanical experience. Men of integrity, reliability and industry wanted, with experience in general drafting, design and layout work. State age, details of experience, salary expected and references. Location Delaware. 2407.

DRAFTSMAN with sufficient experience to enable him to lay out machinery in new plants, including the making of drawings covering electric-light and power systems. Permanent position in engineering department. Prefer man with chemical-plant experience, or who has done drafting for consulting engineer. State fully qualifications and past experience. Applicant must be in possession of technical training. Salary $1300 to start. Location southern Ohio. 2409.

PRESS-ROOM FOREMEN. A Connecticut firm over a century old needs young blood in positions of responsibility. Must have knowledge of and be in sympathy with scientific-management methods. Fair salary and a bonus to start. State age, experience in detail, salary expected and present position, also when you could report for duty. 2410.

ASSISTANT SUPERINTENDENT to become superintending mechanical engineer for electric and finishing plant; should have shop experience and be accustomed to handling men. Some knowledge of chemistry and heat processes preferred. Salary to start $200 a month. Location Niagara Falls. 2412.

BOILER MAN fully conversant with every detail of design and construction of steam boilers, particularly water-tube boilers. Must be willing to make an investment in a progressive boiler shop. Location New Jersey. 2413.

NEW YORK CONCERN desiring to extend sales force for tool steels, want men of good address and shop training to educate for the work of salesmen and steel experts. Men between the ages of 25 and 35. Salary depends upon man. 2414.

MECHANICAL DRAFTSMAN for position in Omaha. Car and locomotive work. Application can be made through New York office. 2415.

POWER-PLANT MEN experienced in industrial lines, design and construction of steel and power plants. Location New York City. 2418.

POWER SUPERINTENDENT to take charge of a power plant near New York City, consisting of 2600 b.hp. of stoker-fired B. & W. boilers burning anthracite, 2500 b.hp. of B. & W. wasteheat boilers, and 15 prime movers—steam turbines and Corliss engines—up to 1500 I.hp. driving d.c. generators and air compressors. 2420.

SALESMAN familiar with time- and cost-keeping methods. Salary and commission basis. Headquarters New York. 2421.

DRAFTSMEN AND FIELD MAN. Young man with knowledge of anthracite-colliery practice. Location Pennsylvania. 2422.

YOUNG MEN with technical training in M. E. course to enter employ of company manufacturing flow meters. Rapid advancement to engineering work in power plants or sales. Location Massachusetts. 2423.

SAFETY INSPECTOR. Man with mechanical training, capable of making intelligent suggestions to engineering department for the provision of all necessary safeguards to comply with the requirements of the law and to make a plant as nearly mechanically safe as possible. Should be well qualified with educational methods to be employed in accident-reduction work. Position will pay $2000 a year. Location New England. 2424.

SALESMAN wanted for an old established firm. Must be cleancut, energetic salesman, not an order taker. Must have thorough knowledge and acquaintance with the automobile trade. While a certain amount of mechanical knowledge is not absolutely essential, such will

[illegible] attention of [illegible] conducting a branch office [illegible] expected and state when [illegible] Middle West. 2428.

[illegible] DRAFTSMEN, preferably with [illegible] Location New York. 24[illegible]9.

MECHANICAL ENGINEER with wide experience in all kinds of [illegible] equipment and solution of labor saving problems [illegible] work for a company having a number of large [illegible] in different parts of the country. Good opportunity for the right man. State age, education, experience and salary desired. Location Middle West. 2430-A.

MECHANICAL ENGINEER having practical experience, particularly in handling and conveying equipment, to study labor-saving problems in a large industrial plant and make recommendations. Good opportunity for the right man. State age, qualifications and salary desired. Location Middle West. 2430-B.

SALES ENGINEERS for hand stoker. Will pay liberal commission on the gross sales price, advance a drawing account of $150 per month. Man should have a technical foundation and be familiar with combustion problems. Would expect a man to spend two weeks with organization to gather selling data, facts and operation of the stoker, thoroughly equipping him for work. Location New England. 2431.

TOOL DESIGNERS AND DRAFTSMAN, particularly those who have had experience on small interchangeable parts. Paying the highest wages obtainable in return for first-class men of engineering ability, also paying a 12½ per cent bonus quarterly, or at the end of full bonus periods, to all employees based on wages earned and for faithful and continuous service. Location New England. 2432.

METALLURGIST, RESEARCH AND EXPERIMENTAL ENGINEER in a New England factory machining and grinding small parts from alloy steel. Man with technical training preferred. 2436.

MAN TO TAKE CHARGE OF SPECIAL CLASS in steam engine practice. The course will consist of one hour a week in the class room and one night of two hours in the engine laboratory. Class will not deal with the students of the regular engineering course, but with the men who are connected in some way with steam engine work, and who wish to obtain a knowledge of the practical and scientific principles underlying the operation of different types of steam engines. Location: New York. [illegible]

YOUNG ENGINEER to take up safety work in connection with plant and to take general charge of the building inspection. Location: New England. 2438-A.

CHIEF CHEMIST in connection with investigation work involved in the manufacture of product. 2438-B.

ASSISTANT MECHANICAL ENGINEER in large manufacturing plant. Young man with experience on pumping machinery preferred. Location New Jersey. 2439.

MEN AVAILABLE

MECHANICAL ENGINEER, EXECUTIVE. Technical education. Two years' commercial experience. Six years as designer on steam turbines and power plants. Five years as works manager of metal-working plant. Desires position as works engineer or assistant to executive in manufacturing or engineering firm. Excellent health and habits. Thirty-one years old, with family. L-392.

FACTORY EXECUTIVE, MASTER MECHANIC OR PLANT SUPERINTENDENT. Age 39. 18 years' experience as production superintendent in the manufacture of engines, condensers, high-vacuum air pumps, centrifugal pumps, etc. General engineering work, both medium and heavy. Has traveled extensively in connection with field work. Good executive, of pleasing personality, alert and resourceful, exercising well-balanced judgment in all dealings and retaining confidence of organization. L-393.

BUILDING EQUIPMENT ENGINEER seeks connection with a manufacturing or construction concern requiring the services of an [illegible] with [illegible] experience in the design, purchase, construction [illegible] plants, heating, ventilating, lighting, refrig[illegible] [illegible] and [illegible] systems. Has also been very successful in [illegible] offices, departments, etc. Services available [illegible] L-3[illegible]4.

[illegible] ENGINEER. Technical graduate, age 25, with [illegible] anti-friction bearing experience, desires position in engineering or engineering sales. Salary $1500 per annum. L-395.

MECHANICAL ENGINEER. Technical graduate, age 38, with 14 years' experience in industrial work as draftsman and engineer, in the manufacture of soap and illuminating gas, and in coal mining and plant construction. At present chief draftsman for a chemical plant. Desires position as chief draftsman or mechanical engineer. Salary $2500 to $3000. Location preferred, East. L-396.

MECHANICAL SUPERINTENDENT. Age 40, broad experience in design, construction, maintenance and operation of machinery, power and industrial plants. Salary $4800. L-397.

EXECUTIVE. M. E. education, age 39, married. Several years' experience in handling men in field, shop and office. Experienced in construction and operation of large lumber-manufacturing plants. Department and territorial manager for large corporation manufacturing and selling mechanical lines. Executive with company contracting for, designing and installing coal-preparation plants. Will consider opportunity in foreign or domestic field. L-398.

CHIEF DRAFTSMAN OR ASSISTANT CHIEF ENGINEER. Mechanically trained, age 29, married. Over four years' practical experience in design and manufacture of jigs, fixtures, gages and tools. Capable of handling men. At present in charge of a vital department of large munition manufacturing concern. Foreign positions considered. L-399.

GRADUATE MECHANICAL ENGINEER of leading technical school desires position of executive nature in connection with building heavy machinery or plant-construction work. Six years' practical experience covering shop work, designing and business. At present engaged in specialty of engine design. L-400.

COMBUSTION AND STEAM ENGINEER. Associate-member, age 29, married. Technical graduate, over six years' experience along lines of power-plant tests and efficiency work. Extended experience with competitive, acceptance and efficiency tests of power-plant equipment, turbines, engines, condensers and auxiliaries, stokers, soot blowers, brick, feedwater regulators, gages, meters, etc. At present employed. Location New York City or vicinity preferred. Salary $2250. L-401.

PLANT ENGINEER. Graduate mechanical engineer with 13 years' experience in the design, erection and operation of power plants and manufacturing machinery. Specialist in the operation of power plants and the repairs and maintenance of machinery. Well trained in the use of electricity as applied to machinery. Most familiar with the equipment found at coal-mining properties. L-402.

MECHANICAL AND ELECTRICAL ENGINEER. Technical graduate, age 35, married. Good executive, with 11 years' experience. Engaged in public-utility work embracing construction, operation and maintenance. Specialist in power generation and distribution. Salary $3600. L-403.

MECHANICAL AND ELECTRICAL ENGINEER. Technical graduate, age 28, with manufacturing experience on gas producers, internal-combustion engines, pumps, compressors, electrical motors, generators, and measuring instruments. General knowledge of power plants, storage batteries, and electrical distribution. At present chief of bureau of gas and electricity in large city. L-404.

PURCHASING ENGINEER of greatest varied experience will change for responsible connection, in charge of active and large organization paying commensurate salary. L-405.

EXECUTIVE MANAGER. An executive of ability and aggressiveness, a mechanical, technical graduate, at present employed, desires to connect with a manufacturer whose business may need systematizing and building up as to organization and production. Has had a varied experience in different branches of manufacturing, operating industrial plants along lines of scientific management, and is fully conversant with modern methods of manufacturing and marketing product. Only interested in a permanent position offering good possibilities for improvement. L-406.

At the Massachusetts Institute of Technology the faculty changes have introduced some new problems since there has been so much demand by the U. S. Government and by industrial corporations related to the war for men of technical skill. So great has been this draft that in the department of electrical engineering one-third of the staff has been called away, in mechanical engineering a dozen men have gone into war work while civil engineering, chemistry, naval architecture and the other departments have sustained serious losses.

ENGINEERING SURVEY

A Review of Engineering Progress and Attainment in Mechanical Engineering and Related Fields, Including a Digest of Current Technical Periodicals and a Selected List of Engineering Articles

British Railways and the War

A PAMPHLET published in London by F. A. McKenzie tells of the part played by British railways in the war.

Before the war the British and German railway organizations presented a striking contrast. The German railways were almost wholly state-owned, and many of them built primarily for purposes not of commerce but of strategy. Railway administration was most closely allied to that of the German Great General Staff. Even the cars were built to a size that could be employed for transporting the maximum number of men, or, in the case of freight cars, gun carriages and war materials.

The British railways, on the other hand, were privately owned and built solely for commercial purposes. It was the business of the railways to provide for the needs of the communities they served and obtain a fair return for their shareholders and nothing else.

There was only one thing done in the way of militarization of transports. In 1871, after the Franco-Prussian war, the British government was empowered by act of Parliament to acquire by royal proclamation any or all of the railways of the United Kingdom in time of war. There were in existence two organizations to deal with this situation. One, a committee of railway managers, first known as the War Railway Council and afterward as the Railway Executive Committee, was to act as a central organization and to coördinate the activities of the different railways in war time. Working in coöperation with it was the Engineer and Railway Staff Corps, a volunteer organization of railway workers, whose purpose was to develop schemes, methods, and personnel for the war railway service. It was composed of general managers of leading railways, prominent contractors, engineers and other railroad men.

Both of these organizations worked in conjunction with the Director-General of Military Transports, and by 1912 complete plans of operation were worked out. In fact, every railroad manager had in his safe a confidential, sealed, unopened document detailing a scheme of mobilization. In it he was told exactly what to do; the trains to be moved; their starting points and destinations, and the entire schedule of running if war came.

On August 4, 1914, the day that war was declared, the railways of England, Wales and Scotland, but not Ireland, were taken over by the government. The terms of compensation to the railroads were not announced at that time, and the lines remained the property of the companies.

At first the sole purpose was to facilitate the movements of troops as the war developed, but as economy became more and more essential the scope of the Railway Executive Committee became extended until now it is in supreme command.

A feat of which British railroad men are quite proud was the transportation of the expeditionary force, numbering 120,000 men, with a vast amount of material of war to Southampton for embarkation for France, simultaneously with the mobilization of the territorials and without essentially disturbing the usual traffic.

Altogether, at Southampton, for example, for practically every day of the first three weeks of war the London and Southwestern Railway handled during a period of 14 hours no fewer than 73 military trains, including the running of them to the boat side and the unloading of the full equipment and ammunition and horses. The trains arrived at intervals, averaging 12 minutes, and practically every train, without exception, came in on schedule time.

To American railroad men it will be of interest to hear that this rapid transportation of the troops to Southampton is recognized by the British railroad men themselves as having been possible only because the docks there had been carefully planned by the railway company for the handling of large masses of men and quantities of material. The trains conveying the troops and freight were run right down to one of the berthing stations; they were emptied there with the greatest expedition and were then sent back. Each train had a prominently placed index number on it by which it was known throughout its trip; its exact time and departure at each place was scheduled and the schedule had to be kept.

One of the noteworthy features of this rapid concentration of troops was that the ordinary traffic of the railways was maintained with comparatively little alteration. Here and there a section of the line was closed for a few hours, particularly sections of some of the junction lines across London, but the general public scarcely realized what was happening.

The conclusion of the final agreement between the government and the companies automatically brought about a great economy in some departments, especially the accounting department and the departments dealing with solicitation of business.

One of the problems which confronted the railroads at the beginning of the war was the demand for higher wages by the men. After the government took over the railroads several agreements were made, culminating in the terms of settlement of November 13, 1915, by which the National Union of Railway Men and the Associated Society of Locomotive Engineers and Firemen undertook not to present to the railway companies any fresh demands for increased bonuses or wages.

The rise of the cost of living proved, however, a stronger factor than formal agreements and several additional war bonuses have since been granted to the men. In justification of these increases in wages it was pointed out that the wages in other industries increased in the meantime. The railway men under the war labor regulations could not leave their employment for other work and it was felt that they could not reasonably be expected to continue work under far lower wages than other men in allied industries in the same districts.

One of the outstanding features of war operation of British railroads is the extensive employment of female labor. Up to the beginning of the war British railways had been very reluctant to employ women even for office positions, but the shortage of men and the desire to release as many as possible for service with the colors caused the introduction of women workers early in 1915.

The pooling system introduced by the government led to

[illegible] extensive economies, such as, for example, the [illegible]ment of the common use of open freight cars, called [illegible]user arrangement. A minor economy was an agreement by the railways to accept each other's "paid" and "to pay" stamps and labels on parcel traffic. This saved much labor and led to a further development in January 1917, when the Railway Executive Committee announced that from a given date the cartage charges for all descriptions of traffic must be paid by the sender at the forwarding station. The whole system of bills and accounts for passenger-goods traffic was thus swept away.

The saving in printing was so extensive that at least one large company was able to sell many tons of paper which had been stored for office use and put this on the market at a time when paper was scarcest.

On July 4, 1917, the Controller of Coal Mines published a system for the purpose of reorganizing the transporting of coal by railways for inland consumption. Under this system England, Wales and Scotland were divided into twenty areas and each area had to take its supplies from certain fixed districts of production. It was estimated that the plan would effect a saving in railway transport of not less than 700 million ton-miles annually. The scheme was based on four main issues:

1 That consumption of coal should take place as near the producing point as possible
2 That in view of the superior facilities offered by the main traffic lines the movement of traffic should follow these routes wherever possible
3 That the movement of coal should, as far as possible, be in well-defined directions—north to south, north to southeast, north to southwest, and east to west
4 That an area producing less coal than sufficed for its own need should not send any portion of its output to other areas. That an area producing more coal than it required for consumption within the area itself should only distribute to adjacent or convenient areas

This scheme did not affect water-borne coal, anthracite, or coke of any description, but was the precursor of other schemes which were to reduce unnecessary traffic in goods to the minimum.

No description of the work of the British railways in the war would be complete without some reference to the service in handling the wounded to which exceptional attention has been paid and for which special trains have been built. In fact, all the great English railway works devoted their utmost skill and care to the ambulance trains, endeavoring to provide the best accommodations for the transportation of the wounded.

The change in the system of management of the British railways, while effected primarily to meet the extraordinary war conditions, was so far-reaching and profound that responsible British railroad men recognize already that the problems in railway management and control raised by the war will not entirely come to an end with the conclusion of peace. A new era has begun in railway management and it will be impossible to go back completely to pre-war conditions. But even if it were possible, it would be undesirable. The British railroad operators have learned a good deal. Coöperation has proved to be better than cut-throat competition.

There are other problems such as the wages of the men after the war and the future of women's labor on the railways, but it is expected that changed conditions after the war may provide in themselves a solution for all these possible problems. British railroads hope that having solved the problems of war traffic and employment in unequal fashion they will master the lesser problems of the coming peace.

Notes from the Engineering Colleges

Throop College of Technology

According to information received from Walter H. Adams of the Department of Mechanical Engineering, comparatively little research work is carried on in mechanical engineering due to lack of time on the part of the instructors. There is being carried out, however, the installation of a wind tunnel housed in a new building to carry on aeronautical research work. This research work will be in charge of Dr. Harry Bateman, who will devote his time mainly to research and will do very little teaching.

With regard to the general laboratory equipment a new building was added last summer, which has doubled the laboratory space available for mechanical-engineering laboratory purposes. A motor-car engine, a 25-hp. air compressor and a 25-hp. heavy-oil engine are in this laboratory, and, in addition to other minor equipment, go to make a very well-equipped laboratory for mechanical-engineering work. Further, the equipment available includes a small engine and a small turbine direct-connected to an electrical generator, with the necessary boiler equipment, condensers, etc.

In the testing laboratory there is a 150,000-lb. Olsen testing machine which was on exhibition at the Panama-Pacific International Exposition. In addition, there is a 30,000-lb. Riehlé tension and compression machine, cement-testing and briquetting equipment, torsion machines, etc.

In the hydraulic laboratory they have a Pelton water wheel, water turbine, single- and multi-stage centrifugal pumps, piston pumps and minor equipment.

The following statement is quoted from Mr. Adams's letter:

"Our laboratory is willing to undertake any preparedness work which it is possible to do with the staff and apparatus available. Over one-third of the students who have entered the Army and Navy have come from the mechanical-engineering course in spite of the fact that we are offering six courses at the College. Last year Throop College was designated as one of the branches of the Reserve Officers' Training Corps, thus initiating work in military training at the College. So far, Throop College of Technology is the only Engineer Unit of the Reserve Officers' Training Corps in the country. This year our professor of military science and tactics will be Captain Charles T. Leeds, Corps of Engineers, U. S. Army, Retired. Captain Leeds is a graduate of West Point and the Massachusetts Institute of Technology, so that it is expected to develop a strong course in military engineering here at the College. We have formed no special units such as ambulance or aviation corps, as our men have gone into all branches of the service."

The first locomotive for American war-service railroads in France was completed in 20 working days, and engines of this type are now being turned out at the rate of about 30 per day. About 680 of these locomotives and over 9000 standard-gage freight cars are on order. The locomotive weighs about 166,400 lb., with the tender about 275,000 lb.—*Official Bulletin.*

U. S. BUREAU OF STANDARDS

The Bureau of Standards, as shown by the following report of its activities, is continuing its active work both on war problems and problems of what may be called peace activities. A significant feature of these activities is the close and growing collaboration between the Bureau and the industries. Thus, as seen from the present report, the Bureau is preparing material for the use of manufacturers of glass pots, and even making pots in its own plant which will enable American manufacturers to produce the more difficult types of glass.

Graphite crucibles experimentally made by the Bureau have been shipped to various foundries for purposes of tests under actual shop conditions.

At the same time work of great practical interest is being carried on in lines requiring a high degree of preliminary scientific training for its prosecution. Thus, the Bureau's study of dicyanin stained glass has yielded unexpectedly satisfactory results, and long infra-red radiations have been successfully photographed. In fact, an invisible spectral region as large as the entire visible spectrum has been thus made accessible to photographic methods in ultra-red. Ten or twenty years ago this would have been justly spoken of as an epoch-making achievement in experimental research, but in the last decade the world has grown so accustomed to great achievement that it is difficult to attract more than its passing attention. This does not, however, detract from the value of work done.

Safety Belts for Aviators

The Bureau of Standards has prepared specifications for leather to be used in the construction of safety belts for aviators.

Lubricants

The Bureau has been engaged on the development of specifications for airplane-motor oil in coöperation with those interested in this problem, including representatives of refining companies. The Bureau has an aero-mechanical engineer engaged in developing and describing an oil suitable for airplane motors. This expert is also working with the sub-committee on lubricants of the International Aircraft Standardization Board.

Optical Glass

The work on special clay pots for making optical glass is progressing rapidly. Pots as large as 28 in. in diameter have been made from porcelain mixtures. Lining of very good mixtures have also been applied to clay pots. In this connection the Bureau is preparing material for the use of manufacturers, as porcelain lining for the glass pots now being made commercially. A large plaster mold has been completed at the Bureau to be used in "casting" pots, and sufficient material has been prepared for "casting" a 28-in. pot in the near future. The use of pots purchased in the open market seems to preclude the possibility of making the more difficult glasses. The Bureau, therefore, is making pots in its own plant, and the work is progressing very rapidly. It is believed that when these are ready, satisfactory glass of all kinds can be made. During the past month two melts of light flint glass, one of a dense flint glass, three of a light crown glass, and three of boro-silicate glass have been successfully completed by members of the staff of the Bureau.

Graphite-Crucible Development

Twenty-six finished experimental crucibles have been completed for service testing in actual practice. These have been shipped to various foundries for this purpose. They are made in sizes used in industrial practice.

Stucco and Plaster

In the investigation of the durability of stucco and plasters, two small test buildings just erected on the Bureau of Standards' grounds have been coated with special stucco in order to study the weathering effects on this type of stucco, and with the special type of construction used. These form a valuable addition to the test structures already erected for this purpose.

Building Stones of the United States

In the investigation of building stones available in this country for structural purposes, 30 different specimens were submitted to laboratory test and examination. These included the determination of specific gravity, or absorption, and of the compression and transverse strength. A freezing and thawing machine is being erected for this work. This will simulate actual weathering conditions, and will be used to determine the life of various types of stones under various weather conditions.

Ultra-Violet Radiation from Quartz Mercury-Vapor Lamps

The increasing importance of quartz mercury-vapor lamps makes it very important that the methods for measuring total radiation and ultra-violet radiation be carefully studied. The Bureau is reducing these measurements of routine operations. Iu the final standardization of such lamps, the Bureau will be in a position to specify the intensity of the invisible ultra-violet radiation in absolute units. Such certification will be analogous to the rating of ordinary electric lamps in terms of candlepower.

Infra-Red Photography

The Bureau's study of dicyanin stained plates has yielded unexpectedly satisfactory results. Infra-red radiation of waves longer than 11,000 Angstron units (1.1 microns) have been successfully photographed, using the iron arc and cobalt as light sources for this purpose. An invisible spectral region as large as the entire visible spectrum is thus made accessible to photographic methods in infra-red. The work was deemed of such importance that maps of the solar spectrum were prepared, covering the region from 6800 Angstron to 9600 Angstron units. The work has been in active operation during the past month.

Exposure Tests of Steel Sheets

A visit was made to Pittsburgh and Annapolis to inspect the steel sheets exposed by the American Society for Testing

[illegible] undoubted evidence that the [illegible] better than the uncop- [illegible] conditions at Annapolis have [illegible] point. It is learned that at Ft. Sheridan [illegible] advanced far enough to justify drawing any conclusion.

News of Other Societies

Southwestern Society of Engineers

The annual convention of the Southwestern Society of Engineers was held at El Paso, Texas, October 18 to 20 inclusive.

The guest and speaker of the Convention was Dr. Ira N. Hollis, President of The American Society of Mechanical Engineers and of the Worcester Polytechnic Institute. His principal address, The Engineer in the Present War, emphasized that men, not inventions, will win the war, the keynote being struck in his words: "The blood of our children, the youth of America, only will solve this war. After all, it is not an engineer's war—it's a war of industrial organization."

Dr. Hollis again addressed the convention at the luncheon at the Ninth Engineers' Camp, Major O'Connor commanding. At this time he lauded the work of the United States destroyers in the war zone, stating they were far superior to anything in the British or German Navies. He again spoke to the society at the annual dinner that closed the formal session, the keynote of this address being that "America is a country of united people," quoting, "We have something now in the country the world has never seen before—three thousand miles of people with the same thoughts and the same ideals."

The opening address, "The Engineering School and the War," by President Barnes, emphasized the lack of research and executive type of engineers, and the belief that the war will teach the schools the need of developing their courses to train men along these lines.

The most enjoyable morning was spent with the Ninth Engineers' Camp, Major O'Connor commanding, and the Eighth Engineers' Camp, Major Peterson commanding, at which sessions Pontoon Bridge Building, Field Surveying, Fortification Work, and Trench Building were thoroughly demonstrated. These sessions, bringing the membership in close touch with Army Engineering, were especially enjoyable and beneficial. The stories of the troubles of cantonment construction as were found at Camp Codie, Deming, N. M., was carefully explained by C. A. Tilton, an auditor of contractor, and Major C. H. Miller, Engineer-in-Charge. The success of the construction of this cantonment against possibly the greatest odds at any of the camps speaks well for American engineering ability, and proves that the American engineer can construct successfully even if the resources at hand are meager.

The address of Dean G. M. Butler, of the University of Arizona, upon Some Effects of the Draft Law on the Arizona Mining Industry, very clearly brought out the problems that the Arizona mining companies have been facing during this great period of stress.

Nominations of officers for the coming year were made as follows: President, Dean G. M. Butler, University of Arizona; First Vice-President, Dean S. H. Worrell, Texas State School of Mines; Secretary, C. E. Barglebaugh; Treasurer, R. W. Goddard. For Directors to serve three years, Messrs. W. E. Robertson and Gerald Sherman, the following officers holding over as Directors: Messrs. Barnes, Gillis, Gladding and Andros.

At the present time the membership of the Society is 119, and it is interesting to know that practically 20 per cent of the membership is now in war service. This, and industrial conditions in Arizona, brought about a smaller attendance than usual, but the enthusiasm and interest in the meetings made up in a large measure for the shortage.

Gas as Gasoline Substitute

The advantages and disadvantages of gas as a substitute for gasoline in motor traction are discussed in a report just issued in England by the executive committee of the British Commercial Gas Association, which says, in part:

"When gas is used on a mobile vehicle several limiting conditions present themselves, inasmuch as the gas for driving the engine must be carried by the vehicle itself. The question of storage, therefore, arises first.

"From information that has appeared in the technical press, the use of gas for motor traction has been successfully worked out by Messrs. Barton Bros., of Beeston. Their arrangement consists of a flexible balloon-like holder carried on the roof of the vehicle. The holders are made of woven fabric treated so as to be impervious to gas and to withstand the effects of weather. They are made in various sizes from 150 to 500 cu. ft. capacity. The gas is therefore stored under a very slight pressure, probably only a few tenths of an inch head (water gage) above atmosphere, and this pressure is steadily maintained as the holder exhausts itself in feeding the engine. So far as the engine is concerned the low pressure of the gas in the flexible holder is of no consequence. The gas flows into the engine just as the air does; that is by the inductive power due to the operation of the engine itself."

The results of an experimental test made by the committee are thus described:

"A car having been equipped with gas reservoirs, it was driven round a district with about the average kind of road and variations of level, and the observations made indicate a radius of action 25 miles per 1000 cu. ft. The average speed was nine miles per hour, including the stopping and slowing down which was several times necessary at crossings, etc., but which is, of course, consistent with everyday conditions.

"Results obtained at Coventry show that the brake power developed by a petrol motor when driven by gas is about 85 per cent of the power developed by petrol, and that this proportion is fairly constant over a wide range of speeds; also for equal brake power on test bench one gallon of petrol appears to be equivalent to 250 cu. ft. of gas.

"Our own observations derived from general running of a vehicle on petrol and gas point to a ratio less favorable to gas, namely, that one gallon of petrol is equivalent to 300 cu. ft. of gas.

"Much, however, of course, depends upon the quality of the gas and the kind of petrol used, there being several qualities of both procurable at the present time.

"Regarding the equivalents of gas and petrol, the gas supplies in different parts of the country are, like electric supplies, not standardized either as to price or quality, and it will be found that the gas obtained at some places will give a better mileage than gas obtained in another place. The gas equivalent is, however, unlikely ever to be higher than 300 cu. ft. per gallon of petrol but may be as low as and even lower than 250 cu. ft. These figures, together with local prices for gas and petrol, will enable those interested to

calculate the relative costs of running." (*Journal of Commerce*, October 16, 1917, p. 9)

Industrial Reconstruction

An important manifesto on industrial reconstruction which has just been issued bears the signatures of more than forty well-known business men and university professors, and of a still larger number of officers of trade associations. The manifesto has also the support of the editors of some seventy trade and technical journals. The scheme outlined in the manifesto is put forward as the practical outcome of all the authoritative suggestions that have been made during the last three years for the organization of British industries and the development of trade and commerce.

Concerning the needs of industrial reconstruction the signatories say that to meet the urgent needs of the times it will be necessary to increase considerably our efforts to develop British industries on the following lines:

1 The mobilization of each industry for common action
2 A greater degree of coöperation between manufacturers
3 Coöperation between labor and capital and the avoidance of industrial strife
4 A more complete association between scientific institutions and traders
5 Education better adapted to our commercial needs
6 Each industry to be studied as a whole, and freed from unnecessary internal competition
7 Every trade to present a united front to foreign competition
8 Output regarded as a duty by both capital and labor
9 Encouragement by the Government of the activities of traders, with a minimum of interference.

It is contended that the matter cannot be left to chance, and that some national scheme is necessary which shall insure the securing of these objects.

Finally the manifesto puts forward under six headings a scheme for industrial reconstruction. It is suggested that the basis of the scheme should be a vocational franchise, which would make possible the organization of each trade separately under a trade council composed of capital and labor, and the decentralization of a large proportion of national work now attempted by Government departments. The Government, it is proposed, should establish a department to promote or encourage trade, and the first function of this department should be to create representative trade councils in every trade. It should be assisted by an advisory council, consisting of the chairman of all the trade councils, and should comprise special departments for export and tariffs, industrial and scientific research, commercial education, statistics and finance, welfare and exhibitions and advertising.

Generally, the scheme involves the establishment of a complete new system of trade government comparable to our existing system of local government, with a ministry at the head with powers similar to those of the local government board, controlling numerous trade councils, with powers comparable to those of existing county councils. It recognizes the essential principle that industrial interests should be grouped by trades and not by localities.

The manifesto, signed as it is largely by manufacturers and officers of employers' associations, is described definitely as an olive branch to labor. It invites the workers cordially to join with the management in the self-government of industry, and offers them an equal status and responsibility on the controlling body. (*Journal of Commerce*, October 27, 1917, p. 2)

International Aircraft Standards

The following list of specifications for aircraft has been adopted to date by the International Aircraft **Standards** Board of the Council of National Defense, F. G. Diffin, Chairman.

1L1. List of specifications
1G1. General specifications for the testing and inspection of metallic materials
1A1. Methods of chemical analysis
2S1. Chemical compositions of steels
2N1. Ingot aluminum
2N2. Ingot copper
2N3. Spelter
3S1. Carbon steel for case-hardening
3S2. Medium-carbon steel bars and billets
3S3. Alloy-steel bars and billets, 100,000 lb. per sq. in. tensile strength
3S4. Alloy-steel bars and billets, 125,000 lb. per sq. in. tensile strength
3S5. Alloy-steel bars and billets, 150,000 lb. per sq. in. tensile strength
3S6. Alloy-steel bars and billets, 175,000 lb. per sq. in. tensile strength
3S7. Alloy-steel bars and billets, 200,000 lb. per sq. in. tensile strength
3S8. Alloy-steel bars and billets, 225,000 lb. per sq. in. tensile strength
3S9. Alloy-steel bars and billets for case-hardening, 170,000 lb. per sq. in. tensile strength
3S10. Alloy-steel bars and billets for case-hardening, 190,000 lb. per sq. in. tensile strength
3S11. Tolerance on steel bars
3S12. High-strength steel wire
3S13. 19 non-flexible steel-wire cable
3S14. 7 by 7 non-flexible steel-wire cable
3S15. 7 by 19 extra-flexible steel-wire cable
3S16. Wire for acetylene welding
3S17. Wire for electric welding
3N1. Gun-metal castings
3N2. Manganese-bronze castings
3N3. Phosphor-bronze castings
3N4. Naval brass or equivalent alloy bars
3N5. Naval brass or equivalent alloy sheet
3N6. Sheet brass
3N7. Brass tubes
3N8. Sheet copper
3N9. Phosphor-bronze strip
3N10. Babbitt metal
3N11. Aluminum-alloy castings
3N12. Sheet aluminum
4P1. Turnbuckles
4P2. Ferrules and thimbles.

Wood for Aeroplanes

The Forest Service, Department of Agriculture, authorizes the following:

When the United States entered the war the need for wood to build airplanes quickly created a difficult problem. Most of the air-seasoned wood available had been bought for air-

[illegible] by the allied nations abroad. Thorough air seasoning of [illegible] requires from one to three years, according to the size and kind of wood. Kiln-dried stock under the [illegible] ordinarily used has frequently proved unsatisfactory and for that reason airplane manufacturers have been reluctant to use it. If the needs of the fighting forces were to be met adequately and without prolonged delay, it was essential that methods of conditioning should be available in which full confidence could be placed.

Long before this situation developed the forest products laboratory of the Forest Service, at Madison, Wis., had been making a scientific study of the drying of wood, and had developed a method of drying which has been very successful with all the woods tried. Several kilns have been built at the laboratory for experimental purposes and a number of demonstrations made in commercial kilns. Ash and spruce are the woods most in demand for airplane construction, and anticipating the present situation the Forest Service secured a shipment of partially air-seasoned ash and spruce plank for preliminary tests.

This material was kiln-dried without injury. Later thoroughly green Sitka spruce, white ash (northern and southern), white oak, Douglas fir, western white pine, and mahogany were secured in the log for testing. The spruce and ash logs were cut up and the green material from each species divided into three matched groups. One group of each species was tested green, another had been set aside to be tested when it has air-dried, and the third group was kiln-dried, trying several methods, and then tested.

Only the results of tests on the spruce have so far been analyzed. Comparison with standard tests which had already been made shows that Sitka spruce can be kiln-dried from the green condition with no more, perhaps less, injury to its mechanical properties than by air seasoning. Definite specifications have been prepared for kiln-drying spruce green from the saw for airplane construction, and if rigidly enforced, they will insure kiln-dried stock of this species equal to air-dried stock.

A preliminary study of propeller construction has shown the need of such information on propeller woods. The testing of the ash and other species now on hand, which include several propeller woods, is being pushed as rapidly as possible, and there seems reason to expect as favorable results as for the spruce. (*Official Bulletin*, October 18, 1917, p. 5)

Smoking Rules for Factories Adopted

Announcement is made by the New York State Industrial Commission that it has adopted the new "smoking rules" as Rule 15 of the Industrial Code, to take effect immediately. This gives the new rules force and effect of law.

According to the rule, smoking may now be permitted in a factory only upon written application by an employer, approved by the State Industrial Commission after inspection by its staff and under certain conditions to be prescribed. The permit shall state the conditions under which each individual permit is issued.

As a general proposition, aside from those conditions hereinbefore specified, smoking may be permitted where conditions are substantially as follows: (1) In buildings where the contents are either non-inflammable or incombustible. (2) In buildings of mill construction where the contents are incombustible. (3) In factory buildings, in separate rooms set apart for the purpose as mentioned before. (4) In foundries and forge shops.

No permit will be issued for smoking in any factory where explosives are manufactured, used or stored. Where smoking is permitted fireproof receptacles must be provided in which to deposit all waste or other inflammable material. Wherever smoking is permitted, the use of celluloid eye-shades, cuff protectors, or other similar devices is prohibited. Portions of any factory where smoking is permitted must be posted. (*Journal of Commerce*, October 29, 1917, p. 17)

Weights of Mercedes Motor Parts

The following interesting table is a recapitulation of the weights of the parts of the Mercedes motor:

Crankshaft complete	34.8 kg.
Lower half of crank case	39.97 kg.
Upper half of crank case	31. kg.
Six cylinders complete	61.24 kg.
Six connecting rods complete	13.86 kg.
Six pistons complete	18.7 kg.
Camshaft complete	21.1 kg.
Carburetor	6.6 kg.
Water pump with shaft and housing	6.6 kg.
Oil pump with shaft	5.85 kg.
Two operating magnetos	13. kg.
One starting magneto	4. kg.
Inlet pipe and ignition wire casing	11. kg.
Miscellaneous parts	5.5 kg.
Total	273.22 kg.
Exhaust pipe complete	7.5 kg.
Radiator empty	26. kg.
Total	306.72 kg.

This Month's Abstracts

New ways to burn crude oil or gas attract an increasing amount of attention in these days of fuel stringency. In the present issue abstracts will be found of descriptions of two such ways; one by W. A. Janssen and the other by A. C. Ionides.

In the section Air Pumps is described the Globe-Johnston rotary vacuum air pump, said to produce a high vacuum.

The section Engineering Materials is particularly rich in good articles this month.

An abstract from a paper before the Ceramic Society of Glasgow presents an explanation why silica brick is so much more resistant in high-temperature firing than ordinary brick.

Guillery gives new data and methods for obtaining more reliable results with the Brinell hardness test.

Prof. W. M. Thornton, by repeating tests formerly carried out at the National Physical Laboratory, determines the factors affecting the heat-insulating value of a roofing material and presents data on the behavior of such materials.

Grain-size inheritance in iron and carbon steel forms the subject of a paper before the American Institute of Mining Engineers, while Herbert J. French gives data obtained in an experimental investigation of the physical-chemical properties of chrome-nickel steels. Finally, several abstracts taken indirectly from German periodicals are reproduced in the same section.

In the section Internal-Combustion Engineering attention is called to an abstract of a French official report on the use of alcohol for fuel purposes in internal-combustion engines and some details of the new Evinrude-Hvid oil engine.

Tables and data are reproduced from a British periodical on the design of coil springs.

In the section Thermodynamics particular attention is called to an abstract of paper by W. C. Stuart, Mem.Am.Soc.M.E., on the performance and design of surface feedwater heaters. Lack of space prevented giving a more detailed abstract of this interesting paper.

REVIEW OF ENGINEERING PERIODICALS

SUBJECTS OF THIS MONTH'S ABSTRACTS

Aeronautics

The Metallurgy of Cast-Iron Aeroplane-Engine Cylinders, F. W. Adams

An article giving data on the mixtures and processes used in the casting of cast-iron aeroplane-engine cylinders.

The tests used are chemical analysis, water-pressure test for porosity, and size-limit test.

The chemical constitution of the iron is specified and usually allows of but little variation, the mixture aimed at being such as will make a cylinder sufficiently hard to insure a reasonable life, but, at the same time, machinable and not porous.

Owing to the thinness of the casting, phosphorus must be relatively high in order to promote fluidity and enable the metal to take the finest parts of the mold. As phosphorus, however, produces brittleness in the iron under shock, its excess must be carefully avoided. Fluidity can also be produced by a high melting temperature, but this has several disadvantages. In the first place more carbon is absorbed by the molten metal, and next, on casting, rapid cooling takes place at critical temperatures, resulting in brittleness and hard patches in the finished casting which cause considerable trouble in machining.

The water test is of great importance. The machined cylinders are tested up to a water pressure of 500 lb. per sq. in. and at this pressure must not show the slightest trace of leakage or even dampness on the outside surface. Failure in this case may be due either to excessive graphitic carbon or blowholes. In the first case a slight leakage usually occurs in the thinner portions of the cylinder and is apparently due to lack of cohesion between the graphite plates and the metal itself.

The original is illustrated by photomicrographs showing the structure of various types of cylinder cast iron. (*Aerial Age Weekly*, vol. 6, no. 7, October 29, 1917, pp. 286-287, 6 figs., *p*)

Air Pumps

Globe-Johnston Rotary Vacuum Air Pump

Description of a rotary valveless air pump designed to produce a high vacuum.

It consists of two main parts, the rotor and the drum, rotating on ball bearings in a specially designed casing. By a small modification the vacuum pump may be converted into an air compressor.

The rotor, Fig. 1, as applied for the vacuum pump, is a hollow member on the outer circumference of which deep double-thread screws are formed. A passage C runs between twin-screw threads A and B into the interior of the rotor. When the machine is producing a vacuum this passage acts as the inlet to the screw threads, but when air is being compressed, it is the outlet. Similarly the pipe F running from the interior of the rotor to the exterior of the machine is the inlet pipe in the vacuum pump and the outlet pipe in the compressor. The screw threads are joined by a large number of narrow partitions or blades D which are equally spaced around

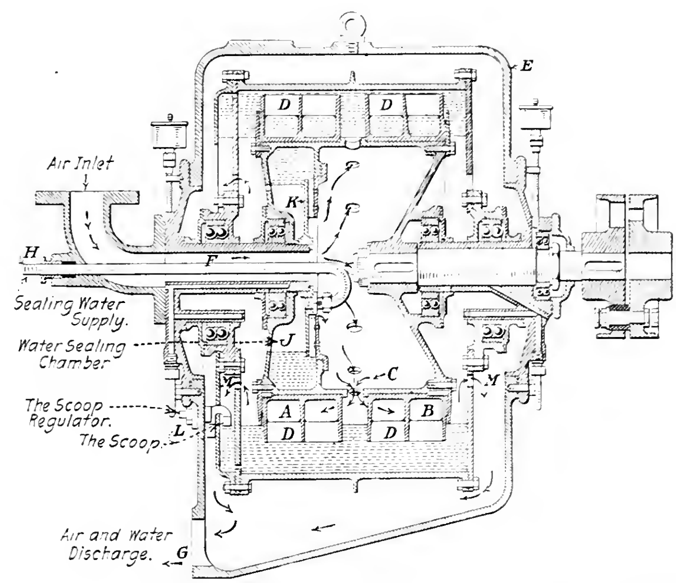


Fig. 1 Globe-Johnston Rotary Vacuum Pump in Section

the periphery of the rotor. The outer and inner edges of these blades are respectively flush with the top of the screw threads and half way down the depth of the threads.

The ring of water is in the first place set up by the action of these blades in conjunction with centrifugal force. Annular rings E, called shrouding blades, fitted to the sides of the rotor and reaching somewhat below the water level on the discharge side, prevent the exhausted or compressed air from returning along the screws when the thread ends leave the water seal.

The rotating drum is a hollow cylinder also running on massive ball bearings. The drum when rotating contains the ring of water and is set eccentrically to the rotor. The relative eccentricity of the rotor and the water ring produces what is called the "working space," Fig. 2. The net circular

[illegible] with the pitch [illegible] rotation is the measure [illegible].

[illegible] pump is a rotating screw [illegible] in conjunction with a ring [illegible] by centrifugal force [illegible]. To put the machine into operation [illegible] through pipe H, Fig. 1, and the pump [illegible]. The water passes through the water sealing [illegible] to the interior of the pump, which it gradually fills until it becomes deep enough to be caught by the partition blades D of the revolving screw rotors A and B. It is thus whirled round the interior of the rotating drum C by these blades.

The friction between the whirling water and the drum causes the latter to revolve also and in a very short time the drum and the rotor are running at practically the same speed. The sealing water continues to flow into the machine until a ring of water is formed within the drum sufficiently deep to submerge the screw threads on the rotor at the point where,

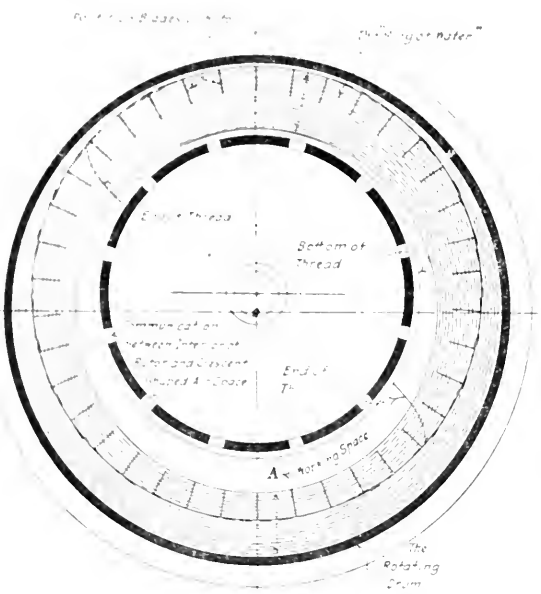


FIG. 2 SECTION SHOWING RING OF WATER IN THE GLOBE-JOHNSTON ROTARY VACUUM PUMP

due to the eccentricity, they approach nearest to the inner periphery of the drum. It is this water maintained in the form of a ring within the drum by centrifugal force operating in connection with the threaded rotor set eccentrically to it, that produces the pump effect.

During the operation of the pump a small stream of water flows continuously into the drum through the pipe H, Fig. 1, and in order to maintain the correct depth in the ring of water a scoop L is provided. The scoop skims half the surplus water and does it continuously while the pump is working. [illegible], vol. 29, no. 340, October 1917, pp. 75-79, 7 figs., [illegible]

Engineering Materials

THE REFRACTORY PROPERTIES OF SILICA. H. LeChatelier and B. Bogitch

It has been found that with clay bricks the arches could not bear the temperature in regenerative firing and would give way in a very short time. On the other hand, silica bricks could stand that temperature. It has not been clear, however, why silica brick is so superior to clay brick. The experiments on the refractory properties of clay carried on by the present investigators give a basis for the explanation of this fact. It appears that clay bricks begin to soften between 1300 and 1400 deg. cent., and, therefore, above that temperature cannot sustain heavy loads without giving way in a continuous and indefinite manner.

They act, therefore, like a vitreous substance, and have no real fusing point, but only an extensive fusibility range.

The difference in the ways in which clay and quartz act is based on the assumption that the latter has a real point of fusion without previous softening, and, consequently, independent of pressure. This has been confirmed experimentally by the writers. When toward 1500 deg. a small cylinder of clay is crushed it can be seen dilating into barrel shape, then completely flattened out into a thin cake, with rounded edges showing, at any moment, properly so-called fracture. When cooled, the crushed mass entirely preserves its former hardness. On the other hand, in the case of a silicon, the first application of the pressure produces no appreciable effect, but on increasing it gradually the test piece breaks abruptly, showing two sliding cones, which are observed in hard materials when working under compression, and the broken fragments do not reunite at all during the cooling. The effort necessary to produce this abrupt breakage decreases gradually with rise of temperature.

The resistance in crushing expressed in kg. per sq. cm. or lb. per sq. in. begins with 170 kg. (2400 lb. per sq. in.) at 15 deg. cent., 120 kg. (1700 lb. per sq. in.) at 1050 deg. cent., and 30 kg. (425 lb. per sq. in.) at 1600 deg cent. These numbers lead by extrapolation to a resistance of 12 kg. (170 lb. per sq. in.) at 1700 deg. cent., the usual temperature of the arches in steel furnaces, a resistance which is about ten times the load sustained by the bricks in the arches. This mechanical resistance, retained up to very high temperatures, is a special peculiarity of silica bricks, and is not found in clay bricks or even in magnesia bricks less fusible than silica.

The reason of the difference is that both clay and magnesia bricks contain basic oxides, such as aluminum, lime, oxides of iron, etc., which all tend to produce a fusible material liquid already toward 1200 deg. Silica, on the contrary, forms a continuous network, in the pores of which the melted mass lodges like water lodges in the pores of pumice stone without diminishing the mechanical resistance. The formation of this network, in consequence of the recrystallization of the silica, is due to the difference of solubility of the different allotropic varieties of silica.

Bricks insufficiently fired whose network is not yet formed are composed of grains of quartz flowing in the metal mass and are plastic like the clay bricks. This explains why insufficiently fired bricks are fusible and useless. When a good silica brick is heated, its strength diminishes with rise of temperature. The reason for this is that the solubility of silica increases with the temperature, and therefore a progressive dissolution of the crystalline network is produced which tends to disintegrate it. This effect is the more delayed the better the network is developed, and it is on this that the quality of silica brick depends before anything else. The problem is, therefore, to study the factors on which the rigidity of the network depends, and these factors appear to be as follows: the proportion of fluxes; the actual temperature of the brick; the good formation of the network; the disintegration of the network through subsequent swelling out.

As regards fluxes, it has been found that the weights of the oxides in the fluxes represent a particularly constant fraction of the weights of the sulphates, on an average 35 per cent.

The temperature which the brick supports depends entirely on the use one wishes to make of it. The highest temperature is in steel furnaces. In ovens for the distillation of coal the temperature is not so high, and, therefore, a double proportion of the basic oxides can be used in the brick which makes its manufacture easier.

The proper constitution of the network is the most delicate part of the manufacture. In order to develop the network, the brick must be kept for a very long time at such a high temperature that the melted magma may be sufficiently fluid. The most favorable conditions appear to be several days firing at a temperature approaching 1450 deg. cent.

The writers state, in conclusion, that all good bricks after heating for an hour at 1600 deg. cent. offer a resistance to crushing at least equal to 10 kg. per sq. cm. The prolongation of heating at this temperature does not materially diminish their strength as compared to what happens with bad bricks. (Abstract of a paper read before the Ceramic Society at Glasgow on October 2, 1917, through *Engineering*, vol. 104, no. 2702, October 12, 1917, pp. 396, e)

BRINELL HARDNESS TESTING OF METALS, M. Guillery

In order to have the results of the Brinell hardness test comparable with each other it is necessary to define the conditions of the test. In the case of steel it is usual to specify them as follows:

Diameter of the ball, 10 mm.
Total pressure, 3000 kg.
Duration of pressure, at least 5 min.

The first two of these conditions are easy to specify, but the third, while theoretically very simple, is in practice impossible to satisfy except in scientific laboratories. In a shop where the number of tests often exceeds 10,000 a day, it is evidently impossible to continue the pressure in each test for 5 min. and it is usual to keep the pressure only for 10 sec. This is liable to cause an error sometimes as high as 8 per cent.

The writer cites the following figures obtained with a constant speed of ball and the pressure being removed as soon as it attained 3000 kg. (Table 1.)

TABLE 1 DATA OF HARDNESS TESTS ON VARIOUS MATERIALS

Impact velocity, kg. per sec.	Dia. mm.	Error	Brinell hardness kg. per sq. mm.	Error	Tensile strength, kg. per sq. mm.	Error	Error per cent
MILD STEEL							
0	4.74	0	159	0	55.6	0	0
12.5.....	4.72	0.02	161	2	56.3	.7	1.2
25	4.70	0.04	163	4	57.0	1.4	2.4
1500	4.60	0.14	171	8	59.8	4.1	7.1
MEDIUM STEEL TEMPERED AND ANNEALED							
0	4.094	0	212.5	0	74.3	0	0
12.5.......	4.074	0.020	217	4.5	76.0	1.7	2.2
25	4.059	0.035	221.5	9	77.6	3.3	4.3
1500	3.975	0.118	227	14.5	79.4	5.4	7

A very simple mechanical arrangement makes it possible to eliminate this source of error. If the pressure is removed as soon as 3000 kg. are attained, the diameter of imprint will be too small by a quantity dD. If, on the other hand, instead of the pressure being stopped at 3000 kg. it is carried to $3000 + dP$, then the diameter of imprint will be increased. Now, if a suitable value of dP is selected, then the error resulting from insufficient duration of action of pressure will be exactly compensated. As a matter of fact, we will have essentially the relation

$$\frac{dP}{3000} = \frac{2\,dD}{D}$$

With an impact of 1500 kg. per sec. we have for the first steel in the above table $dD = 0.14$. Hence,

$$dP = 3000\frac{2 \times 0.14}{4.74} = 177 \text{ kg.}$$

It is quite possible to build an apparatus in which the maximum pressure attained will be regulated by the velocity of impact.

Let us assume that the pressure is transmitted to the ball

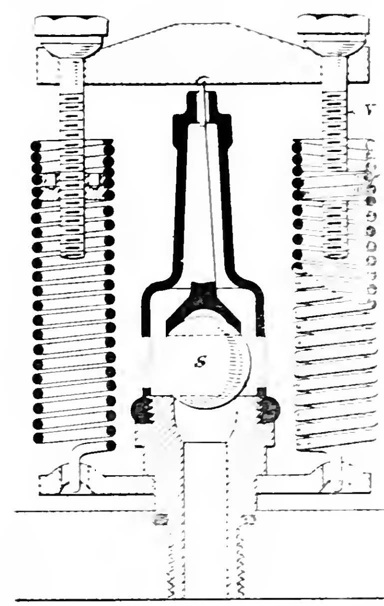


FIG. 3 GUILLERY APPARATUS FOR ADJUSTING THE PRESSURE IN THE BRINELL HARDNESS TEST

by a frictionless hydraulic piston in which the watertightness is insured by a strip of rubber. The pressure exerted on the piston is limited by the lift of the valve formed by the sphere S, Fig. 3, carried on a [illegible] seat. The pressure necessary to lift the valve is then strictly determined by the full section of the seat and the effort applied to the sphere. This effort is produced by the springs, the tension of which may be varied as desired by means of the tightening nuts D, and the useful length, by means of the screws E which act on the spirals themselves of the springs at rest.

For purposes of regulation this arrangement gives two independent variables: length and tension of the spring. The effort opposing the lift of the valve depends on the height of this lift, which increases the elongation, and hence the tension of the spring. The apparatus is regulated by "cut and try," so as to have on a given steel the normal diameters of imprint for two velocities of impact varying

[illegible] 30. The apparatus is at the same time [illegible] the intermediary velocities, as shown by [illegible]

TABLE 2 [illegible] HARDNESS TESTS ON AN IMPROVED BRINELL-GUILLERY APPARATUS

[illegible]	[illegible]	200	[illegible]	600	1000	1,500	3000
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.40	4.39	4.39

TABLE 3 FURTHER DATA OF TESTS ON VARIOUS MATERIALS

	Velocity of impact, in kg. per sec.				
	12.5	100	600	3000	
Mild steel	5.67	5.66	5.67	5.68	5.66
Medium steel, tempered and annealed	4.40	4.36	4.36	4.36	4.36
Nickel-chrome, untreated	3.63	3.60	3.59	3.62	3.58
Nickel-chrome, annealed.	2.61	2.62	2.62	2.63	2.60

Theoretically a new regulation should be made for each different metal. However, for ordinary carbon steels and for such special steels as chrome and chrome nickel which have undergone some heat treatment the same regulation holds good, as shown by the following results, Table 3.

This apparatus has been functioning for several months without having ever gotten out of order. On pieces of the same shape and easy to handle the testing is done at the rate of 600 imprints per hour. Of the 10 sec. employed for each operation 8 sec. are for the manipulations and 2 sec. for applying pressure. (*Essai de dureté des métaux à la bille Brinell, Guillery, Comptes rendus de séances de l'Académie des Sciences*, vol. 165, no. 15, October 8, 1917, pp. 468-471, 1 fig., *e*)

The Heat-Insulating Value of Roofing Materials, Prof. W. M. Thornton

In the last-but-one report of the National Physical Laboratory, there is an account of a test of roofing by means of measuring the heat lost from a heated room, which leads to the remarkable conclusion that the rate of emission of heat by the radiation from the covering surface has more effect on the inside temperature than the rate of conduction of heat through the material.

This result is of importance in the roofing of large factories of semi-permanent nature where the temperature depends more upon the covering than in the case of buildings having a closed air space under the roof. In the present case the test of the National Physical Laboratory was repeated by a method the reverse of that used by them; namely, instead of heating a room and measuring the heat lost through the roof, a smaller chamber was made by bolting together slabs of 3-in. thick "nonpareil" cork and exposing its cover to strong radiation. The box was made 18 in. square and 2 ft. deep inside, so that slabs of roofing of convenient size, such as slates, could be placed in position to cover the chamber without requiring special support.

The test consisted in observing the rate of rise of temperature in the chamber from the time the radiation was applied. The method was such as to give good comparative values.

The results obtained confirm the National Physical Laboratory conclusion that the heat-insulating value of a roofing material depends more upon the nature of its surface than upon its thermal conductivity. A sheet of galvanized iron was obtained having a practically mirrorlike surface. Only 111 heat units entered per 1000 sq. ft. per hour, but that the heat transmitted depends largely on surface conditions was seen at once by the increased rate of transmission caused by blackening the surface facing *into* the box, the other surface being unchanged. Reversing the plate so that the outer surface was black and the inner bright more than doubled the lost rate, and when both surfaces were blackened, the large amount of 581 units per hour was transmitted.

A suggestion was made in the National Physical Laboratory report that air spaces in roofing materials might be advantageous. A satisfactory means of doing this is to lay corrugated asbestos cement plates on the thinnest asphalted felt, or any other light sheet material, supported by the roof frames. The effect of this, as seen from the table, is equal to that of an aluminum surface, and where heat insulation and lightness are of the first importance, a strong and efficient roofing can be made in this way at a reasonable cost.

TABLE 4 HEAT TRANSMITTED THROUGH ROOFING MATERIAL EXPOSED TO STRONG RADIATION

	Material	Rise of temperature in testing chamber, deg. cent. per min.	B.t.u. per 100 sq. ft. per hour	Thickness in inches	Weight, lb. per sq. ft.
1	Bright galvanized iron sheet	0.268	111	0.04	1.6
2	Galvanized iron, blackened below	0.40	168	0.04	1.6
3	Galvanized iron, blackened above	0.93	385	0.04	1.6
4	Galvanized iron blackened above and below	1.40	581	0.04	1.6
5	Galvanized corrugated iron after one month's exposure to the weather	0.75	310	0.033	1.28
6	Do., after one year's exposure	1.02	422	0.033	1.28
7	No. 6, painted black above	1.13	472	0.033	1.28
8	Roofing glass, serrated	1.10	453	0.22	2.25
9	Welsh slate	0.81	337	0.17	2.0
10	Westmoreland slate	0.60	248	0.25	4.8
11	7/8-in. T. G. deal covered with asphalted felt	0.30	124	1.0	2.6
12	Corrugated fibrocement after one month in use	0.78	325	0.2	1.8
13	Do., after one year in use	0.80	334	0.2	1.8
14	Do., painted dead black	0.82	341	0.2	1.8
15	Do., "aluminum-finished" outside	0.50	207	0.2	1.8
16	Do., laid on top of thin asphalted felt	0.51	211	0.25	2.0

The main data obtained in the test are presented in Table 4. The "fibrocement" referred to in the table is an artificial roofing material containing asbestos manufactured by a British company. (*Engineering*, vol. 104, no. 2703, October 19, 1917, pp. 405-406, *e*.)

Grain-Size Inheritance in Iron and Carbon Steel, Zay Jeffries

Discussion of the question of inheritance of ferrite grain size from that of austenite, together with the general question of grain refining in steel and iron.

The writer reports on series of tests on grain size in transformation products of iron and steel such as 0.7 per cent carbon steel (in this series of tests, among other things, data were found giving an explanation why cast steel has its grain better refined after two heatings and coolings than after one), 0.2 per cent carbon steel, Armco iron, and finally electrolytic iron.

Because of lack of space only the conclusions reached can be reported here.

1 The ferrite grain size in pure iron, the ferrite and pearlite grain size in hypoeutectoid steel, the pearlite grain size in eutectoid steel and the cementite and pearlite grain size of hypereutectoid steel are not inherited from the grain size of the mother austenite.

2 The only structural feature that is generally inherited from the austenite of hypo- and hypereutectoid steels on cooling through their transformation ranges is the position of the excess ferrite or cementite at the austenite grain boundaries, sometimes causing complete and sometimes incomplete networks which outline the old austenite grain boundaries. Rapid cooling through the transformation range will cause the noninheritance of this structural (network) feature.

3 The austenite grain boundaries themselves are nearly always effaced in all steels, and also in pure iron during the *Ar* transformations.

4 The grain-size refining of steel and iron is brought about by the combined effect of non-inheritance of the transformation products on either heating or cooling, i.e., the austenite transformation products do not inherit their grain size from the austenite on cooling through the transformation range, nor does austenite inherit its grain size from the products which form austenite on heating.

5 In general, in both iron and carbon steel, the larger the austenite grain size, the larger will be the grain size of the transformation products on cooling. This, of course, assumes all other conditions constant except the austenite grain size. An exception is found to this general rule in very pure iron such as electrolytic iron. In this instance small austenite grains may form very large ferrite grains on cooling through Ar_3.

6 In iron and steel, the larger the ferrite, cementite or pearlite grain size, the larger will be the austenite grain size on heating above the *Ac* transformations, or vice versa.

7 The faster the rate of cooling of iron and steel through the *Ar* transformation range, the smaller will be the grain size of the transformation products and vice versa.

8 The faster the rate of heating of iron and steel, other conditions remaining the same, the smaller will be the austenite grain size.

9 The greater the temperature gradient during the transformations in iron and steel on heating or cooling, the larger will be the grain size.

10 If the grain size of a transformation product in iron and steel immediately after the transformation is smaller than the equilibrium grain size of that product under the existing conditions, the equilibrium grain size will be established by the known laws of grain growth.

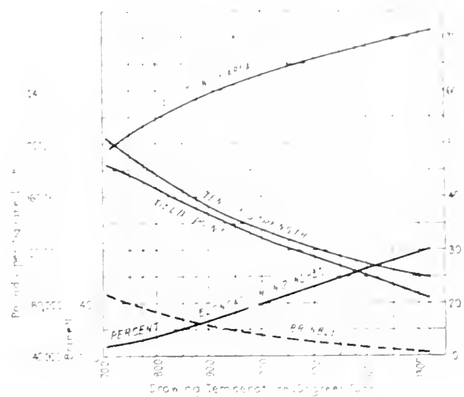
11 A single grain of any constituent in iron or steel (austenite, ferrite, pearlite), when forced by thermal treatment to undergo one of the *A* transformations, must transform from at least one nucleus, but may and nearly always does transform more than one nucleus. (*Bulletin of the American Institute of Mining Engineers*, no. 131, November 1917, pp. 1883-1899, 5 figs., 3 tables, *te*)

Physico-Chemical Properties of Chrome-Nickel Steels, Herbert J. French

Data of tests designed to show the properties which may be developed by heat treatment of certain chrome-nickel steels, especially those lately employed for automobile and aeroplane engine construction.

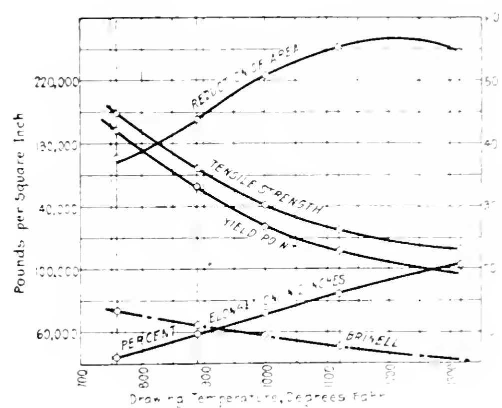
Standard tensile test specimens (0.505 in. by 2 in.) were heat-treated in a laboratory electric furnace, and the results thus obtained were then checked in actual production by including standard test sections in the ordinary large oil-fired furnaces. All temperatures are given in degrees fahrenheit.

In quenching care was taken to introduce the steel into the oil as quickly as possible after leaving the furnace. It was then kept in motion in the oil for about 1 min.



C	0.35	P	0.014	Cr	0.50
Mn	0.64	Ni	1.47	S	0.023

Fig. 4 Open Hearth. Forged to About 1 In. Round. Oil-Quenched 1470 Deg. Fahr. Drawn as Given.



C	0.43	PS	low	Cr	0.72
Mn	0.52	Ni	1.16		

Fig. 5 Open-Hearth. Forged to About 1 In. Round and Heat-Treated. Oil-Quenched 1475 Deg. Fahr. Drawn as Given

Tensile test values shown in Figs. 4 and 5 serve to give a good idea of the physical properties which may be developed by heat-treating steel of the following standard specification:

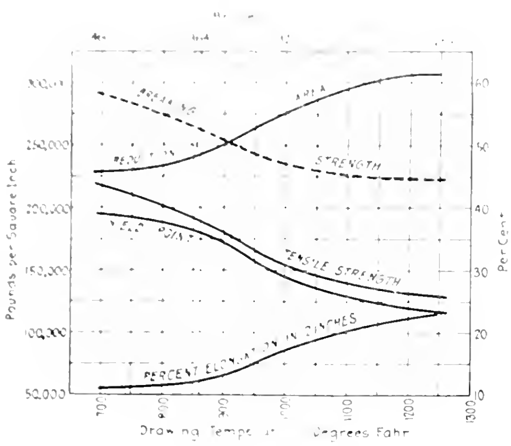
	Per Cent
Carbon	0.35—0.45
Nickel	1.00—1.50
Chromium	0.50—0.75
Manganese	0.50—0.80
Phosphorus, max.	0.04
Sulphur, max.	0.04

The article contains data on two other steels with high nickel and chromium contents. A good representative of such is Fig. 6, where the nickel content rises to 2.56 per cent and the chromium content to 1.01 per cent. In all, five types of steel are discussed.

[illegible] recommended, among other purposes, for the [illegible] aeroplane engine in the United [illegible] they are suited for automobile [illegible]

[illegible] remind, however, that steels of high nickel [illegible] are very susceptible to improper work- [illegible] This refers particularly to heat [illegible] Lower chrome nickel steels will stand more [illegible] manufacturing, and will show the effects of improper working to a less marked degree. What is especially to be avoided is too rapid heating, and particularly heating in an open fire, which leaves the center of the mass of metal cold and the outside "dripping." Quite often the effect of cold working is less serious than when the whole mass of steel uniformly heated is hammered at too low a temperature. This condition of strain can be obliterated if proper heat-treatment methods are employed.

Ordinary annealing may soften the steel so that the hard-



C	0.39	P	0.016	Cr	1.013
Mn	0.36	Ni	2.56	S	0.016

FIG. 6 ACID OPEN-HEARTH. FORGED TO ABOUT 1 IN. ROUND. HEAT-TREATED. OIL-QUENCHED 1475 DEG. FAHR. DRAWN AS GIVEN

ness test will show nearly normal results, but machining will still be difficult. (*Metallurgical and Chemical Engineering*, vol. 17, no. 8, October 15, 1917, pp. 473-476, 10 figs., *e*)

STRUCTURE OF SCHOOP SPRAYED-METAL COATING, H. Arnold (*Zeits. Anorg. Chem.* 99. 1. pp. 67-72, March 15, 1917. *Engineering* 104, p. 126, August 3, 1917.)

Examining the coatings microscopically (photographs reproduced) the author, of the Metallisator Gesell., finds that the drop of fusing metal is drawn out, by the gas and air currents, into a thread which breaks up into small particles; in the case of aluminum the particles form splashes, from 0.01 to 0.15 mm. in diameter, provided with a short tail and showing a dendritic structure. Polishing and etching of the coatings brings out wavy lines. Zinc, sprayed on glass, partly peels off again and contracts to irregular crescents; tin forms rings frequently double rings. There is no alloying of two sprayed metals, except perhaps with lead and antimony, unless [illegible] heating follows; the union is merely mechanical. [illegible] spray coatings, even of aluminum rolled into [illegible] distinguished from electrolytic and other [illegible] *Abstracts*, Section B. Electrical Engi- [illegible] vol. 20, part 9 [No. 237], September 29, 1917, p. 307)

HARDNESS OF COMMERCIAL ALLOYS, P. Ludwik (*Zeits. Vereines Deutsch. Ing.*, 61. pp. 549-554, June 30, 1917.)

Gives the results of measurements of hardness of a large number of the most important technical alloys of Cu, Sn, Pb, Zn, Al, Bi, Mg, Sb, Ag, with the five first-named metals in various proportions and combinations. These alloys include aluminum bronze, german silver, manganin, white metal, magnalium, etc. (*Science Abstracts*, Section B, Electrical Engineering, vol. 20, part 9 [No. 237], September 29, 1917, p. 305)

INFLUENCE OF THE METHOD OF PRODUCTION AND THE DIRECTION OF ROLLING ON THE PROPERTIES OF SHEET COPPER ROLLED TO VARIOUS THICKNESSES, W. Müller (*Zeits. Vereines Deutsch. Ing.*, 61. pp. 65-67, January 27, 1917.)

The tensile strength of sheet copper increases steadily with the reduction in rolling, the yield point increasing rapidly up to 20-30 per cent reduction; above this it is proportional to the ultimate strength. The elongation falls rapidly until the reduction in rolling attains 20-30 per cent, after which it remains nearly constant. With regard to the influence of the method of production, the modulus of elasticity is affected most in that the larger the grain size the higher the modulus. The hardness and the tensile strength, however, decrease with increase in grain size. No previous systematic investigation has been made of the influence of direction of rolling on mechanical properties, but it is generally assumed that the lowest strength is to be found at right angles to the direction of rolling. There appears to be a well-defined connection between the mechanical properties of the test piece and the angle which its axis makes with the direction of rolling; this is best shown by the bending test. Test pieces cut at 30 deg. to the direction of rolling exhibited the maximum resistance to bending. The modulus and tensile strength were found to be greater at right angles to the direction of rolling than in a direction parallel to it. Experiments on annealing showed that the increased strength of the sheets subjected to greatest reduction in rolling, is maintained after annealing at all temperatures. This hysteresis has been confirmed by a study of the specific gravities. (*Science Abstracts,* Section B, Electrical Engineering, vol. 20, part 9 [No. 237], September 29, 1917, p. 305)

Firing

NEW WAY TO BURN CRUDE OIL, W. A. Janssen

During the past year there has been developed a system of oil burning wherein the oil, instead of being atomized or vaporized, is gasefied in a special designed vaporizer outside of the furnace. The gaseous product is forced into a combustion chamber under positive pressure. The air for combustion is delivered by a compressor at about 2 lb. pressure and a velocity of 150 ft. per sec. With the admixture of oil in the vaporizer, a gaseous product is formed which is delivered to the combustion chamber under continuous pressure.

The cast-iron preheater, Fig. 7, consists of a closed cast-iron box with openings to connecting boxes for the admission of incoming air. A series of vertical flues are provided to permit a passage of the outgoing waste gases through the apparatus, thus providing a source of heat for preheating the air for combustion. When more than one preheater is used they are stacked one over the other, so arranged that the inlet

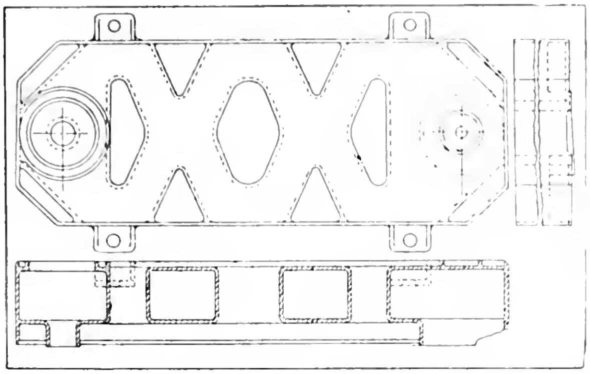


FIG. 7 GENERAL ARRANGEMENT OF THE CAST-IRON PREHEATER

opening of one connects with the outlet opening of another. The purpose of this arrangement is to throw out of line the vertical flues, thereby retarding the flow of outgoing gases and permitting a greater heat absorption through the walls of the preheaters.

The vaporizer, Fig. 8, is a hollow cast-iron fitting. Within it are a series of baffles, which form a winding, zigzag path for the gaseous mixture of the air and oil.

To obtain perfect combustion, the proportions of oil and air must be right and the temperature of the preheated air must also be correct. The installation operates most efficiently when the temperature of the air is about 800 deg. fahr., giving a net temperature of the gaseous mixture of about 700 deg. fahr.

The velocity of the gaseous mixture should be about 150 ft. per sec. in order to prevent flame propagation in the direction of the source. This is most essential, as the temperature of ignition, 1050 deg. fahr., is only a few hundred degrees higher than the temperature of the gaseous mixture.

To the heavy fuel oils of commerce about 180 ft. of free air are required per pound of oil, or about 1500 cu. ft. of free air per gallon—equivalent to 25 cu. ft. of free air per minute per gallon of oil per hour. High economies in oil consumption are claimed for this method. (Paper presented at the Annual Meeting of the American Foundrymen's Association at Boston, September 27, 1917, abstracted through *The Iron Age*, vol. 1, no. 18, November 1, 1917, pp. 1049-1050, 2 figs., *d*)

PROPORTIONING CHIMNEYS ON FUEL BASIS, Henry Wisostow

The writer believes that proportioning chimneys on the basis of formulæ given in handbooks and textbooks is not satisfactory, and suggests a somewhat different method, based on the following considerations:

The object which a chimney should accomplish is twofold: first, it should deliver sufficient fresh air to the fire to maintain combustion; and, second, it must discharge the products of combustion into the atmosphere. Hence, the best chimney is the smallest one that will do the work.

Contrary to the general idea, the composition of chimney gases runs very uniform for the same class of service and differs little with different services. The services may be divided into two classes, low-pressure for heating and high-pressure for heating and power or power alone.

The composition of chimney gases is largely affected by infiltration of air through the setting and into the gas passages. The average results from a large number of chimneys investigated are tabulated, as follows:

	Average CO_2, per cent	Average stack temperature, deg. fahr.	Average velocity, ft. per sec.
Low-pressure heating . .	4.5	180	10
High-pressure.	6.5	450	25

With the percentage of CO_2 given, the weight of the chimney gas can be figured closely. The quantity of the gas and the velocity are the two main factors determining the area of the chimney. Increase of velocity increases the stack loss, but this loss is not very large. Velocities of from 10 to 40 ft. per sec. are met in practice. With high velocities the rate of combustion is increased, which is followed by an increase in temperature, compensating for the increased draft loss due to a higher velocity.

Friction head in the chimney usually remains inside of 0.001 in. of water per lineal foot height of the chimney when the velocity remains under 30 ft.

Chimney height is determined by the amount of draft required. In cases where chimneys must be built higher than this, the area per pound of chimney gas can be reduced in inverse ratio to the square root of the height. The area is determined by the quantity of the gas per second and the velocity. As previously stated, a stack velocity of 25 ft. per sec. is a good working velocity, although for sharp, short peak loads a velocity of 30 ft. per sec. may be used. Chimney friction loss per foot under 30 ft. velocity per second will be inside of 0.001 in. of water. The gas weight may be obtained from the quantity of fuel required. The volume of gas is proportional to the temperature, and this may be taken as 450 deg. fahr. In all calculations absolute temperatures must be used. Draft required divided by the available draft per foot of height will give the stack height.

Available draft per foot of chimney for an average stack temperature of 450 deg. fahr. is equal to the actual difference in weight of the gases inside and outside of the chimney, expressed in inches of water per square inch, less 0.001 in. friction loss.

Composition of chimney gases can be taken as 6.5 per cent of CO_2, 11.5 per cent of O_2, and the rest nitrogen. From these figures the weight and volume can be obtained. Actual composition of the chimney gases varies slightly, there being a trace of CO, SO, SO_2, and slightly more nitrogen than was in the air. This is why the CO_2 and O_2 total 18 per cent in chimney gases instead of over 20 per cent, as in free air.

The quantity of combustible required to provide the desired amount of heat can be taken as composed of pure carbon with

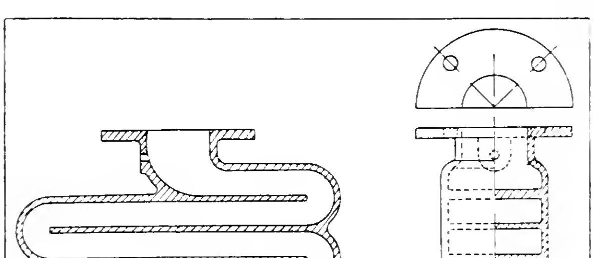


FIG. 8 CAST-IRON VAPORIZER

a heat value of 14,000 B.t.u. The combined efficiency of the boiler and furnace can be considered as 60 per cent for high- and 40 for low-pressure plants.

The foregoing data reduced for quick reference in practical work will be as follows: (1) Draft available per foot of chimney above the grate = 0.0063 in. of water, (2) combustible per horsepower, 4 lb., (3) area required per pound of combustible will be 14 sq. in. for high-pressure plants; (4) area correction for chimney above 150 ft. high per pound of combustible is (14 × 12/√H) (square root of chimney height). (*Power*, vol. 46, no. 18, October 30, 1917, pp. 610-611, *p.*)

Principles and Methods of a New System of Gas Firing, A. C. Ionides

The system described employs flues downwardly displaced in order to avoid any possible loss of heat.

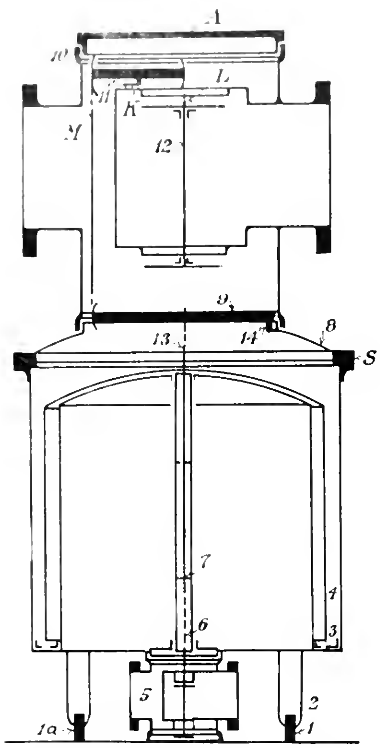


Fig. 9 Mixing Balance for the Ionides System of Gas Firing

The first problem that presented itself in applying this new principle was that of establishing and maintaining a constant mixture. There are three main variables to be dealt with as regards mixture: first, the inlet pressure of the air; second, the inlet pressure of the gas; third, the variation in consumption of either air or gas that may occur in any given installation.

The first problem was the most difficult to solve, since in many cases, as for domestic purposes, it was necessary to deal with considerable differences of pressure. This problem was solved by the construction of a device which the writer calls a mixing balance.

This balance, Fig. 9, consists of a sensitive bell, 4, with a requisite length of seal. The inside of this bell is subjected to the static pressure of gas and the outside to the static pressure of the air. Hence, when the static pressure of the gas increases, the arrangement is such that the flow of gas cuts itself off and the flow of air is, to some extent, increased. Likewise, when the static pressure of the air above increases, it shuts itself off and opens the gas correspondingly. As a result, the pressure of gas and air are always held in a constant ratio, whatever be the variation of either the inlet pressure of gas and air or consumption.

If the mixture of gas and air is rich in gas the flame is lengthened. On the other hand, if the proportions approach six or seven volumes of air to one of gas (according to the quality of the gas), it is quite possible, given silica or any other good catalyzer, to have no flame at all, but nearly surface combustion. Should a good catalyzer be placed at right angles to a stream of well-proportioned mixture, a glowing disk will be observed. On the other hand, if all catalyzers in front of this stream are avoided, the combustion can be spread

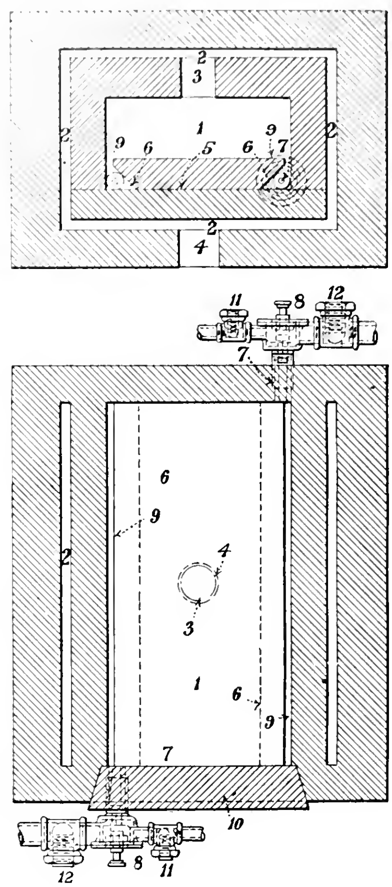


Fig. 10 Ionides Rectangular Barrel Furnace

out to a very considerable length. The author has proved by experience that with the ¾-in. injector, or even ½-in., it can be spread out to a length of 3 ft. of almost homogeneous combustion by putting the injector into the channel of firebrick open at the top. This permits even distribution of the heat units in a furnace or blower.

Next, it was found that the hotter the furnace grew, the less was the consumption of gas. This is, to a certain extent, due to expansion of gases by combustion. Assume that the gas mixture enters the furnace at, say, 15 deg. cent. If the temperature of the furnace was 1700 deg., it will have expanded to 1700/(273 + 15), or 5¾ times its initial volume.

If the waste gases, instead of passing into a chimney open at the top, are displaced downwardly through a contracted exit of predetermined cross-sectional area, this will cause a

resistance to the flow of incoming gases and provide the elements of the most refined thermostat without any mechanically working parts. It is claimed that by these means the temperature to be maintained can be predetermined by calculation.

The problem of determining the mixture was solved by a simple plan of fitting an ordinary gas cock with a piece of copper tubing bent with an easy bend and enlarged at the further end. Then a piece of india rubber tubing and an incandescent mantle are fed with the mixture, the light indicating the character of the mixture. If the meshes of the mantle are visible, it means an oxidizing mixture. If the mantle is in its most brilliant state, the mixture is very near the neutral point. On the other hand, if any unburned gas is seen to escape from the mantle in the shape of a blue flame, the mixture will be a reducing one. This provides a sensitive indicator.

The actual construction of the furnace is shown in Fig. 10. The operation of this furnace is as follows:

A heating chamber, 1, having a door, 10, at the front, is provided above and below, and, upon the greater portion of its sides, with two jacketing flue spaces, 2. The chamber, 1, communicates by one or two central apertures, 3, with the top flue space, and the heating elements passing through the said aperture pass downwards through the flues, 2, and are finally discharged through the outlet pipe, 4. In the bricks, 5, forming the floor there is provided along each of the two long sides a narrow combustion chamber, 6, into which the nozzle, 7, delivers mixture from a mixture device, 8, provided with gas- and air-adjusting means, 11 and 12. The long combustion chambers, 6, each deliver the products of combustion by a long, narrow slot, 9, into the furnace chamber, 1. The nozzle is positioned at one end of the long combustion chamber, so that the heating elements, due to their travel along the chamber and their upward motion to escape through the slot, 9, enter the furnace chamber, 1, with a diagonal movement parallel to the wall thereof. The gases passing along the wall will tend to turn at the angle when meeting the adjacent wall, and thus a whirling motion of the gases round the walls of the chamber will be created. If the nozzles of the two combustion chambers are arranged at opposite ends of the furnace, as shown, this whirling will be accentuated, the gases being gradually drawn inward across the roof of the furnace chamber on their way to escape at the outlet aperture, shown in the figure at 3.

A half-ton billet-heating furnace has been made, in which the gas consumption was 1.3 cu. ft. per lb. for full forging heat; the scaling was negligible. It is claimed that actual tests (data in original article) show that in brass melting an economy analogous to that afforded in steel forging can be effected. The Vickers Co. applied this system to a barrel-heating furnace, 36 in. by 12 in. by 3 in. inside, which resulted in their coming to an agreement to establish this system throughout their works.

As an indication of the correctness of the principles employed, the author would point out that a light worked by means of a pressure balance feeding a small incandescent mantle will produce 130 to 150 candlepower, with a consumption of under 3 cu. ft. per hour of town gas of standard calorific value; whereas, it can be stated on the authority of Mr. J. G. Clark in *Gas Journal,* May 4, 1915, that the highest-candlepower light obtainable at this pressure by other systems averages 22 candlepower per cu. ft. of gas consumed —variable, of course, owing to the atmospheric burner. (*The Engineer,* October 12, 1917, pp. 320-321, 5 figs., *d*)

Effect of Brick Arch on Smoke Abatement, J. T. Anthony

The paper refers mainly to locomotive practice, but some of its conclusions may have a bearing also in application to stationary boilers.

The Chicago Smoke Commission made extensive tests with and without the arch and found that the presence of the arch has certain beneficial results.

Tests recently conducted on a Mikado-type locomotive show smoke reductions varying from 50 per cent at low and medium rates of firing to 31 per cent at high rates of firing. The locomotive was hand-fired, using high-volatile Pennsylvania gas coal screened over a $1\frac{1}{4}$-in. mesh screen. This locomotive had 70 sq. ft. of grate area, a barrel combustion chamber and a 76-in. arch supported on four 3-in. arch tubes.

In these tests the increase in evaporation due to the arch varied from $8\frac{1}{2}$ to $15\frac{1}{2}$ per cent.

As regards the reasons why the arch decreases smoke, the following is to be borne in mind: With the conditions that prevail in the locomotive firebox it is easier to prevent the formation of soot than to burn it when once formed. The precipitation of soot can be prevented by having an excess of the heated air above the fuel bed. Research work done by the U. S. Bureau of Mines indicates that the hydrocarbons from the fuel bed are decomposed when they have traveled but a few inches from the top of the fuel bed, and hence if the precipitation of carbon is to be prevented the air or oxygen must be introduced at the top of the fuel bed and intimately mixed with the issuing hydrocarbons.

The chief function of the brick arch in abating smoke is that by baffling the gas mixture and compelling all the gases to pass through a relatively restricted area above the arch, an intimate mixture of the volatile combustible with the oxygen is insured. Where the arch is provided any excess air coming through this portion of the fire on the front of the grates is heated up, deflected and forced back over the end of the arch where it is mixed with the gaseous combustibles rising from the green coal under the door.

The results obtained with the arch depend, however, materially upon the method of firing. To reduce smoke to a minimum a slight level fire should be carried. With the fuel bed in this condition and a "scatter" type of firing being used, a uniform air supply is obtained throughout the fuel bed, as well as a uniform distillation of the hydrocarbons. (Paper read at the Convention of the Smoke Prevention Association, Columbus, Ohio, September, 1917; abstracted through *Power,* vol. 46, no. 16, October 16, 1917, pp. 540-541, *p*)

Handling and Conveying

Power Plant of the St. Joseph Lead Company,
E. L. Broome, Mem.Am.Soc.M.E.

Description of a new central plant serving several mining properties of the St. Joseph Lead Company, operating in St. Joseph, Mo. Of particular interest is the system of handling the coal and feedwater.

The coal is received from an elevated track discharging into a 30-ton steel track hopper underneath, by means of an opposed pair of reciprocating trough-shaped grizzlies. The smaller sizes fall into chutes at each side of the crusher and thence are fed directly to the belt. The larger pieces roll over the ends of the grizzlies and fall in the center into the crusher hopper, from which they are delivered on a 20-in. inclined belt conveyor driven from the upper end and provided with a magnetic pulley for the removal of pieces of iron. The belt

[illegible] a circular steel bunker 30 ft. in diameter, lined with 4 in. of reinforced concrete and having a capacity of 400 tons. Under the bunker is an 8-ton weighing hopper provided with an automatic registering scale beam and discharging into duplicate horizontal helical conveyors 12 in. in diameter, extending the full length of the boiler room over the stoker hoppers, the trough being provided with a rack-and-pinion operated sliding gate over each stoker. This solution of the fuel-supply problem results in a light, well-ventilated boiler room, while the spiral conveyors insure a very homogeneous condition of fuel at the stoker hopper and permit a uniform moistening of the fuel (this latter practice has been adopted to prevent coking and reduce dust).

Water for boiler feed is drawn for the mine and a maximum of softening is insisted upon. The mine water runs about 18 grains per gallon total hardness, equally divided between carbonates of calcium and magnesia. Two complete

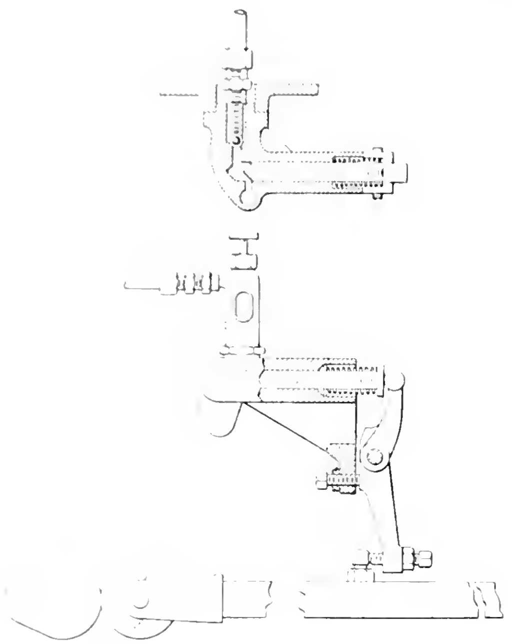


FIG. 11 SPECIAL OIL PUMP FOR LUBRICATING THE CYLINDER OF THE EVINRUDE OIL ENGINE

water-softening treatments have been installed. The lime-soda treatment of the continuous type takes the raw water at 18 grains per gallon hardness and reduces this hardness to five grains per gallon. This water is then passed through a pressure sand filter into a Permutit softening filter, where it is reduced to zero hardness. (*Power*, vol. 46, no. 18, October 30, 1917, pp. 582-585, 6 figs., *d*)

Internal-Combustion Engineering

ALCOHOL AND HYDROCARBONS AS FUELS

In 1916 a committee was appointed by the Minister of Commerce and Industries of France to consider the scope of national resources in fuels for internal-combustion engines. This committee has presented an extensive report from which the following data are abstracted.

In the first place, the report considers alcohol. It points out that in addition to grain alcohol proper enormous amounts of [illegible] alcohol can be derived from the treatment of [illegible]. The method of production of ethyl alcohol consists in the proper treatment of wood shavings or sawdust, from which may be obtained up to 15 per cent of alcohol (which is real ethyl alcohol, and not wood alcohol). In addition, alcohol may be prepared synthetically. In the first place, acetylene is produced from calcium chloride. Next, by an electric arc ethylene is extracted from acetylene, and this, in turn, gives sulfovinic acid, which is used for the production of alcohol.

Acetylene may be used in another way for the production of ethyl alcohol. The acetylene is passed through a solution containing one-thousandth part of bichloride of mercury, which results in the production of acetaldehyde, which latter, after being heated, is converted into alcohol by hydrogenation. The synthetic production of alcohol known in France only as a laboratory process is commercially used in Germany.

In view of the fact that a heavy tax exists on alcohol used for drinking purposes, all industrial alcohol must be denatured. In France a denaturing agent used is methylene containing 25 per cent of acetone and at least 2.5 per cent of pyrogenous impurities.

Among other things, it has been found that denatured 90 per cent alcohol can be used in gasoline engines under the following conditions: increased compression, altered distribution, and the employment of special means for preheating the charge and starting the engine. A more convenient method would have been the use of a mixture of three carbureting fuels in the present gasoline engines.

The use of such a mixture is based on the ability to satisfy certain conditions. In the first place, all these fuels should easily dissolve in each other in all proportions. Now commercial benzol containing 14 per cent of toluene and 1 per cent of xylene is very soluble in 90 per cent alcohol, but it would take 40 volumes of 95 per cent alcohol to dissolve 60 volumes of gasoline. Hence, for industrial purposes, it is necessary to use 95 per cent alcohol, of which 100 volumes dissolve 900 volumes of benzol and 150 volumes of gasoline.

It is very likely, however, that after the war benzol will be used in other industries, such as, for example, the production of dyes. In that case its price would make its use as a fuel prohibitive. In view of this possibility, the employment of ether-ethyl as an auxiliary fuel has been investigated.

The manufacture of ether is very simple, and its price is only seven or eight per cent that of alcohol. The only obstacle that lies in the way of its more extensive use is in the regulations of the French Excise Department. It appears that otherwise a mixture of alcohol, ether and kerosene could be used for both power and lighting purposes.

As regards the power purposes, extensive tests have shown that a mixture of 65 per cent of 95 to 96 per cent alcohol, with 10 per cent of ether and 25 per cent of a hydrocarbon fuel, can be burned perfectly well in an engine. In fact, with this mixture there is no trouble in starting an engine, and the consumption per volume is approximately the same as that of gasoline, at least for light vehicles.

The same fuel for stationary motors and trucks has given a less satisfactory result, the consumption per volume, as compared with gasoline, varying in approximately the inverse ratio of the heat values of the respective fuels. (*L'emploi de l'alcool industriel et des hydrocarbons comme carburants*, P.M., *Le Génèe Civil*, vol. 71, no. 14, October 6, 1917, pp. 225-228, 2 figs., *gp*)

EVINRUDE OIL ENGINE

In THE JOURNAL were given data on the Hvid cycle of oil engines. Essentially it is a high-compression cycle similar to that used in the Diesel engine, but with a different system of injecting the fuel. In the cylinder there is a cup with two

tiny openings at the side. The compression forces air through these openings so that the air in the cup is highly heated. This high temperature volatilizes a small portion of low-boiling fuel which is present in every oil and causes a sort of explosion in the cup, driving the fuel out in a spray.

The present engine is built by the Evinrude Motor Co. of Milwaukee, Wis. At present only $1\frac{1}{2}$-hp. and 3-hp. sizes are being built, but it is announced larger sizes will be added later.

The $1\frac{1}{2}$-hp. engine has a $3\frac{1}{4}$-in. bore and 5-in. stroke and is designed to operate at 600 r.p.m. The fuel tank is passed between the flywheels just over the crankcase, and fuel is supplied to the fuel cup by gravity.

The cylinder is lubricated by a special oil pump shown in Fig. 11. Oil from the lubricating-oil tank, which forms a small compartment of the fuel tank, flows to the oil pump through a side feed, and is then forced by the plunger through the cylinder wall to the surface of the piston. The pump is timed to operate when the piston is in its extreme outward position during the exhaust stroke. In this manner the oil is regularly and at the proper time fed in the cycle. (*The Gas Engine*, vol. 19, no. 11, November 1917, pp. 536-537, 6 figs., *d*)

TABLE 6 VALUES OF k

S.W.G. No.	Round Wire	Square Wire
7/0	93,750	99,150
6/0	69,530	73,550
5/0	52,240	55,260
4/0	38,400	40,610
3/0	28,720	30,380
2/0	22,000	23,270
0	16,530	17,490
1	12,150	12,850
2	8,704	9,206
3	6,050	6,400
4	4,345	4,596
5	3,030	3,205
6	2,040	2,158
7	1,440	1,524
8	983.1	1,040
9	645	682.3
10	402.6	423.8
11	271.6	287.3
12	175.5	185.7
13	107.5	113.7
14	61.44	65
15	40.31	42.64
16	25.16	26.62
17	14.75	14.61
18	7.962	8.422
19	3.840	4.061
20	2.518	2.664
21	1.573	1.663
22	0.9225	0.9757
23	0.4980	0.5267
24	0.3510	0.3713
25	0.2400	0.2639

TABLE 7 CUBES AND FOURTH POWERS OF GAGES

S.W.G No.	Equivalents		Cube	4th Power
	Approx. in.	Dec. in.		
7/0	1/2	.500	.12500	.06250
6/0	15/32 –	.464	.09990	.04635
5/0	7/16 –	.432	.08062	.03483
4/0	13/32 –	.400	.06400	.02560
3/0	3/8 –	.372	.05148	.01915
2/0	11/32 –	.348	.04214	.01467
0	21/64 –	.324	.03401	.01102
1	19/64 –	.300	.02700	.008.100
2	9/32 –	.276	.02102	.005.803
3	1/4 –	.252	.01600	.004.033
4	15/64 –	.232	01249	.002 897
5	7/32 –	.212	.009.528	.002.020
6	3/16 –	.192	.007.078	.001.359
7	11/64 –	.176	.005.452	.000.959.5
8	5/32 –	.160	.004.096	.000.655.4
9	9/64 –	.144	.002.986	.000.430.0
10	1/8 –	.128	.002.097	.000.268.4
11	7/64 –	.116	.001.561	.000.181.1
12	7/64 –	.104	.001.125	.000.117.0
13	3/32 –	.092	.000.778.7	.000.071.64
14	5/64 –	.080	.000.512.0	.000.040.96
15	5/64 –	.072	.000.373.2	.000.026.87
16	1/16 –	.064	.000.262.1	.000.016.78
17	1/16 –	.056	.000.175.6	.000.009.834
18	3/64 –	.048	.000.110.6	.000.005.308
19	3/64 –	.040	.000.064.00	.000.002.560
20	1/32 –	.036	.000.046.66	.000.001.679
21	1/32	.032	.000.032.77	.000.001.049
22	1/36	.028	.000.021.95	.000.000.615
23	1/42	.024	.000.013.82	.000.000.332
24	1/45	.022	.000.010.65	.000.000.234
25	1/50	.020	.000.008.000	.000.000.160

Mechanics

THE DESIGN OF COIL SPRINGS, W. Ferrier Brown

In these notes it is the intention to simplify and accelerate the calculation of coiled springs as far as is practicable by embodying constants, which are supplied in tabular form.

The formulæ given in the various engineering pocketbooks for coil springs are practically alike, and differ mainly in the arrangement of the formulæ. The selection for these notes is that given in Lineham's Mechanical Engineering, as this has been proved to give accurate results.

The symbols used in this formula are:

D = diameter of wire in inches
Δ = total deflection in inches
W = total load in lb.
w = load per inch deflection in lb.
n = number of free coils
d = diameter of coil pitch circle in inches
c = 12,000,000 lb. for steel.

For round wire:

$$\Delta = \frac{8Wnd^3}{cD^4} \quad \text{.......... [1]}$$

$$\text{and } w = \frac{cD^4}{8nd^3} \quad \text{.......... [2]}$$

For square wire:

$$\Delta = \frac{60.5\,Wnd^3}{8cD^4} \quad \text{.......... [3]}$$

$$\text{and } w = \frac{8cD^4}{60.5\,nd^3} \quad \text{.......... [4]}$$

Equations [2] and [4] form the basis, and from these the total deflection can easily be calculated thus:

$$\Delta = \frac{W}{w} \quad \text{.......... [5]}$$

In addition to deflection, it is necessary to know the gage or diameter of wire of which to make the spring to take a certain load.

In Adams's Engineers' Handbook, the following formulæ are given:

Safe load (W) for springs, such as valve springs

$$= \frac{1,750\,D^3}{d} \quad \text{.......... [6]}$$

This can be transposed to read:

$$D = \sqrt[3]{\frac{11,750}{Wd}} \text{ for round section.. [7]}$$

For square section wire use the relation

$$D = \sqrt{\frac{Wd}{15,000}} \ldots\ldots [8]$$

[illegible] for springs that can be worked almost to the elastic limit

$$\frac{5,400\,D^4}{[illegible]} \ldots\ldots [9]$$

$$\text{or } D = \sqrt{\frac{Wd}{27,400}} \text{ for round wire.. } [10]$$

$$\text{and } D = \sqrt{\frac{Wd}{30,000}} \text{ for square wire. } [11]$$

On examination of Equations [2] and [4] it will be seen that the term cD^4 is a constant factor, and has the values $cD^4/8$ in Equation [2] and $8cD^4/60.5$ in Equation [4].

Let the constants be represented by k. Equations [2] and [4] will then read:

$$w = \frac{k}{nd^3} \ldots\ldots\ldots\ldots\ldots\ldots [12]$$

The value of k will be selected from the column for round or square wire, as the case may be, in Table 6.

In this table values of k for round and square wire have been calculated over a range of from 7/0 S.W.G. to 25 S.W.G. This range covers the average run of automobile work. Special cases can always be calculated from the equations in their original form, i.e., Equations [2] and [4].

Table 7 gives the cubes and the fourth powers of the various gages. These are used in conjunction with Equations [2], [4], [6] and [9].

(*The Automobile Engineer*, vol. 7, no. 107, October, 1917, p. 286)

Refrigeration

Corrosion of Brine Pipe, F. N. Speller

A report of a recent experience with corrosion of brine coils in an ice skating rink in Pittsburgh, Pa.

The pipe used was $1\frac{1}{4}$-in. double-length butt-welded standard-type steel pipe. It was found that after a comparatively short period of service the pipe was badly pitted.

The pipe was first used in the rink, but during the following summer was stored on a river barge. An analysis of the rust and scale from the inside of this pipe indicated in some cases a considerable amount of calcium chloride.

It appears that the pitting may have been due to two causes. First, heavy mill scale which is incidental to the practice of making butt-welded pipe; but while the cinder is present in all pipe and is an accelerator of corrosion on account of its electronegative character compared with iron, corrosion can only occur when moisture and oxygen are present together. Here is where the presence of calcium chloride in the scale comes in. Pure calcium chloride with pure water is not very corrosive, especially at low temperatures out of contact with the air, but when present even in small quantities on the inside of a moist pipe it will retain this moisture on account of its hygroscopic character. It appears therefore that the pipe was subjected to a combination of elements, such as mill scale, calcium chloride, moisture, oxygen and temperature above normal during the summer months, all of which tend to accelerate corrosion.

From data given in the article it appears that the fact that the pipe was steel had comparatively little to do with the result, which was due to improper conditions of storage of the pipe. (*A. S. R. E. Journal*, vol. 4, no. 2, September, 1917, pp. 220-224, 1 fig., *p*)

Railroad Engineering

Santa Fe Type Locomotives for the Union Pacific System

Description of locomotives now being built by The Baldwin Locomotive Company for the Union Pacific System. The locomotives are of a heavy and powerful design, so arranged that either coal or oil can be used.

An interesting feature is the trailing truck (Delta), built with a massive steel casting, which serves the triple purpose of a frame, radius bar and equalizer. The truck is equalized with the two rear pairs of drivers. The equalization is through a central, vertical heart-shaped link, which is suspended from a transverse beam hung from the rear driving springs. This link acts not only as the equalizer connection, but also as the rear-truck radius-bar pin. It is circular in section at its lower end, and is guided in the frame cradle casting. The bearing between the equalizer frame of the truck and the locomotive frame is made with a spherical surface to provide sufficient flexibility. (*Railway Review*, vol. 61, no. 18, Nov. 3, 1917, pp. 541-542, 2 figs., *d*)

Automatic Straight Air-Brake System

Description of a new air-brake system recently announced by the Automatic Straight Air-Brake Company for freight and passenger equipment.

This brake system provides a quick-action passenger brake, one brake cylinder being used for a service application and two brake cylinders for an emergency application of the brake. As the triple valve is capable for compensating for varying volumes in brake cylinders, a two-brake cylinder can be added to existing freight equipment for empty and load braking.

Due to its construction and operation this brake has the characteristics of a straight air brake, and, at the same time, is automatically operated. The straight air features are obtained through the fact that with every application of the brakes air is exhausted from the brake pipe under each car.

Design of the triple valve is such that, when fully charged, the pressure in the brake pipe, acting on the underside of the diaphragm, balances the pressure in the auxiliary reservoir acting on the upper side. The reduction in brake-pipe pressure causes the auxiliary-reservoir pressure to force the diaphragm downwards, admitting air to the brake cylinder from the brake pipe and service reservoir. The air in the brake cylinder acts on a second diaphragm which is connected to the first and which is of half its area. The pressure in the auxiliary reservoir remains unbalanced, forcing the diaphragm down until the force exerted by the brake-pipe pressure on the underside of this diaphragm, plus force exerted by the air in the brake cylinder on its diaphragm exceeds it. The diaphragm will then be raised and the supply of air to the brake cylinder cut off.

Hence, the brake-cylinder pressure bears a direct relation to the brake-pipe reduction and is not affected by the brake-piston travel or brake-cylinder leakage. By regulating the brake-pipe pressure any brake-cylinder pressure may be obtained. Besides, each triple valve is provided with means for making a graduated or quick release.

One of the features of this brake is that service applications can be varied at the will of the engineman by his regulation

of the brake-pipe pressure without the necessity of releasing the brakes before a reapplication when operating with the graduated release.

The article describes in detail the operation of the brake, and gives data of exhibition tests made by the company on a 100-car test rack. (*Railway Age Gazette*, vol. 63, no. 16, October 19, 1917, pp. 697-700, 4 figs., *d*)

Thermodynamics

Performance and Design of Surface Feedwater Heaters, M. C. Stuart, Mem.Am.Soc.M.E.

The writer develops his theory of heat transmission from the fundamental law that heat transmission is proportional to temperature difference.

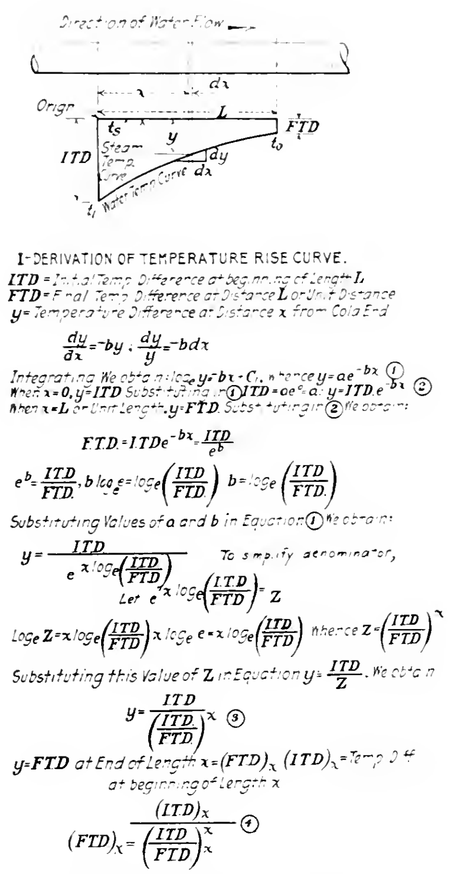


Fig. 12 Derivation of Curve of Temperature Rise

This assumption in the case of a tube with steam on one side and water on the other side of the metal wall may be expressed by the differential equation $dy/dx = -by$, which after integration, reduces to the equation of the temperature-rise curve (1), Fig. 12. After determination of the values of the constants a and b, in terms of temperature, this equation is reduced to the simple forms (3) and (4), Fig. 12.

From this the writer proceeds to the determination of, first, the mean temperature difference between water and steam, and then of heat-transfer rate from steam to water, Fig. 13, the mean temperature difference being defined as the average distance between the curves of steam temperature and water temperature.

Experimentally, the validity of the theoretical relations between temperatures and tube lengths may be best demonstrated on multi-pass feedwater heaters, in which temperature readings are obtained at the end of each pass because such tests give simultaneous data for performance of identical sections of a heater with identical conditions of steam pressure and water flow.

A recent test of a four-pass heater, made at the U. S. Naval Engineering Experiment Station, Annapolis, Md., gave the following data for a run in which the water velocity was 5.14 ft. per sec. and the steam temperature was 227.2 deg. fahr.

	Water Temperatures, Deg. Fahr. Inlet	Outlet
First pass	85.6	133.4
Second pass	133.4	165.8
Third pass	165.8	186.7
Fourth pass	186.7	201.3

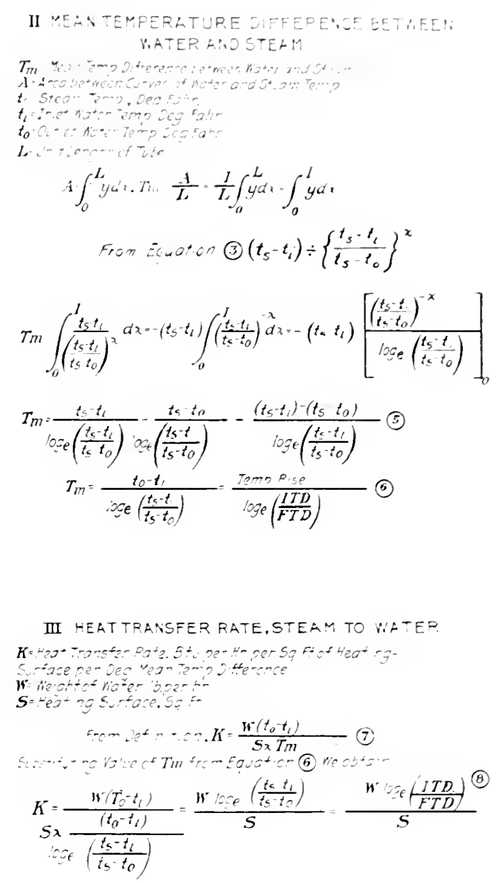


Fig. 13 Derivation of Curve of Mean Temperature Difference and Heat-Transfer Coefficient

These temperatures are plotted in Fig. 14 in what may be called a temperature diagram. The abscissæ are the inlet temperatures of the several passes and the ordinates are the corresponding outlet temperatures. A base line is drawn diagonally across the diagram through points of equal temperature, and the line of inlet temperature vs. outlet temperature, which is drawn through the plotted points, is extended to meet the base line at a point corresponding to the steam temperature, this line intersecting the base line at the steam temperature, because if water enters any pass at the temperature of the steam there will, of course, be no temperature rise and the temperatures of inlet water, outlet water, and steam will be equal.

In a multi-pass heater the outlet temperature of one pass becomes the inlet temperature of the next pass, as shown graphically by the "stairway" formed between the tempera-

... in one line, both indicated in the figure ... the relation between the temperature diagram and the theory, as previously developed, the following is ... If the temperature line of the diagram is straight and ... the base line at the steam temperature, it is evident that the ratio of initial temperature difference to final temperature difference is constant. From formula [8] for the ... heat transfer coefficients, it is seen that the constant value of W and S, as existing in the several passes of the ... pass heater K, will be constant if the ratio (I. T. D.) to (F. T. D.) is constant. Inasmuch as the temperature diagram satisfies this condition, this confirms the theory that the

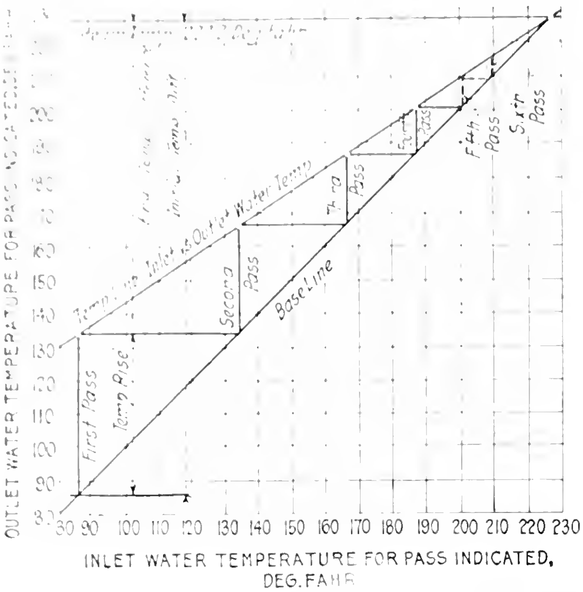


FIG. 14 TEMPERATURE DIAGRAM FOR FOUR-PASS FEEDWATER HEATER BY SEPARATE PASSES

heat-transfer coefficient is independent of temperature and depends only on the ratio of initial to final temperature difference.

To extend the method to another field, there is shown in Fig. 15 a temperature diagram plotted from the classic test of Mr. G. A. Orrok, Mem.Am.Soc.M.E., on The Transmission of Heat in Surface Condensation, published in the Transactions of the American Society of Mechanical Engineers, 1910, p. 1139. The test was made upon a single condenser tube through which water flowed, and which was surrounded by steam. The line DF was plotted from runs in which the steam temperatures were constant at 115 deg., and the inlet-water temperatures varied from 53 to 110 deg. fahr. The line BC was plotted from runs in which the water temperatures were constant at 50 deg. and the steam temperatures were varied from 115 to 187 deg. fahr. Space will not be taken here to analyze these results, but it may be stated that the temperature line BC is straight and the line DF is nearly straight, and that from the formula for heat-transfer factor $K = \frac{W}{S} \log_e \frac{\text{I. T. D.}}{\text{F. T. D.}}$ it is seen that a straight line on the temperature diagram corresponds to a constant value of K. The exact value of K along the temperature line may be determined from the ratio of $\frac{\text{I. T. D.}}{\text{F. T. D.}}$ as found from the temperature diagram, and the values of W and S. The effect of tube length on water temperature may be shown by forming a stairway between the temperature line and the base line.

The analytical relation between tube length and temperature rise along the tube was derived in Fig. 12 and is represented by formula [4]. In the present paper the writer gives three graphical methods of showing the relation between tube length and water temperature.

A logarithmic plot of heat-transfer factors and friction drop is given in the original article where the values of heat-transfer coefficients are plotted against water velocity on logarithmic coördinates. The relation between K and the velocity in feet per second may be expressed by the equation $K = 339\ V^{0.61}$, which form agrees with the results found by Orrok and others. The value of K may be composed from the value of the ratio $\frac{\text{I. T. D.}}{\text{F. T. D.}}$ as given by the temperature diagram and a temperature diagram for any velocity may be drawn by solving for the value of $\frac{\text{I. T. D.}}{\text{F. T. D.}}$ from the value of K for that velocity.

On the whole, the writer comes to the final conclusion that the design of a feedwater heater or other form of heat-transfer apparatus consists of determining the proper balance among the factors: tube length, number of tubes, velocity, total sur-

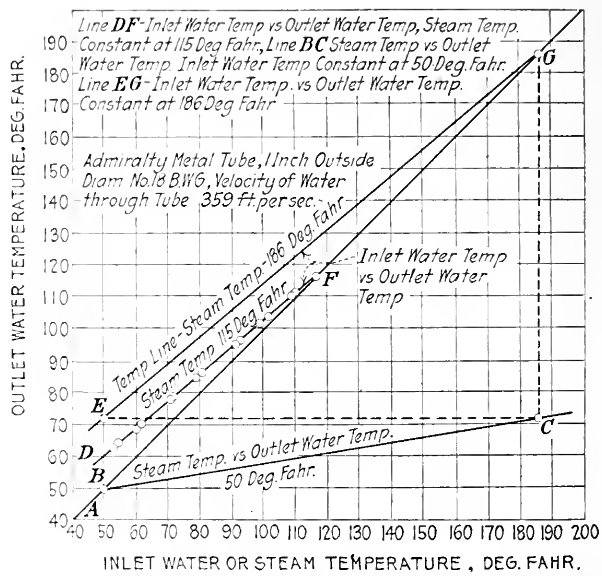


FIG. 15 TEMPERATURE DIAGRAM FROM TESTS OF CONDENSER TUBE BY GEO. A. ORROK

face, friction drop and temperature rise. An analytical method of design for feedwater heaters is likewise indicated. This method essentially is based upon the relation between heat-transfer coefficients and velocity. $K = aV^n \ldots$ [1], and the relation between friction loss and velocity $H = bLV^m \ldots$ [3]. By combining these two empirical equations with the theoretical equation for heat-transfer coëfficient, equation [2], there finally results equation

$$V^{1-n+m} = \frac{aC_2H}{bc_1 \log_e\left(\frac{t_s - t_1}{t_s - t_o}\right)}$$

(*Journal of the American Society of Naval Engineers*, vol. 29, no. 3, August 1917, pp. 503-524, 16 figs., *tA*)

Photostatic copies of any of the articles abstracted in the Survey may be obtained through the Library Service Bureau.

SELECTED TITLES OF ENGINEERING ARTICLES

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Le Mal des Aviateurs et la Sélection des Pilotes Militares, Dr. Leon Binet. Revue Générale des Sciences Pures et Appliquées, 28e année, no. 19, October 15, 1917, pp. 540-545, 4 figs.
Air sickness and selection of military pilots.

Whirling Table and Method of Testing Model Airscrews at N. P. L., A. Fage. Aviation and Aeronautical Engineering, vol. 3, no. 7, November 1, 1917, pp. 455-459, 8 figs.

†The Metallurgy of Cast Iron Aeroplane Engine Cylinders, F. W. Adams. Aerial Age Weekly, vol. 6, no. 7, October 29, 1917, pp. 286-287, 6 figs.

Means of Obtaining High Volumetric Efficiency for Aviation Engines. Aviation, vol. 3, no. 6, October 15, 1917, pp. 397-380, 5 figs.

Sheathing and Balancing Airplane Propellers, George B. Fuller. The Automboile and Automotive Industries, vol. 37, no. 17, October 25, 1917, pp. 703-705, 3 figs.

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The Frontenac Racing Car. The Automobile Engineer, vol. 7, no. 107, October 1917, pp. 287-290, 6 figs.

Adjusting Lanchester-Packard Vibration Damper. Automotive Industries, vol. 37, no. 19, November 8, 1917, p. 823, 2 figs.

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The Textile Institute. The Engineer, vol. 124, no. 3225, October 19, 1917, pp. 331-332.

Third Exposition of Chemical Industries. The Journal of Industrial and Engineering Chemistry, vol. 9, no. 11, November 1, 1917, pp. 1005-1007.

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AMERICAN SOCIETY OF MECHANICAL ENGINEERS, THE. Condensed Catalogues of Mechanical Equipment with General Classified Directory and Engineering Data Section. *New York, 1917.*
——— Transactions. vol. 38. *New York, 1917.*

CATSKILL AQUEDUCT AND EARLIER WATER SUPPLIES OF THE CITY OF NEW YORK. *New York, 1917.* Gift of Catskill Aqueduct Celebration Committee.

MACHINERY'S SHOP RECEIPTS AND FORMULAS. Ed. 2. *New York, 1911.* Gift of Industrial Press.

MANUAL OF INSTRUCTIONS FOR TRADE CATALOG COMPILATION. By O. A. Morgner. *New York, 1917.* Gift of Wynkoop-Hallenbeck-Crawford Co.

MESOPOTAMIA. The Key to the Future. By Canon Parfit. *London, 1917.* Gift of W. M. Dixon.

SECOND PAN AMERICAN SCIENTIFIC CONGRESS. Proceedings. Washington, Dec. 27, 1915—Jan. 8, 1916. vols. 7, 10. *Washington, 1917.* Gift of Pan American Union.

TRADE CATALOGUES

BRIDGEPORT BRASS COMPANY. Bridgeport, Conn.
Bulletin no. 10. Trolley wire. Sept. 1917.

PERSONALS

In these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by December 17 in order to appear in the January issue.

CHANGES OF POSITION

SAKICHI ISHIMURA, formerly draftsman with Cornwall and Raymo, Inc., New York, has become affiliated with Nippon Deuchi and Company, of Kyoto, Japan, as engineer.

LLOYD LOGAN, formerly assistant mechanical engineer, Wescott and Mapes, Inc., New Haven, Conn., has become affiliated with the Union Sulphur Company, Sulphur Mine, La.

CHARLES J. SIMEON has accepted a position with the Curtiss Aeroplane Company, Buffalo, N. Y. He was formerly works manager of the Reed-Prentice Company, Worcester, Mass.

JOHN P. ILSLEY, formerly associated with the Niles-Bement-Pond Company, New York, has assumed the position of general manager of the Becker Milling Machine Company, Hyde Park, Mass.

HOWARD G. BENEDICT, works manager of the Aeromarine Plane and Motor Company, Keyport, N. J., has become affiliated with The Glenn L. Martin Company, Cleveland, Ohio, in a similar capacity.

WILLIAM S. LUCEY has become affiliated with the Hammermill Paper Company, Erie, Pa. He was until recently connected with the Eastman Kodak Company, Rochester, N. Y., in the capacity of mechanical engineer.

CHARLES F. MACGILL, formerly efficiency engineer with the Remington Arms and Ammunition Company, Bridgeport, Conn., has joined the engineering department of the Bullock Engineering Works, Inc., Bridgeport, Conn.

GEORGE F. NORDENHOLT, until recently chief inspector of the Harrisburg Pipe and Pipe Bending Company, Harrisburg, Pa., has assumed the duties of inspector of the Budd Manufacturing Company, Philadelphia, Pa.

H. P. AHRNKE, until recently western representative of the Dairy Machinery and Construction Company, Inc., Chicago, Ill., has become identified with the Davis-Watkins Dairymen's Manufacturing Company, Chicago, Ill.

E. L. C. CLARK, until recently connected with the New England Westinghouse Company, Springfield, Mass., has accepted the position of works manager of the Tractor Branch of the Moline Plow Company, Rock Island, Ill.

ANTHONY KENNEDY, formerly vice-president and general manager of the L. H. Miller Safe and Iron Works, Baltimore, Md., has assumed the duties of vice-president of The Hollar Company, bank vault engineers of Philadelphia, Pa.

ASA J. NEFF has terminated his relations with the American Public Service Company, Abilene, Tex., as efficiency engineer, to accept a similar position with the General Engineering and Management Corporation, of New York.

ROY S. KING has accepted the position of professor of experimental engineering at the Georgia School of Technology, Atlanta, Ga. He was formerly assistant professor of mechanical engineering at the University of Arizona, Tucson, Ariz.

LESTER G. CATTERMOLE, formerly in the employ of the Hannahs Manufacturing Company, Kenosha, Wis., has become connected with the Cooley and Martin Company, Chicago, Ill., in the capacity of efficiency engineer, specializing on woodworking.

CADWALLADER EVANS, JR., is no longer connected with The Delaware and Hudson Company, Scranton, Pa., as general superintendent of the coal department, but is connected with the International Salt Company, with headquarters at Retsoff, N. Y.

GEORGE S. BLANKENHORN has become associated with the American International Shipbuilding Corporation, Philadelphia, Pa., as assistant to the manager of machinery fabrication. He was formerly connected with the consulting engineering department of the Allis-Chalmers Manufacturing Company, West Allis, Wis.

FREDERICK W. LUCHT, JR., formerly on the engineering staff of The Denver Engineering Works Company, Denver, Colo., has become affiliated with the tool design department of the Packard Motor Car Company, of Detroit, Mich., in connection with Government work on the Liberty motor.

H. P. MEREDITH, formerly master mechanic of the Pennsylvania Railroad at Baltimore, Md., Sunbury, Pa., and Wilmington, Del., respectively, has become affiliated with the E. I. DuPont de Nemours and Company, of Wilmington, Del., as engineer in charge of mechanical maintenance, shop methods and efficiency.

HUBERT C. VERHEY has resigned his position as chief designing engineer for the marine Diesel engine department of the Busch-Sulzer Brothers Diesel Engine Company, of St. Louis, Mo., last April, in order to enter the consulting engineering field on Diesel engines, and has now entered the service of the Government in the capacity of chief draftsman of the Emergency Fleet Corporation, Washington, D. C., where he is slated eventually to take charge of Diesel-engine work.

ANNOUNCEMENTS

RUDOLPH H. FOX has accepted a commission of First Lieutenant in the Ordnance Officers' Reserve Corps.

HAROLD K. BEACH has joined the staff of the Cleveland Brass and Copper Company, as mechanical superintendent.

HERBERT H. KESSLER has received a commission as First Lieutenant, Ordnance Section of the Officers' Reserve Corps.

ERNEST R. KENNER has become associated with the Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa.

WILLIAM E. DOLL has been awarded a commission in the United States Army, 35th Engineers, reporting to Camp Grant, Rockford, Ill.

J. E. MACARTHUR, formerly superintendent at the Toronto, Ont., Canada plant of the Russell Motor Car Company, is now located at the Buffalo, N. Y., office of the same company.

GEORGE E. MERRYWEATHER, president of the Motch and Merryweather Machinery Company, Cleveland, O., has been named to take charge of the machine tool section of the War Industries Board.

WINTHROP G. HALL, superintendent of the Spencer Wire Company, Worcester, Mass., has been granted a 10-weeks leave of absence to enter Y. M. C. A. work at Camp Devens, Ayer, Mass.

HENRY C. ARMSTRONG, formerly metallurgical expert, United States Navy, has received a commission in the Ordnance Department of the Army as Captain in the Reserve Corps, and will be ordered to duty shortly.

W. C. BRIGGS, for the past ten years associated with W. A. Battey of the New York office of the Shepard Electric Crane and Hoist Company, in the capacity of sales engineer, has been made district manager of the company.

JOHN HUNTER, chief engineer for the Union Electric Light and Power Company, St. Louis, Mo., has been appointed by the U. S. Government to aid in directing the construction of the American marine fleet, with special charge of shipbuilding operations on the Passaic River in New Jersey.

R. K. HOLLAND, GEORGE E. ACKERMAN and H. K. HOLLAND, formerly associated with Gardner S. Williams, consulting engineer of Ann Arbor, Mich., have opened offices at Ann Arbor, Mich., and Chicago, Ill., under the firm name of Holland, Ackerman and Holland, consulting engineers.

WALTER C. ALLEN, president of the Yale and Towne Manufacturing Company, was granted leave of absence to enable him to respond to the call of the United States Government for service in France. Mr. Allen expects to be commissioned as a Major in the Signal Corps, and to leave soon for France, to take up the duties assigned to him.

F. W. HARDING, consulting engineer of the Canadian Consolidated Rubber Company of Montreal, Que., Canada, has in addition to his other duties taken direct charge of the Rubber Machinery Shops as manager. The Rubber Machinery Shops are owned by the Canadian Consolidated Rubber Company.

HARRY L. HORNING, vice-president and general manager of the Waukesha Motor Company, Waukesha, Wis., and chairman of the motor products section of the War Industries Board, was the guest of honor at the weekly luncheon of the City Club of Milwaukee, on November 3, and discussed the remarkable achievement of American automotive engineers in producing the new military truck in record-breaking time.

THE NEW BOOKS

ALL books received by The Journal will be listed under this heading, generally accompanied by brief descriptive notes. Works of special importance to mechanical engineers will be commented on at length by members and others peculiarly qualified by reason of their experience and training.

Unified Accounting Methods for Industrials. By Clinton E. Woods. [illegible] Cost Accounting, Etc. The [illegible] New York, [illegible] Cloth [illegible] in. 184 pp., [illegible]

The book opens with a review of the functions and duties of the new profession of industrial engineering, together with a clear statement of the general principles involved and the things to be accomplished.

The author states that the profession of industrial engineering has not as yet received the recognition required to clothe it with the dignity of a collegiate degree, as in other branches of engineering. This, I believe, is fortunate, for rather than extend the subdivisions of the only two logical divisions of engineering, namely, civil and military, the colleges would do well to abolish some of the divisions now recognized by collegiate degrees.

Attention is called to the great number of manufacturing concerns which are doing such a variety of work that they do not know where they stand. Their cost systems do not show on which articles they are really making or losing money —their only idea of distributing operating expense being by a lump sum prorated over the entire product.

The author advocates the departmental distribution of expense, and one would gather from his book that he would undoubtedly extend this to the more accurate method of distributing departmentally on the machine-hour basis.

The results obtained from standardization of equipment and labor methods are well covered, as are all the broader applications of industrial engineering.

The chapter on Analyzing an Industrial Manager's Monthly Balance Sheet will be of interest to all managers who are desirous of getting at the real facts regarding the businesses they manage. The forms shown illustrate the method used, and, of course, can be varied to suit any business. This fact should always be remembered in criticising forms. Forms are simply the tools used to collect information or to perform certain functions. No matter how excellent forms and blanks may be, they of themselves will not run a business.

The subject of General Stores is carefully described, and in this connection it is stated that "No departments in any manufacturing business contribute more to its health or wealth than do the departments of storekeeping." This is most true, for if a manufacturing concern has not absolute control of its stores it cannot do much along the line of industrial engineering. A visit through the factories of this country will show any experienced engineer how little this fact is recognized even at this late date, futile attempts at planning and at time and motion study being made by many people without even a thought to the matter of stores and the control of materials.

The author holds that the Stores Department should come under the Purchasing Department. This, I believe, is wrong from an organization point of view.

He also advises that "The price to be used for any costing or inventory purposes should always be that of the last purchase from any regular source of supply." This is entirely unnecessary if stores records are kept on a unit plan and each delivery of a particular material is kept separate, as is done by many up-to-date factories. Costing and inventorying can then be made on a basis of what was paid for material, not at the last cost.

While the methods of storekeeping described are well thought out, I believe that they are more complicated than there is need for, and they do not represent the latest thought on the subject. The chapters on Handling of Production Schedules are subject to this same criticism of complexity.

In Chapter X is noticed the expression "non-productive labor," which is the bugaboo of so many manufacturers. I think that all industrial engineers should refrain from using the expressions "productive" and "non-productive" labor, which are borrowed from the economist and have no place in modern manufacturing business. Much better is it if we substitute the more accurate terms "direct" and "indirect" labor. In a well-run concern there will be no non-productive labor, but there may be indirect labor. It should, I believe, be one of the duties of engineers to banish this misleading expression "non-productive labor."

Under Employment and Handling of Labor, the author advocates the paying of employees four times a month instead of once a week. The reason for this is that it saves the making out of one entire payroll per month, and the splitting of another, which is required by the weekly method. This method will undoubtedly save a little clerical expense but will probably not be acceptable to the employees. Workmen figure by the week, their rent, etc., being as a rule due at such periods, and they like to know definitely the day on which they are to be paid. To be paid on Monday one week and Tuesday the next, would, I believe, be an excellent method of starting labor difficulties. If the time cards are on a unit scheme and the payroll summed daily, the weekly pay and monthly total are easily secured with little clerical work.

It is unfortunate for business in general, and the manufacturer in particular, that our year is not made up of thirteen months of four weeks each, as this would have numerous advantages for purposes of comparison. Perhaps as the world advances we may yet come to this.

In Chapter XII the matter of organization is dealt with, as well as distribution of labor, material and expense. These are about the most important matters that the industrial engineer has to consider, and might easily take up a book in themselves. The methods illustrated are interesting and instructive.

The remainder of the book is devoted to accounting methods and principles, which are well handled.

While many of the details might not be agreed to by all industrial engineers, the work nevertheless presents a clear outline of the matter and forms a valuable addition to the literature of the subject. It would be well for many manufacturers who have been troubled during the past few years by the fact that they were not showing the profits they should, or were even encountering considerable losses due to antiquated methods of running their plants, to "read, mark and inwardly digest" Mr. Woods's latest publication.

George M. Forrest.